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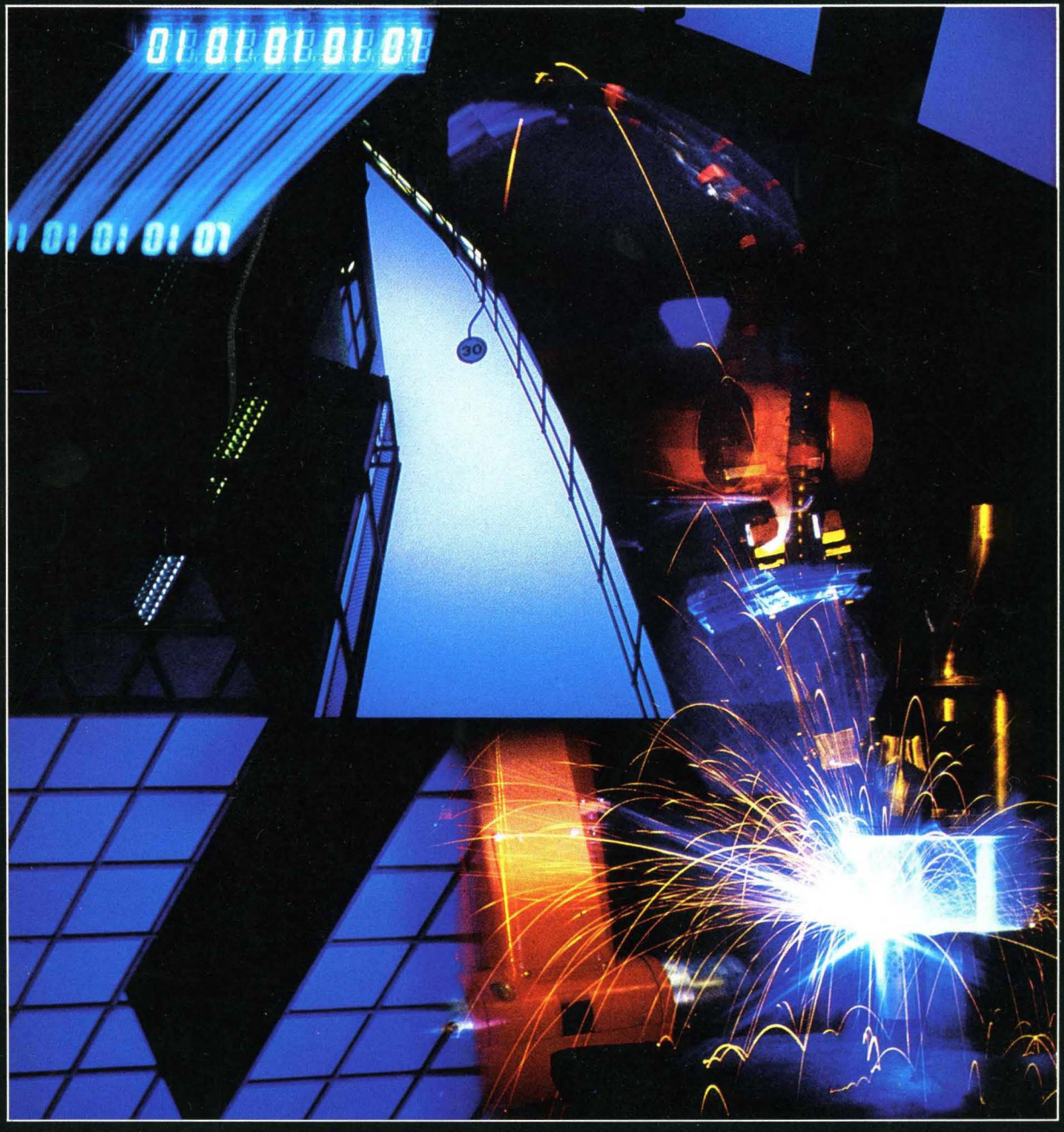
OEM Boards and Systems Handbook



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When Intel invented the microprocessor in 1971, it created the era of microcomputers. Whether used as microcontrollers in automobiles or microwave ovens, or as personal computers or supercomputers, Intel's microcomputers have always offered leading-edge technology. In the second half of the 1980s, Intel architectures have held at least a 75% market share of microprocessors at 16 bits and above. Intel continues to strive for the highest standards in memory, microcomputer components, modules, and systems to give its customers the best possible competitive advantages.

OEM BOARDS AND SYSTEMS HANDBOOK

1988

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Table of Contents

Table of Contents (Continued)

Table of Contents (Continued)

Table of Contents (Continued)

Table of Contents (Continued)

Alphanumeric Index

Alphanumeric Index (Continued)

Alphanumeric Index (Continued)

CUSTOMER SUPPORT

CUSTOMER SUPPORT

Customer Support is Intel's complete support service that provides Intel customers with hardware support, software support, customer training, and consulting services. For more information contact your local sales offices.

After a customer purchases any system hardware or software product, service and support become major factors in determining whether that product will continue to meet a customer's expectations. Such support requires an international support organization and a breadth of programs to meet a variety of customer needs. As you might expect, Intel's customer support is quite extensive. It includes factory repair services and worldwide field service offices providing hardware repair services, software support services, customer training classes, and consulting services.

HARDWARE SUPPORT SERVICES

Intel is committed to providing an international service support package through a wide variety of service offerings available from Intel Hardware Support.

SOFTWARE SUPPORT SERVICES

Intel's software support consists of two levels of contracts. Standard support includes TIPS (Technical Information Phone Service), updates and subscription service (product-specific troubleshooting guides and COMMENTS Magazine). Basic support includes updates and the subscription service. Contracts are sold in environments which represent product groupings (i.e., iRMX environment).

CONSULTING SERVICES

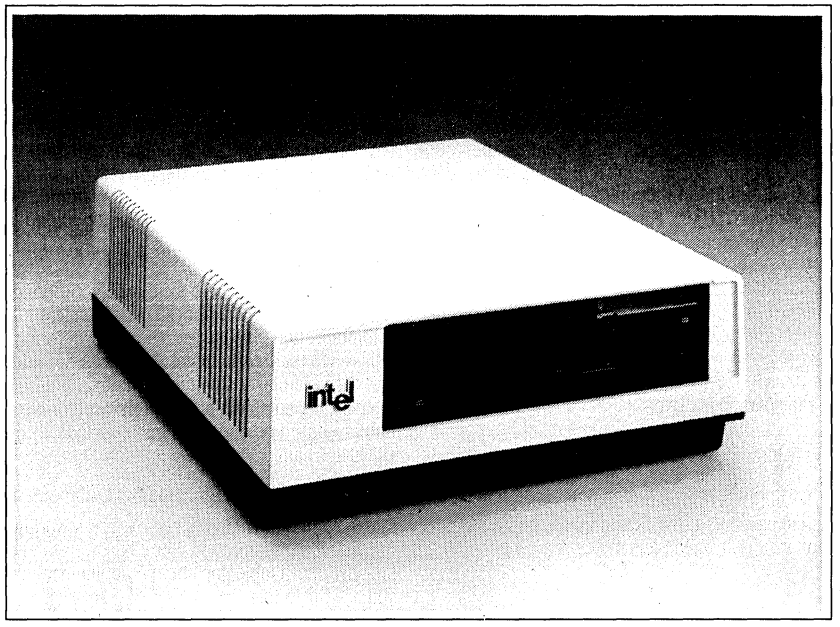
Intel provides field systems engineering services for any phase of your development or support effort. You can use our systems engineers in a variety of ways ranging from assistance in using a new product, developing an application, personalizing training, and customizing or tailoring an Intel product to providing technical and management consulting. Systems Engineers are well versed in technical areas such as microcommunications, real-time applications, embedded microcontrollers, and network services. You know your application needs; we know our products. Working together we can help you get a successful product to market in the least possible time.

CUSTOMER TRAINING

Intel offers a wide range of instructional programs covering various aspects of system design and implementation. In just three to ten days a limited number of individuals learn more in a single workshop than in weeks of self-study. For optimum convenience, workshops are scheduled regularly at Training Centers worldwide or we can take our workshops to you for on-site instruction. Covering a wide variety of topics, Intel's major course categories include: architecture and assembly language, programming and operating systems, bitbus and LAN applications.

Integrated Microcomputer Systems

1



SYSTEM 310 AP

The System 310 AP is faster than many minicomputers. Powerful dedicated processors for communications and mass storage input/output control allow the 8 MHz 80286 CPU to concentrate on application software. The System 310 AP is open, which means you can upgrade performance and/or functionality in the future without purchasing a new system. The open system design protects your investment from becoming obsolete. Open systems design also means easy system customization with Intel and third-party add-in Multibus boards.

FEATURES

- 80286 Based System
- Open System MULTIBUS® architecture for upgradeability and growth
- XENIX* Operating System
- iRMX® Operating System
- OpenNET™ Local Area Networking
- Total hardware and software support from Intel's worldwide customer support organization

September, 1987
Order Number: 270129-004

SYSTEM 310 AP—AN OPEN SYSTEM

The Intel System 310 AP is based on the MULTIBUS architecture, (IEEE 796) industry standard system bus supported by over 200 vendors providing over 2000 compatible products.

The System 310 AP is an 80286 based open system designed with expansion in mind. The system can be expanded to accommodate up to 9MB of parity-checked RAM, all accessible with no wait states across MULTIBUS's Local Bus Extension (LBX™). For terminal communications, the systems can be expanded to a total of 18 RS232 serial ports.

The System 310 AP supports 20MB-140MB of Winchester disk storage. Mass storage can be expanded to 560MB using the 311 Peripheral Subsystem. The 310 AP also supports a 320KB 5¼" floppy drive and a 60MB streaming tape cartridge drive.

XENIX OPERATING SYSTEM

Intel XENIX is the highest performance Xenix available. XENIX, UNIX and DOS applications can be ported quickly and all system elements are user configurable. Over 200 utilities support a rich Open System environment.

iRMX® OPERATING SYSTEM

The iRMX operating system delivers real-time performance. Designed to manage and extend the resources of the System 310 AP, this multitasking operating system provides configurable resources ranging from interrupt management and standard device drivers to data file maintenance commands for human interface and program development. A wide range of popular industry standard high-level languages are supported for application development. The iRMX facilities also include powerful utilities for easy, interactive configuration and debugging.

OpenNET™—STANDARD IN NETWORKING

Intel supports and drives local area networking standards and technology for microsystems and micro-communications industries. The OpenNET Product family adheres to the International Standards Organization (ISO) and the seven layer Open Systems Interconnect (OSI) model. Only complete products that conform to this model and are based on open and public standards carry the OpenNET name.

INTEL SERVICE AND SUPPORT

The System 310 AP is backed by Intel's worldwide service and support organization. Total hardware and software support is available, including a hotline number for when you need help fast.

SPECIFICATIONS

SYSTEM/MODELS	310 AP-17	310 AP-44	310 AP-41	310 AP-42	310 AP-88	310 AP-82	310 AP-141	310 AP-142	310 AP-143	310 AP-145	310 AP-146
Microprocessor	80286 8 MHz	80286 8 MHz	80286 8 MHz	80286 8 MHz	80286 8 MHz	80286 8 MHz	80286 8 MHz	80286 8 MHz	80286 8 MHz	80286 8 MHz	80286 8 MHz
Numeric Coprocessor	80287	80287	80287	80287	80287	80287	80287	80287	80287	80287	80287
RAM Memory	1MB	1MB	1MB	1MB	2MB	2MB	1MB	2MB	2MB	2MB	2MB
Floppy	360KB	360KB	360KB	360KB	360KB	360KB	360KB	360KB	360KB	360KB	360KB
Mass Storage	20MB	40MB	40MB	40MB	80MB	85MB	140MB	140MB	140MB	140MB	140MB
Tape Backup	NA	NA	NA	60MB	60MB	60MB	60MB	60MB	60MB	60MB	60MB
Serial I/O Ports	2	6	10	10	10	14	2	10	14	10	18
Parallel Ports	1	1	1	1	1	1	1	1	1	1	1
OpenNET							Yes			Yes	

ENVIRONMENT

Operating Temperature	10°C to 35°C
Wet Bulb Temperature	26°C maximum
Relative Humidity	20% to 70% noncondensing
Altitude	Sea level to 8,000 feet

REGULATIONS

Meets or exceeds the following requirements:

Safety	
US	UL114
Canada	CSA C22.2
EMI/RFI	
US and Canada	FCC Docket 20780—Class A

ELECTRICAL

DC Power Output	360 watt maximum
AC Power Input	88-132 VAC or 180-264 VAC, 47-63 Hz (user selectable)

DIMENSIONS

Height	6½"
Width	17"
Depth	22"
Weight	Approx. 55 lbs

ORDERING INFORMATION

For more information or the number of your nearest sales office call 800-548-4725 (good in the U.S. and Canada).

UNITED STATES, Intel Corporation
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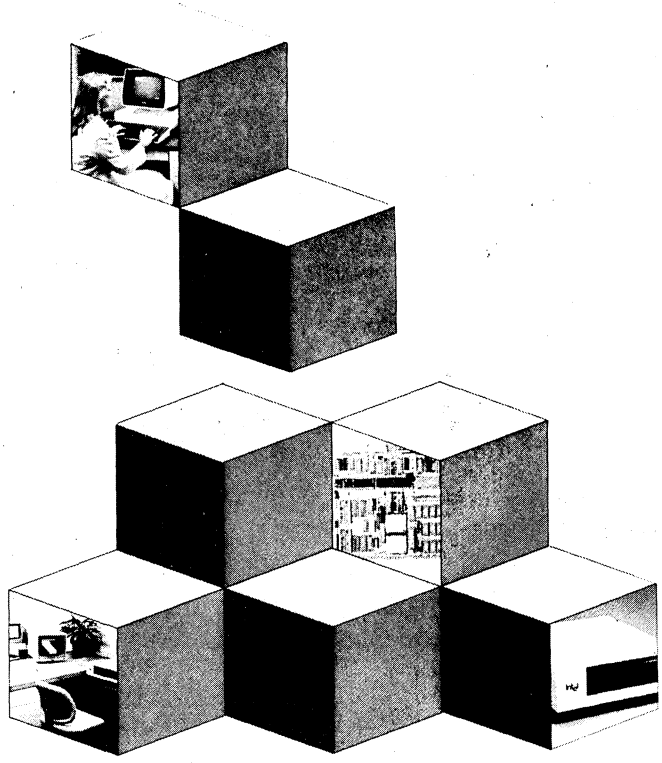

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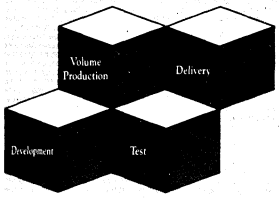
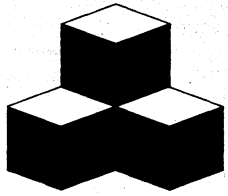


Intel Factory Resource



Custom Systems Integration will assign an engineering/manufacturing team to develop and deliver your custom product.

We listen and respond to your unique specification requirements, from special environmentals to other MULTIBUS® compatible peripherals and boards.

Intel Custom Systems Integration Affords Unique Added Value...

Custom systems are manufactured under the same rigorous manufacturing process and quality standards as Intel's widely acclaimed standard MULTIBUS systems and board products.

Intel's volume manufacturing facilities mean product is available when you need it.

Service support programs are tailorable to your unique requirements through Intel's Customer Support Operation.

1: Discovery, configuration and quote. Complete the design configurator on the following pages. Contact your Intel sales representative for assistance (non-disclosure available on request).

Mail configurator to your local Intel sales representative or send to:

Intel Corporation
Custom Systems Integration
5200 NE Elam Young Parkway
Hillsboro, Oregon 97124
Mail Stop: HF2-61
Attn: Jackie Randall
or call (503) 696-7664

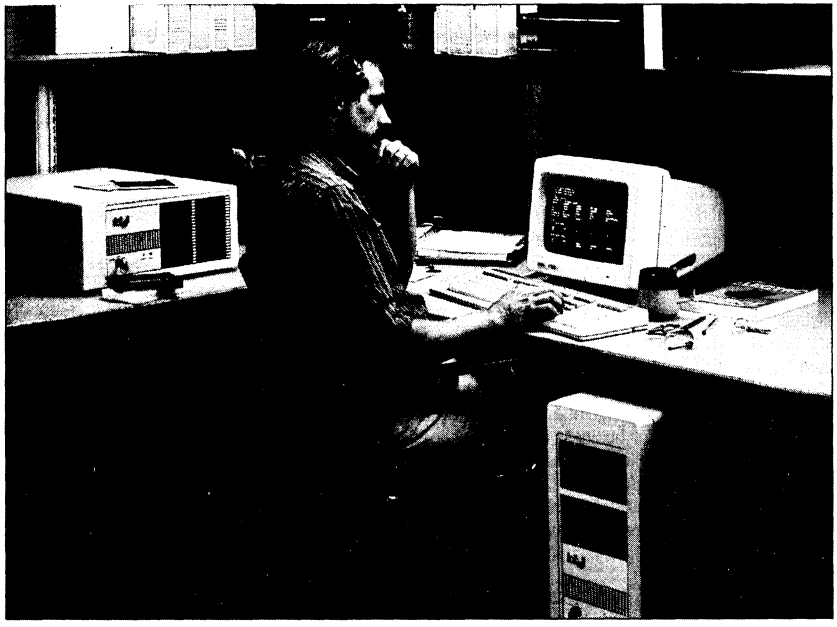
Three Easy Steps to your Custom Systems Success...

One of Intel's custom systems marketing representatives will call to review with you the configration and delivery details.

Intel will then deliver a quote specifying per unit price, non-recurring engineering costs, and delivery estimates based on volume.

2: Detailed product specification and contract. Intel will work closely with you to develop a detailed product specification for mutual signoff, define contractual terms and conditions, and contract signoff.

3: Ordering and delivery. Intel will assign a project team and set manufacturing schedules. A prototype will be made available for approval and final signing of product specification prior to volume shipments. Intel will meet with you periodically for project review.

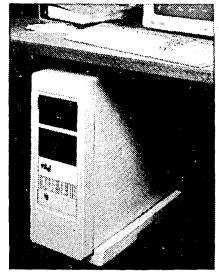


XENIX SYSTEM 320

Intel combines the power of its high performance 386-based System 320, the industry standard XENIX multiuser multi-tasking operating system, complete network service, software, and comprehensive customer support capabilities to deliver, install and maintain a complete system. The result is the XENIX System 320, giving you the performance and capabilities of a minicomputer at less than half the cost. The system is especially suited for office applications requiring multiple users and networking of PCs and terminals.

XENIX SYSTEM 320 FEATURES

- 80386 Based System
- XENIX Operating System
- Open System Architecture
- OpenNET™ Local Area Networking
- Complete Installation, Service and Support
- Range of Configurations



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August, 1987
Order Number: 280730-001

XENIX OPERATING SYSTEM

Intel XENIX is the highest performance Xenix available. XENIX, UNIX* and DOS applications can be ported quickly and all system elements are user configurable. Over 200 utilities support a rich Open System environment.

Intel XENIX supports a wide range of system software and hardware options unsurpassed by any other XENIX implementation. A menu-driven installation utility and other installation utilities ensure that the user can build exactly what is required, interactively.

SYSTEM 320—AN OPEN SYSTEM

The XENIX System 320 is based on the MULTIBUS™ architecture, (IEEE 796) industry standard system bus supported by over 200 vendors providing over 2000 compatible products and the XENIX Operating System. Intel XENIX supports a broad range of application and system software. Programs for business data processing, scientific and engineering applications, communications, database management, word processing, graphics and many more are available from Intel and third-party suppliers. A complete set of programming languages are also available, in addition to the C compiler included with the system.

OpenNET™—THE STANDARD IN NETWORKING

Intel XENIX System 320 supports OpenNET, which adheres to the International Standards Organization (ISO) and the seven-layer Open Systems Interconnect (OSI) model. Only complete products that conform to this model and are based on open and public standards carry the OpenNET name.

OpenNET's network File Access (NFA) is compatible with Microsoft's MS*NET and IBM's PC Networks Program. System resources and the processing power of XENIX can be shared among PCs and terminal users over the network. Extensive mail facilities are supported across an OpenNET network. Intel XENIX also several all popular host communication protocols sold directly by Intel as well as by third-party suppliers.

INSTALLATION SERVICE & SUPPORT

The Intel XENIX System 320 is backed by Intel's worldwide service and support organization. Installation is available to quickly get the system up and running. Complete hardware and software support is available, including a hotline number for when the user needs help fast. Intel also provides hands-on training workshops to give the user a thorough understanding of the XENIX System 320. These workshops are conducted at Intel training centers or customer sites worldwide.

SPECIFICATIONS

ENVIRONMENT

Operating Temperature	10°C to 40°C
Wet Bulb Temperature	26°C maximum
Relative Humidity	85% at 40°C
Altitude	Sea level to 10,000 feet

REGULATIONS

Meets or exceeds the following requirements:

Safety	
US	UL 478
Canada	CSZ C22.2
Europe	IEC 435
EMI/RFI	
US and Canada	FCC Class B Computing Device
Europe	VDE Limit Class B

ELECTRICAL

DC Power Output	435 watt maximum
AC Power Input	88-132 VAC or 176-264 VAC, 47-63 Hz, single phase

DIMENSIONS

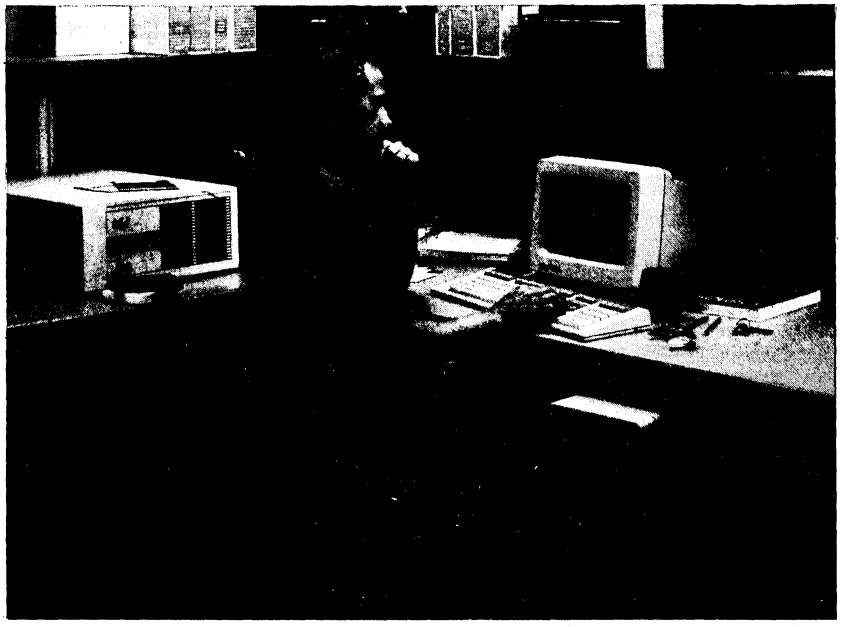
Height	8"
Width	17.5"
Depth	22.25"
Weight	Approx. 55 lbs

ORDERING INFORMATION

For more information contact your SMS account representative:

SMS Data Products Group, Inc.
1505 Planning Research Drive
McLean, VA 22012
(703) 833-8600

*UNIX is a registered trademark of AT&T.

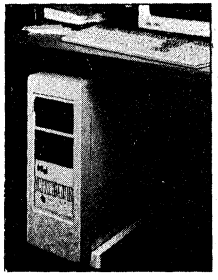


iRMX® SYSTEM 320

Intel combines the power of its high performance 386-based System 320, the widely used iRMX 286 real-time software, complete network service software and comprehensive customer support capabilities to deliver, install and maintain a complete system. The result is the iRMX System 320 gives you the performance and capabilities of a minicomputer at less than half the cost. The system is especially suited for applications requiring real-time response and resource control typically found in financial transaction, industrial automation, medical and communications markets. The iRMX System 320 is also appropriate as the development environment for module-based design.

iRMX® SYSTEM 320 FEATURES

- 80386 Based System
- iRMX Real-time Multitasking Operating System
- Open System Architecture
- OpenNET Local Area Networking
- Complete Installation, Service and Support
- Worldwide User Group Support
- Range of Configurations



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June, 1987
Order Number: 280502-001

iRMX® 286—REAL-TIME SOFTWARE

The iRMX 286 operating system delivers real-time performance. Designed to manage and extend the resources of the System 320, this multitasking operating system provides configurable resources ranging from interrupt management and standard device drivers to data file maintenance commands for human interface and program development. The iRMX 286 facilities also include powerful utilities for easy, interactive configuration and debugging.

SYSTEM 320—AN OPEN SYSTEM

The iRMX System 320 is based on MULTIBUS architecture, (IEEE 796) industry standard system bus supported by over 200 vendors providing over 2000 compatible products, and on the iRMX 286 operating system composed of modular layers, highly configurable for tailoring to target applications. A wide range of popular industry standard high-level languages are supported for application development. Special configurations can be tailored by the user, by Intel's Custom System Integration group or by Intel's authorized Value Added Distribution Centers.

OpenNET™— THE STANDARD IN NETWORKING

Intel supports and drives local area networking standards and technology for microsystems and microcommunications industries. The OpenNET product family adheres to the International Standards Organization (ISO) and the seven layer Open Systems Interconnect (OSI) model. Only complete products that conform to this model and are based on open and public standards carry the OpenNET name.

INSTALLATION SERVICE & SUPPORT

The Intel iRMX System 320 is backed by Intel's worldwide service and support organization. Installation is available to quickly get the system up and running. Total hardware and software support is available, including a hotline number for when the user needs help fast. Intel also provides hands-on training workshops to give the user a thorough understanding of the iRMX System 320. These workshops are conducted at Intel training centers or customer sites worldwide.

WORLDWIDE USER GROUP SUPPORT

iRUG (iRMX User Group), provides members a user's library of iRMX software tools and utilities, access to the group bulletin board, receipt of regularly published newsletters and invitations to User Group Conferences. iRUG numbers over 42 local chapters in 20 countries worldwide.

RANGE OF CONFIGURATIONS

Intel offers a wide range of configurations for the iRMX System 320. Contact your local Intel representative for further information.

SPECIFICATIONS

ENVIRONMENT

Operating Temperature	10°C to 40°C
Wet Bulb Temperature	26°C maximum
Relative Humidity	85% at 40°C
Altitude	Sea level to 10,000 feet

REGULATIONS

Meets or exceeds the following requirements:

Safety	
US	UL 478
Canada	CSA C22.2
Europe	IEC 435
EMI/RFI	
US and Canada	FCC Class B Computing Device
Europe	VDE Limit Class B

ELECTRICAL

DC Power Output	435 watt maximum
AC Power Input	88-132 VAC or 176-264 VAC, 47-63 Hz, single phase

DIMENSIONS

Height	8"
Width	17.5"
Depth	22.25"
Weight	Approx. 55 lbs

ORDERING INFORMATION

For more information contact your local Intel sales representative or

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5200 NE Elam Young Parkway
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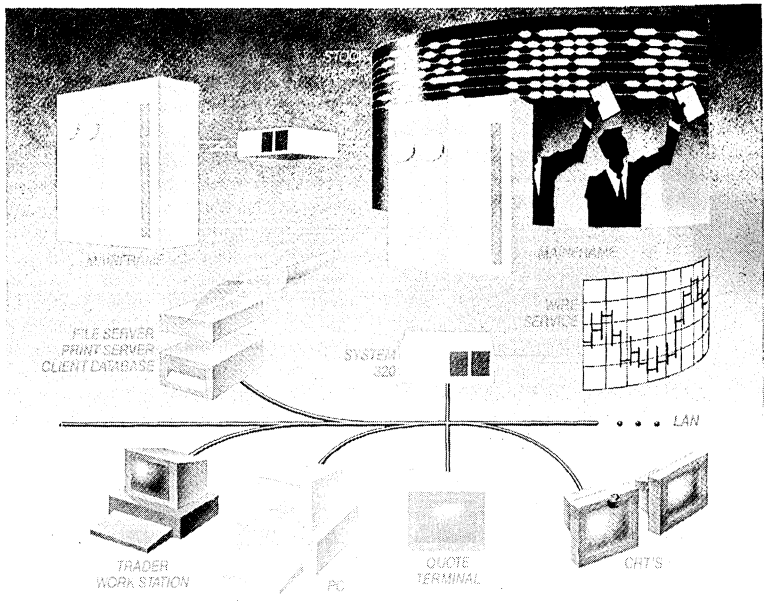
Tel: (5) 844-4555

FINANCIAL REAL-TIME SYSTEM 320



FINANCIAL SYSTEM 320

Intel combines the power of its high performance 80386 based System 320, the iRMX 286 Real-Time Software, complete network service software and comprehensive customer support capabilities to provide a complete FINANCIAL SERVICES NETWORK. Effective in distributing real-time financial data from mainframes to users, the System 320 gives you the performance and capabilities of a minicomputer at less than half the cost.

Based on MULTIBUS® architecture, the IEEE 796 industry standard system bus, the System 320 is supported by over 200 vendors providing over 2000 compatible products. This openness to standards allows for a variety of configurations to meet the unique needs of financial clients. Intel's Financial System 320 is used by prominent stock exchanges, brokerage firms and investment banks. Special configurations can be tailored by the user, by Intel's Custom System Integration group or by Intel's authorized Value Added Distribution Centers.

iRMX® SYSTEM 320 FEATURES:

- High performance trade data distribution
- 80386 Based System
- iRMX Real-time, Multitasking Operating System
- OpenNET Local Area Networking Based Entirely on Standards
- Host communication to mainframes
- Complete installation, service and support
- Range of Configurations

June, 1987
Order Number: 280504-001

iRMX® 286—REAL-TIME SOFTWARE

The IRMX 286 operating system delivers real-time performance. Designed to manage and extend the resources of the System 320, this multitasking operating system provides configurable resources. These range from interrupt management and standard device drivers to data file maintenance commands for human interface and program development. The iRMX 286 facilities also include a wide range of popular industry standard high-level languages for application development, and powerful utilities for easy, interactive configuration and debugging.

OpenNET™—THE STANDARD IN NETWORKING

Intel supports and drives local area networking standards and technology for microsystems and microcommunications industries. The OpenNET product family adheres to the International Standards Organization (ISO) seven layer Open Systems Interconnect (OSI) model. Only complete products that conform to this model and are based on open and public standards carry the OpenNET name.

COMMUNICATIONS TO HOSTS

The System 320 has communication capabilities to host computers utilizing X.25 and SNA protocols. The host communication capability allows users to have real-time access to the host through the System 320 making more effective use of mainframe processing.

INSTALLATION SERVICE AND SUPPORT

The Intel System 320 is backed by Intel's worldwide service and support organization. Custom support agreements provide the exact service levels required by customer's applications. Service can also extend to offer support for non-Intel products. Intel's customer support organization has offices in 100 locations worldwide. Installation is available to quickly get your system up and running. This total hardware and software support includes a hotline number for when you ned help fast. Intel also provides hands-on training workshops to give the user a thorough understanding of the System 320. These workshops are conducted at Intel training centers or customer sites worldwide.

RANGE OF CONFIGURATIONS

Intel offers a range of configurations for the iRMX System 320. Contact your local Intel representative for further information.

SPECIFICATIONS

ENVIRONMENT

Operating Temperature	10°C to 40°C
Wet Bulb Temperature	26°C maximum
Relative Humidity	85% at 40°C
Altitude	Sea level to 10,000 feet

REGULATIONS

Meets or exceeds the following requirements:

Safety	
US	UL 478
Canada	CSA C22.2
Europe	IEC 435
EMI/RFI	
US	FCC Class B Computing Device
Europe	VDE Limit Class B

ELECTRICAL

DC Power Output	435 watt maximum
AC Power Input	88-132 VAC or 176-267 VAC, 47-63 Hz, single phase

DIMENSIONS

Height	8"
Width	17.5"
Depth	22.25"
Weight	approx 55 lbs

ORDERING INFORMATION

For more information contact your local Intel sales representative or

Intel Corporation
5200 NE Elam Young Parkway
Hillsboro, OR 97124
(503) 681-8080

UNITED STATES, Intel Corporation
3065 Bowers Ave., Santa Clara, CA 95051
Tel: (408) 987-8080

JAPAN, Intel Japan K.K.
5-6 Tokodai Toyosato-machi, Tsukuba-gun, Ibaraki-ken 300-26
Tel: 029747-8511

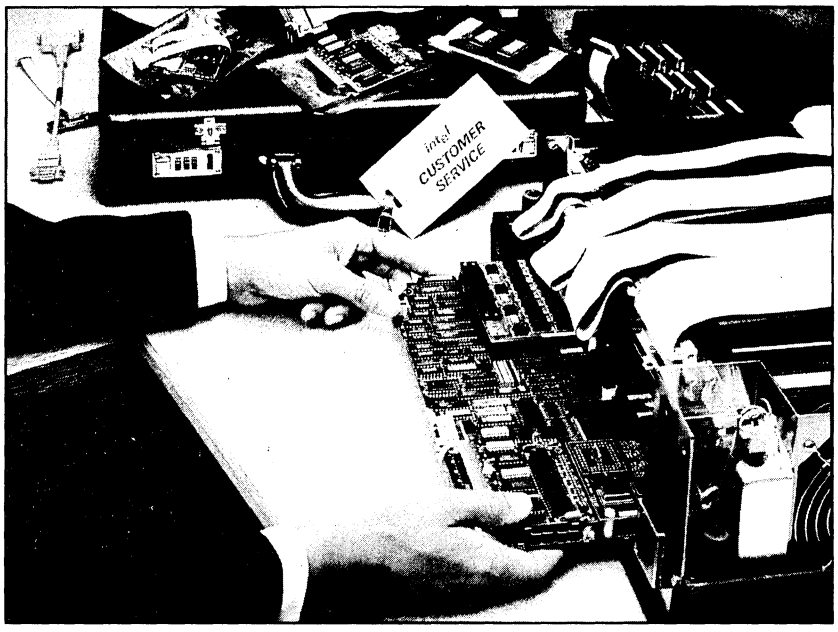
FRANCE, Intel Paris
1 Rue Edison, BP 303, 78054 Saint-Quentin-en-Yvelines Cedex
Tel: (33) 1-30-57-7000

UNITED KINGDOM, Intel Corporation (U.K.) Ltd.
Pipers Way, Swindon, Wiltshire, England SN3 1RJ
Tel: (0793) 696000

WEST GERMANY, Intel Semiconductor GmbH
Seidlestrasse 27, D-8000 Muenchen 2
Tel: (89) 53891

HONG KONG, Intel Semiconductor Ltd.
1701-3 Connaught Centre, 1 Connaught Road
Tel: (5) 844-4555

SYSTEM 310AP 386 UPGRADE



Intel's 310AP 386 Upgrade offers the user an upgrade path to the performance of the Intel 80386 without sacrificing existing software and hardware investments. This Customer Service Installed upgrade is designed for the System 310AP series of microcomputer systems using iRMX 286 or XENIX 286 operating systems.

STANDARD FEATURES

- 16 MHz 80386 Microprocessor
- 16 Bit 80287 Numeric Data Processor
- Memory Options:
  1, 2, 4 and 8 MB
  0 wait state RAM
- Systems Confidence Test (SCT) and boot firmware
- Installed by Intel Customer Service at your location

intel

June, 1987
Order Number: 280705-001

The iSXM 386 AP Kit is designed to meet certain UL, FCC, CSA, IEC and VDE requirements when it is installed into an INTEL System 310AP. It is the responsibility of the customer to reconfirm that the specific systems they have created from MULTIBUS elements continue to meet the required safety and environmental specifications in the customer environment. Intel is not responsible for any changes made after the product is accepted by Intel's customer.

SAFETY REQUIREMENT/EMI LIMITS

The iSXM 386 AP Kit is designed to meet:

Safety:
- UL 478 5th edition
- CSA C22.2 no. 154
- TUV IEC435 and VDE 0806

RMI/EMI:
- FCC 47 CFR Part 15 Subpart J Class A
- VDE 0871 Level A

Actual compliance will depend on the modules, peripherals and cable connectors which you install in the system.

ELECTRICAL

Voltage and Maximum Current:

iSXM 386 AP-1, 1 MB Memory

±5 VDC	±5%	12.5 amps
+12 VDC	±5%	0.025 amps
−12 VDC	±5%	0.025 amps

2 MB Memory add .3 amps @5 VDC
4 MB Memory add .0 amps @5 VDC
8 MB Memory add .3 amps @5 VDC

*XENIX is a trademark of Microsoft Corp.

BASE REQUIREMENTS

You must have current copy of iRMX 286 Release 2.0 or later or XENIX* Release 3.5 or later installed on your system before the system can be upgraded. The −4 and −8 kits are recommended for use on 80 MB or 140 MB Winchester based systems only.

ORDERING INFORMATION

Your memory requirements will determine the product order code:

Memory Requirement	Order Code
1 MB RAM	iSXM386AP-1
2 MB RAM	iSXM386AP-2
4 MB RAM	iSXM386AP-4
8 MB RAM	iSXM386AP-8

SYSTEM SOFTWARE

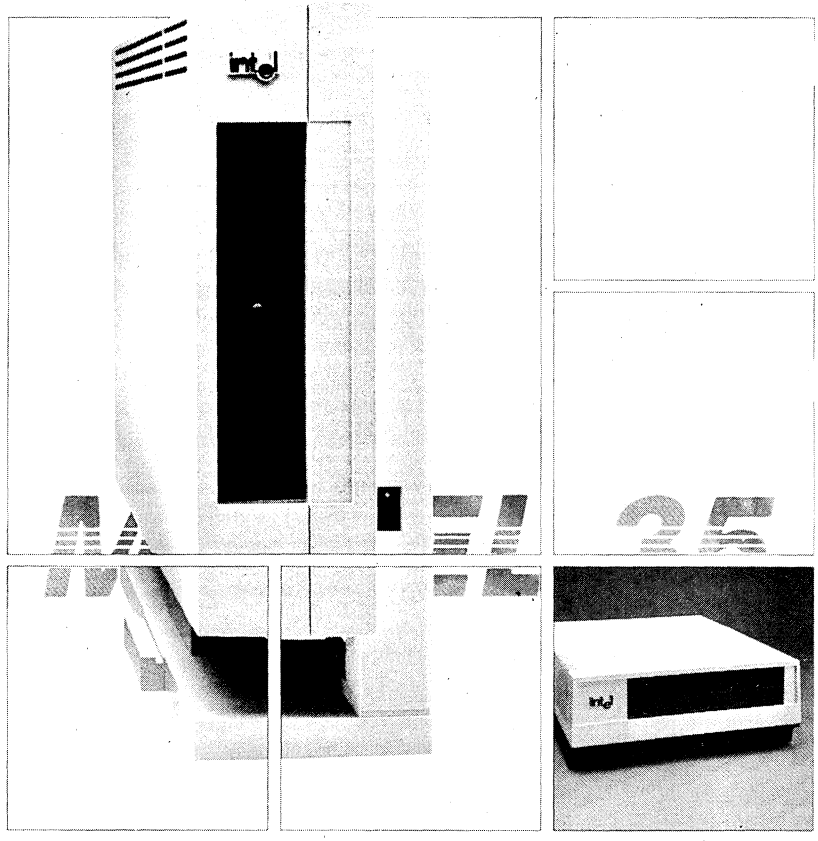
iRMX 286 Languages:
FORTRAN 286, C286
Assembler 286, PL/M 286

XENIX Languages:
FORTRAN 286, C286
Assembler 286, COBOL
BASIC

Intel believes that the information in this document is accurate as of its publication date. Such information is subject to change without notice. Intel is not responsible for any inadvertent errors.

SYSTEM 310 MODEL 35

- Real-Time Operating System Support (iRMX™ 86)
- 8MHz 8086 CPU and 8087 Math Coprocessor
- Five MULTIBUS® Expansion Slots
- 320KB Floppy Disk Drive
- 20MB Formatted Winchester Drive



ORDER NUMBER: 280296-002

SPECIFICATIONS

CPU: 8 MHz 8086

NDP: 8 MHz 8087

RAM: 640KB 0 wait state dual ported on-board RAM

I/O: One RS232 serial communications port,
One Centronics parallel port

Mass Storage:
320KB Flexible disk drive,
20MB Winchester drive

DC Power Output: 220 Watts Maximum (Expansion)
+5V @ 30A (17A)
+12V @ 4.7A (1.1A)
−12V @ 4.7A (4.5A)

MULTIBUS® Expansion Slots: 5 @ 0.625 in.

Environmental Specification:
Operating: 10°C to 35°C
26°C maximum Wet Bulb temperature
20% to 80% Relative Humidity, non-condensing

Altitude: Sea Level to 2,400 meters

Shock: 30 G Non-operating

Vibration: 5 Hz to 1 KHz Random
0.001 G2/Hz (1 G rms) Operating

Regulatory Agency Specifications:
Meets: UL 114-Safety
CSA 22.2 Safety
Docket 20780 Class A - RFI/EMI
Designed to Meet: IEC 435-Safety
VDE 0871 Class A - RFI/EMI

Actual compliance will depend on any additional user installed options to the System 310 Model 35.

Dimensions: Height: 165 mm (6.5 in)
Width: 432 mm (17 in)
Depth: 508 mm (20 in)
Weight: 25Kg/51 Lb

ORDERING INFORMATION

System Hardware: SYS31035

Chassis Trak 300S non-pivoting rack slides or equivalent are available from Chassis Trak, Inc., P.O. Box 39100, Indianapolis, Indiana 46239.

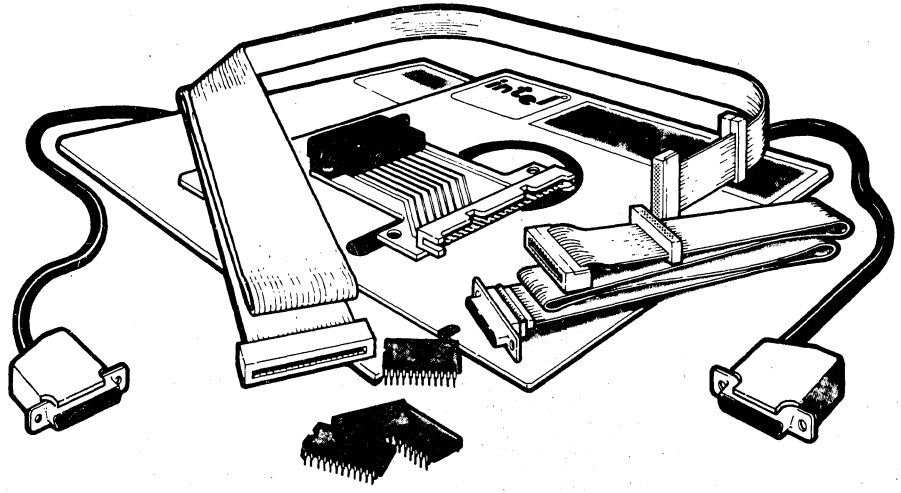
Specifications subject to change without notice.

Systems Software 2

iSDM™
SYSTEM DEBUG MONITOR

- **Supports Target System Debugging for iSBC® 8086, 8088, 80186, 80188, 80286 and 80386 Based Applications**
- **Provides Interactive Debugging Commands Including Single-Step Code Execution and Symbolic Displays of Results**
- **Supports 8087 Numeric Processor Extension (NPX) for High-Speed Math Applications**
- **Allows Building of Custom Commands Through the Command Extension Interface (CEI)**
- **Supports Application Access to ISIS-II Files**
- **Provides Program Load Capability from an Intellec® Development System and from iSBC 8086, 8088, 80186, 80188, 80286 and 80836 iRMX® 86 and 286 Development System**
- **Contains Configuration Facilities which Allow an Applications Bootstrap from iRMX® File Compatible Peripherals**
- **Modular to Allow Use from an Intellec® Development System, from a Stand-Alone Terminal or from iRMX 86 or iRMX 286 Based Systems**

The Intel iSDM™ System Debug Monitor package contains the necessary hardware, software, cables, EPROMs and documentation required to interface, through a serial or parallel connection, an iSBC 86/05, 86/12A, 86/14, 86/30, 88/25, 88/40, 88/45, 186/03, 186/51, 188/48, 286/10, 286/10A, 286/12, 386/2X, or 8086, 8088, 80186 or 80188, 80286 and 80386 target system to an MDS 800, Series II, Series III, or Series IV Intellec® Microcomputer Development System or iRMX 86 or 286 Based System for execution and interactive debugging of applications software on the target system. The Monitor can: load programs into the target system; execute the programs instruction by instruction or at full speed; set breakpoints; and examine/modify CPU registers, memory content, and other crucial environmental details. Additional custom commands can be built using the Command Extension Interface (CEI). The Monitor supports the OEM's choice of the iRMX 86 Operating System, the iRMX 286 Operating System, the iRMX 88 Real-Time Multi-Tasking Executive or a custom system for the target application system. OEM's may utilize any iRMX supported target system peripheral for a bootstrap of the application system or have full access to the ISIS-II files of the Intellec System or the iRMX file system.



230882-1

October 1987
Order Number: 230882-004

FUNCTIONAL DESCRIPTION

Overview

The iSDM Monitor extends the software development capabilities of the Intellec system so the user can effectively develop applications to ensure timely product availability.

The iSDM package consists of four parts:

- The loader program
- The iSDM Monitor
- The Command Extension Interface (CEI)
- The ISIS-II Interface

The user can use the iSDM package to load programs into the target system from the development system, execute programs in an instruction-by-instruction manner, and add custom commands through the command extension interface. The user also has the option of using just the iSDM Monitor and the CEI in a stand-alone application, without the use of a development system.

Powerful Debugging Commands

The iSDM Monitor contains a powerful set of commands to support the debugging process. Some of the features included are: bootstrap of application software; selective execution of program modules based on breakpoints or single stepping requests; examination, modification and movement of memory contents; examination and modification of CPU registers, including NPX registers. All results are displayed in clearly understandable formats. Refer to Table 1 for a more detailed list of the iSDM monitor commands.

Numeric Data Processor Support

Arithmetic applications utilizing the 8087 or 80287 Numeric Processor Extension (NPX) are fully supported by the iSDM Monitor. In addition to executing applications with the full NPX performance, users may examine and modify the NPX's registers using decimal and real number format.

This feature allows the user to feel confident that correct and meaningful numbers are entered for the application without having to encode and decode complex real, integer, and BCD hexadecimal formats.

Command Extension Interface (CEI)

The Command Extension Interface (CEI) allows the addition of custom commands to the iSDM Monitor commands. The CEI consists of various procedures that can be used to generate custom commands. Up to three custom commands (or sets of commands) can be added to the monitor without programming new EPROMs or changing the monitor's source code.

Table 1. Monitor Commands

Command	Function
B	**Bootstrap** application program from target system peripheral device
C	**Compare** two memory blocks
D	**Display** contents of memory block
E*	**Exit** from loader program to ISIS-II Interface
F	**Find** specified constant in a memory block
G	**Execute** application program
I	**Input** and display data obtained from input port
L*	**Load** absolute object file into target system memory
M	**Move** contents of memory block to another location
N	**Display and execute** single instruction
O	**Output** data to output port
P	**Print** values of literals
R*	**Load and execute** absolute object file in target system memory
S	**Display and (optionally) modify** contents of memory
T*	**Transfer** block of memory to file
U, V, W	**User** defined custom commands extensions
X	**Examine and (optionally) modify** CPU and NPX registers

*Commands require an attached development system.

ISIS-II Interface

The ISIS-II interface consists of libraries which contain interfaces to ISIS-II I/O calls. A program running on an 8086, 8088, 80186, or 80188-based system can use the ISIS-II interface and access the individual ISIS-II I/O calls. The interface allows the inclusion of these calls into the program; however, most of the calls require a Series II/Series III system. Table 2 contains a summary of the major I/O calls and parameters.

Program Load Capability

The iSDM loader allows the loading of 8086, 8088, 80186, 80188, 80286 or 80386-based programs into the target system. It executes on a development system and communicates with the target system through a serial or a parallel load interface.

Configuration Facility

The monitor contains a full set of configuration facilities which allows it to be carefully tailored to the requirements of the target system. Pre-configured EPROM-resident monitors are supplied by Intel for the iSBC 86/05A, 86/14, 86/30, 86/35, 88/25, 88/10A, 88/45, 186/03A, 186/51, 188/48, 188/56, 286/10A, 286/12, 286/100, 386/2X, and 386/100 boards. The monitor must be configured by the user for the iSBC 86/12A board and for other 8086, 8088, 80186, or 80188 applications. iRMX 86 and iRMX 286 system users may use the configuration facilities to include the Bootstrap Loader (V5.0 or newer) in the monitor.

Variety of Connections Available

The physical interface between the development system and the target system can be established in one of three ways. The systems can be connected via a serial link, a parallel link or a fast parallel link. The cabling arrangement is different depending upon the development system being used.

The iSDM Monitor does not require the use of a development system. The monitor can be used by simply attaching a stand-alone terminal to the target system.

Table 2. Routines for Services Available to Target System Applications

Routine	Target System Function
ATTRIB	Changes to ISIS-II file **attribute**
CI	Returns a character **input** from the **console**
CO	Transfers a character for **console output**
CLOSE	**Closes** an opened file
DELETE	**Deletes** the specified file
DQ$CFG	Returns information about monitor's communication link and type
ERROR	Displays an **error** message on the console
EXIT	**Exits** to the target system monitor
LOAD	**Loads** target system memory with object code file
OPEN	**Opens** a file for access
READ	**Reads** up to 4096 bytes from a file to memory
RENAME	**Renames** a disk file
SEEK	**Seeks** to the specified file location
WRITE	**Writes** up to 4096 bytes from memory to a file

SPECIFICATIONS

Hardware

- Supported iSBC Microcomputers:
  - iSBC 86/05 Single Board Computer
  - iSBC 86/12A Single Board Computer
  - iSBC 86/14 Single Board Computer
  - iSBC 86/30 Single Board Computer
  - iSBC 88/25 Single Board Computer
  - iSBC 88/40 Single Board Computer
  - iSBC 88/45 Single Board Computer
  - iSBC 186/30 Single Board Computer
  - iSBC 186/51 Single Board Computer
  - iSBC 188/48 Single Board Computer
  - iSBC 186/56 Single Board Computer
  - iSBC 86/35 Single Board Computer
  - iSBC 88/40A Single Board Computer
  - iSBC 816/03A Single Board Computer
  - iSBC 286/10A Single Board Computer
  - iSBC 286/12 Single Board Computer
  - iSBC 286/100 Single Board Computer
  - iSBC 386/2X Single Board Computer
  - iSBC 386/100 Single Board Computer
- Supported iSBX MULTIMODULE Boards:
  - iSBX 350 Parallel I/O MULTIMODULE Board
  - iSBX 351 Serial I/O MULTIMODULE Board

iSDM™ 86 Package Contents

Cables:

1—Parallel I/O Cable (upload/download)
4—RS232 Cable Assemblies
Hardware package for the cable assemblies

Interface and Execution Software Diskettes:
2—SSIDD, ISIS 11-Format 8″
2—DSIDD, iRMX-Format 5¼″
2—SSIDD, iRMX—Format 8″

System Monitor EPROMs:

Intel Board	EPROM Description
iSBC 86/05A iSBC 86/14 iSBC 86/30 iSBC 86/35	Two 27128 EPROMs
iSBC 86/12A*	SUBMIT Files on the Release Diskette

System Monitor EPROMs: (Continued)

Intel Board	EPROM Description
iSBC 88/25	Two 27128 EPROMs
iSBC 88/40A	Two 27128 EPROMs
iSBC 88/45	Two 27128 EPROMs
iSBC 186/03A	Two 27128 EPROMs
iSBC 186/51	Two 27128 EPROMs
iSBC 188/48 iSBC 188/56	Two 27128 EPROMs
iSBC 286/10A iSBC 286/12	Two 27128 EPROMs
iSBC 286/100	Two 27128 EPROMs
iSBC 386/2X	Two 27256 EPROMs
iSBC 386/100	Two 27256 EPROMs

Reference Manual (Supplied):

iSDM System Debug Monitor Installation and Configuration

iSDM System Debug Monitor User's Guide

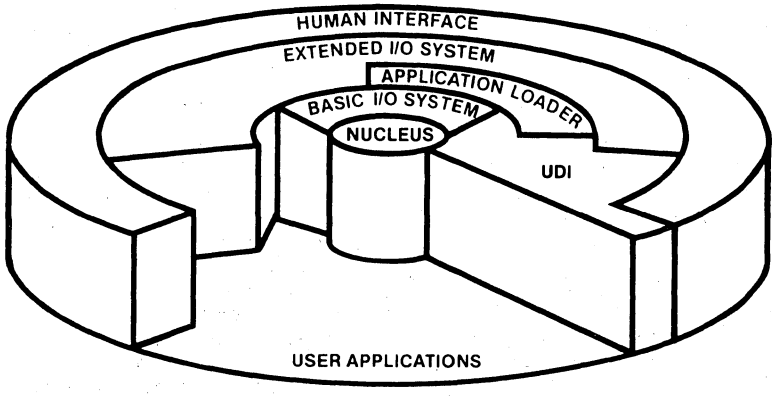
ORDERING INFORMATION

Part Number	Description
iSDM RO	Object Software Intellec to target system interface and target system monitor, suitable for use on iSBC 86, 88, 186, 188, 286, 386 computers, or other iAPX 86, 88, 186, 188, 286, 386 microcomputers. Package includes cables, EPROMs, software and reference manual. The OEM license option listed here allows users to incorporate iSDM into their applications. Each use requires payment of an Incorporation Fee. The iSDM package also includes 90 days of support services that include Software Program Report Services. As with all Intel Software, purchase of any of these options requires execution of a standard Intel Software License Agreement.

iRMX® 86 OPERATING SYSTEM

- **Real-Time Processor Management for Time-Critical 8086, 8088, 80186, 80188, and 80286 (Real Address Mode) Applications**
- **On-Target System Development with Universal Development Interface (UDI)**
- **Configurable System Size and Function for Diverse Application Requirements**
- **All iRMX® 86 Code Can Be (P)ROM'ed to Support Totally Solid State Designs**
- **Configured Systems for the 8086 and 80286 Processors in Intel Integrated System Products (iSYS 86/300 and iSYS 286/300)**
- **Multi-Terminal Support with Multi-User Human Interface**
- **Broad Range of Device Drivers Included for Industry Standard MULTIBUS® Peripheral Controllers**
- **Complete Support of 8087 and 80287 Processor Extension**
- **Powerful Utilities for Interactive Configuration and Real-Time Debugging**

The iRMX 86 Operating System is an easy-to-use, real-time, multi-tasking and multi-programming software system designed to manage and extend to resources of iSBC® 86, iSBC 186, iSBC 188, and iSBC 286 Single Board Computers, as well as other 8086, 8088, 80186, 80188, and 80286 (Real Address Mode) based microcomputers. iRMX 86 functions are available in silicon with the 8086/30, 88/30, 186/30 and 188/30 Operating System Processors, in a user configurable software package. iRMX 86 functions are also fully integrated into the SYSTEM 86/300 and SYSTEM 286/300 Family of Microcomputer Systems. The Operating System provides a number of standard interfaces that allow iRMX 86 applications to take advantage of industry standard device controllers, hardware components, and a number of software packages developed by Independent Software Vendors (ISVs). Many high-performance features extend the utility of iRMX 86 Systems into applications such as data collection, transaction processing, and process control where immediate access to advances in VLSI technology is paramount. These systems may deliver real-time performance and explicit control over resources; yet also support applications with multiple users needing to simultaneously access terminals. The configurable layers of the System provide services ranging from interrupt management and standard device drivers for many sophisticated controllers, to data file maintenance commands provided by a comprehensive multi-user human interface. By providing access to the standard Universal Development Interface (UDI) for each user terminal, Original Equipment Manufacturers (OEMs) can pass program development and target application customization capabilities to their users.



210885-1

iRMX® VLSI Operating System

October 1987
Order Number: 210885-003

The iRMX 86 Operating System is a complete set of system software modules that provide the resource management functions needed by computer systems. These management functions allow Original Equipment Manufacturers (OEMs) to best use resources available in microcomputer systems while getting their products to market quickly, saving time and money. Engineers are relieved of writing complex system software and can concentrate instead on their application software.

This data sheet describes the major features of the iRMX 86 Operating System. The benefits provided to engineers who write application software and to users who want to take advantage of improving microcomputer price and performance are explained. The first section outlines the system resource management functions of the Operating System and describes several system calls. The second section gives a detailed overview of iRMX 86 features aimed at serving both the iRMX 86 system designer and programmer, as well as the end users of the product into which the Operating System is incorporated.

FUNCTIONAL DESCRIPTION

To take best advantage of 8086, 8088, 80186, 80188, and 80286 (Real Address Mode) microprocessors in applications where the computer is required to perform many functions simultaneously, the iRMX 86 Operating System provides a multiprogramming environment in which many independent, multi-tasking application programs may run. The flexibility of independent environments allows application programmers to separately manage each application's resources during both the development and test phases.

The resource management functions of the iRMX 86 System are supported by a number of configurable software layers. While many of the functions supplied by the innermost layer, the Nucleus, are required by all systems, all other functions are optional. The I/O systems, for example, may be omitted in systems having no secondary storage requirement. Each layer provides functions that encourage application programmers to use modular design techniques for quick development of easily maintainable programs.

The components of the iRMX 86 Operating System provide both implicit and explicit management of system resources. These resources include processor scheduling, up to one megabyte of system memory, up to 57 independent interrupt sources, all input and output devices, as well as directory and data files contained on mass storage devices and accessed by a number of independent users. Management of these system resources and methods for sharing resources between multiple processors and users is discussed in the following sections.

Process Management

To implement multi-tasking application systems, programmers require a method of managing the different processes of their application, and for allowing the processes to communicate with each other. The Nucleus layer of the iRMX 86 System provides a number of facilities to efficiently manage these processes, and to effectively communicate between them. These facilities are provided by system calls that manipulate data structures called tasks, jobs, regions, semaphores and mailboxes. The iRMX 86 System refers to these structures as 'objects".

Tasks are the basic element of all applications built on the iRMX 86 Operating System. Each task is an entity capable of executing CPU instructions and issuing system calls in order to perform a function. Tasks are characterized by their register values (including those of an optional 8087 or 80287 Numeric Processor Extension), a priority between 0 and 255, and the resources associated with them.

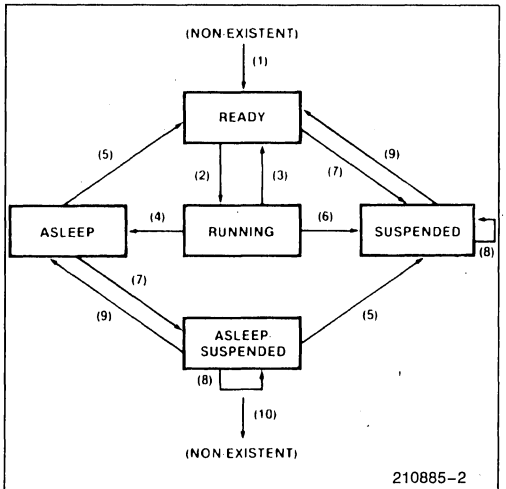
Each iRMX 86 task in the system is scheduled for operation by the iRMX 86 Nucleus. Figure 1 shows the five states in which each task may be placed, and some examples of how a task may move from one state to another. The iRMX 86 Nucleus ensures that each task is placed in the correct state, defined by the events in its external environment and by the task issuing system calls. Each task has a priority to indicate its relative importance and need to respond to its environment. The Nucleus guarantees that the highest priority ready-to-run task is the task that runs.

Jobs are used to define the operating environment of a group of tasks. Jobs effectively limit the scope of an application by collecting all of its tasks and other objects into one group. Because the environment for execution of an application is defined by an iRMX 86 job, separate applications can be efficiently developed by separate development teams.

The iRMX 86 Operating System provides two primary techniques for real-time event synchronization in multi-task applications: regions and semaphores.

Regions are used to restrict access to critical sections of code and data. Once the iRMX 86 Operating System gives a task access to resources guarded by a region, no other tasks may make use of the resources, and the task is given protection against deletion and suspension. Regions are typically used to protect data structures from being simultaneously updated by multiple tasks.

Semaphores are used to provide mutual exclusion between tasks. They contain abstract "units" that are sent between the tasks, and can be used to implement the cooperative sharing of resources.



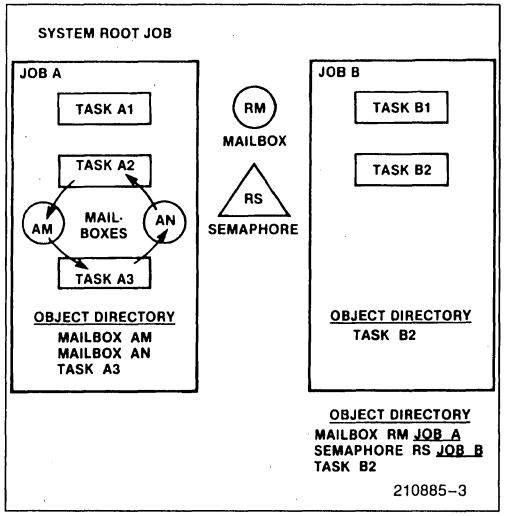
NOTES:
1. Task is created.
2. Task becomes highest priority ready task.
3. Task gets pre-empted by one with higher priority.
4. Task calls SLEEP or task waits at an exchange.
5. Task sleep period has ended, message was sent to waiting task or wait has ended.
6. Task calls SUSPEND on self.
7. Task suspended by other than self.
8. Task suspended by other than self or a resume that did not bring suspension depth to zero.
9. Task was resumed by other task.
10. Task is deleted.

Figure 1. Task State Diagram

Multi-tasking applications must communicate information and share system resources among cooperating tasks. The iRMX 86 Operating System assigns a unique 16-bit number, called a token, to each object created in the System. Any task in possession of this token is able to access the object. The iRMX 86 Nucleus allows tasks to gain access to objects, and hence system resources, at run-time with two additional mechanisms: mailboxes and object directories.

Mailboxes are used by tasks wishing to share objects with other tasks. A task may share an object by sending the object token via a mailbox. The receiving task can check to see if a token is there, or can wait at the mailbox until a token is present.

Object Directories are also used to make an object available to other tasks. An object is made public by cataloging its token and name in a directory. In this manner, any task can gain access to the object by knowing its name, and job environment that contains the directory.



Two example jobs are shown in Figure 2 to demonstrate how two tasks can share an object that was not known to the programmer at the time the tasks were developed. Both Job 'A' and Job 'B' exist within the environment of the 'Root Job' that forms the foundation of all iRMX 86 systems. Each job posses-es a directory in which tasks may catalog the name of an object. Semaphore 'RS', for example, is accessable by all tasks in the system, because its name is cataloged in the directory of the Root Job. Mailbox "AN" can be used to transfer objects between Tasks 'A2' and 'A3' because its token is accessable in the object directory for Job 'A'.

Table 1 lists the major functions of the iRMX 86 Nucleus that manage system processes.

Memory Management

Each job in an iRMX 86 System defines the amount of the one megabyte of addressable memory to be used by its tasks. The iRMX 86 Operating System manages system memory and allows jobs to share this critical resource by providing another object type: segments.

Segments are contiguous pieces of memory between 16 Bytes and 64 Kbytes in length, that exist within the environment of the job in which they were created. Segments form the fundamental piece of system memory used for task stacks, data storage, system buffers, loading programs from secondary storage, passing information between tasks, etc.

The example in Figure 2 also demonstrates when information is shared between Tasks 'A2' and 'A3'; 'A2' only needs to create a segment, put the information in the memory allocated, and send it via the Mailbox 'AM' using the RQ$SEND$MESSAGE sys-

Table 1. Process Management System Calls

System Call	Function Performed
RQ$CREATE$JOB	Creates an environment for a number of tasks and other objects, as well as creating an initial task and its stack.
RQ$DELETE$JOB	Deletes a job and all the objects currently defined within its bounds. All memory used is returned to the job from which the deleted job was created.
RQ$OFFSPRING	Provides a list of all the current jobs created by the specified job.
RQ$CATALOG$OBJECT	Enters a name and token for an object into the object directory of a job.
RQ$UNCATALOG$OBJECT	Removes an object's token and its name from a job's object directory.
RQ$LOOKUP$OBJECT	Returns a token for the object with the specified name found in the object directory of the specified job.
RQGETTYPE	Returns a code for the type of object referred to by the specified token.
RQ$CREATE$MAILBOX	Creates a mailbox with queues for waiting tasks and objects with FIFO or PRIORITY discipline.
RQ$DELETE$MAILBOX	Deletes a mailbox.
RQ$SEND$MESSAGE	Sends an object to a specified mailbox. If a task is waiting, the object is passed to the appropriate task according to the queuing discipline. If no task is waiting, the object is queued at the mailbox.
RQ$RECEIVE$MESSAGE	Attempts to receive an object token from a specified mailbox. The calling task may choose to wait for a specified number of system time units if no token is available.
RQ$DISABLE$DELETION	Prevents the deletion of a specified object by increasing its disable count by one.
RQ$ENABLE$DELETION	Reduces the disable count of an object by one, and if zero, enables deletion of that object.
RQ$FORCE$DELETE	Forces the deletion of a specified object if the disable count is either 0 or 1.
RQ$CREATE$TASK	Creates a task with the specified priority and stack area.
RQ$DELETE$TASK	Deletes a task from the system, and removes it from any queues in which it may be waiting.
RQ$SUSPENDS$TASK	Suspends the operation of a task. If the task is already suspended, its suspension depth is increased by one.
RQ$RESUME$TASK	Resumes a task. If the task had been suspended multiple times, the suspension depth is reduced by one, and it remains suspended.
RQ$SLEEP	Causes a task to enter the ASLEEP state for a specified number of system time units.
RQGETTASK$TOKENS	Gets the token for the calling task or associated objects within its environment.
RQSETPRIORITY	Dynamically alters the priority of the specified task.
RQGETPRIORITY	Obtains the current priority of a specified task.
RQ$CREATE$REGION	Creates a region, with an associated queue of FIFO or PRIORITY ordering discipline.
RQ$DELETE$REGION	Deletes the specified region if it is not currently in use.
RQ$ACCEPT$CONTROL	Gains control of a region only if the region is immediately available.
RQ$RECEIVE$CONTROL	Gains control of a region. The calling task may specify the number of system time units it wishes to wait if the region is not immediately available.
RQ$SEND$CONTROL	Relinquishes control of a region.
RQ$CREATE$SEMAPHORE	Creates a semaphore.
RQ$DELETE$SEMAPHORE	Deletes a semaphore.
RQ$SEND$UNITS	Increases a semaphore counter by the specified number of units.
RQ$RECEIVE$UNITS	Attempts to gain a specified number of units from a semaphore. If the units are not immediately available, the calling task may choose to wait.

tem call (see Table 1). Task 'A3' would get the message by using the RQ$RECEIVE$MESSAGE system call. The Figure also shows how the receiving task could signal the sending task by sending an acknowledgement via the second Mailbox 'AN'.

Each job is created with both maximum and minimum limits set for its memory pool. Memory required by all objects and resources created in the job is taken from this pool. If more memory is required, a job may be allowed to borrow memory from the pool of its containing job (the job from which it was created). In this manner, initial jobs may efficiently allocate memory to jobs they subsequently create, without knowing their exact requirements.

The iRMX 86 Operating System supplies other memory management functions to search specific address ranges for available memory. The System performs this search at system initialization, and can be configured to ignore non-existent memory and addresses reserved for I/O devices and other application requirements.

Table 2 lists the major system calls used to manage the system memory.

Interrupt Management

Real-time systems, by their nature, must respond to asynchronous and unpredictable events quickly. The iRMX 86 Operating System uses interrupts and the event-driven Nucleus described earlier to give real-time response to events. Use of a pre-emptive scheduling technique ensures that the servicing of high priority events always takes precedence over other system activites.

The iRMX 86 Operating system gives applications the flexibility to optimize either interrupt response time or interrupt response capability by providing two tiers of Interrupt Management. These two distinct tiers are managed by Interrupt Handlers and Interrupt Tasks.

Interrupt Handlers are the first tier of interrupt service. For small simple functions, interrupt handlers are often the most efficient means of responding to an event. They provide faster response than interrupt tasks, but must be kept simple since interrupts (except the 8086, 8088, 80186, 80188, and 80286 non-maskable interrupt) are masked during their execution. When extended service is required, interrupt handlers "signal" a waiting interrupt task that, in turn, performs more complicated functions.

Interrupt Tasks are distinct tasks whose priority is associated with a hardware interrupt level. They are permitted to make an iRMX 86 system call. While an interrupt task is servicing an interrupt, interrupts of lower priority are not allowed to pre-empt the system.

Table 3 shows the iRMX 86 System Calls provided to manage interrupts.

Table 2. Memory Management System Calls

System Call	Function Performed
RQ$CREATE$SEGMENT	Dynamically allocates a memory segment of the specified size.
RQ$DELETE$SEGMENT	Deletes the specified segment by deallocating the memory.
RQGETPOOL$ATTRIBUTES	Returns attributes such as the minimum and maximum, as well as current size of the memory in the environment of the calling task's job.
RQGETSIZE	Returns the size (in bytes) of a segment.
RQSETPOOL$MIN	Dynamically changes the minimum memory requirements of the job environment containing the calling task.

Table. 3. Interrupt Management System Calls

System Call	Function Performed
RQSETINTERRUPT	Assigns an interrupt handler and, if desired, an interrupt task to the specified interrupt level. Usually the calling task becomes the interrupt task.
RQ$RESET$INTERRUPT	Disables an interrupt level, and cancels the assignment of the interrupt handler for that level. If an interrupt task was assigned, it is deleted.
RQGETLEVEL	Returns the number of the highest priority interrupt level currently being processed.
RQ$SIGNAL$INTERRUPT	Used by an interrupt handler to signal the associated interrupt task that an interrupt has occurred.
RQ$WAIT$INTERRUPT	Used by an interrupt task to SLEEP until the associated interrupt handler signals the occurrence of an interrupt.
RQ$EXIT$INTERRUPT	Used by an interrupt handler to relinqish control of the System.
RQ$ENABLE	Enables the hardware to accept interrupts from a specified level.
RQ$DISABLE	Disables the hardware from accepting interrupts at or below a specified level.

INTERRUPT MANAGEMENT EXAMPLE

Figure 3 illustrates how the iRMX 86 Interrupt System may be used to output strings of characters to a printer. In the example, a mailbox named 'PRINT' is used by all tasks in the system to queue messages to be printed. Application tasks put the characters in segments that are transmitted to the printer interrupt task via the PRINT Mailbox. Once printing is complete, the same interrupt task passes the messages on to another application via the FINISHED Mailbox so that an operator message can be displayed.

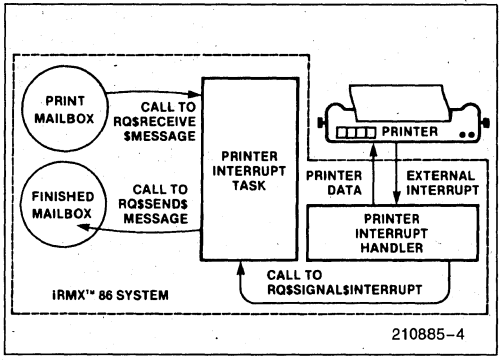


Figure 3. Interrupt Management Example

Basic I/O System

The Basic I/O System (BIOS) provides the direct access to I/O devices needed by real-time applications. The BIOS allows I/O functions to overlap other system functions. In this manner, application tasks make asynchronous calls to the iRMX 86 BIOS, and proceed to perform other activities. When the I/O request must be completed before an application can continue, the task waits at a mailbox for the result of the operation. Some system calls provided by the BOIS are listed in Table 4.

The Basic I/O System communicates with peripheral devices through device drivers. These device drivers provide the System with four basic functions needed to control and communicate with devices: Initialize I/O, Finish I/O, Queue I/O, and Cancel I/O. Using the device driver interface, users of non-standard devices may write custom drivers compatible with the I/O System.

The iRMX 86 Operating System includes a number of device drivers to allow applications to use standard USART serial communications devices, multiple CRTs and keyboards, bubble memories, diskettes, disks, a Centronics-type parallel printer, and many of Intel's iSBC and iSBX™ device controllers (see Table 8). If an application requires use of a non-standard device, users need only write a device driver to be included with the BIOS, and access it as if it were part of the standard system. For most common random-access devices, this job is further simplified by using standard routines provided with the System. Use of this technique ensures that applications can remain device independent.

Table 4. Key BIOS I/O Management System Calls

System Calls	Function Performed
RQAATTACH$FILE	Creates a Connection to an existing file.
RQACHANGE$ACCESS	Changes the types of accesses permitted to the specified user(s) for a specific file.
RQACLOSE	Closes the Connection to the specified file so that it may be used again, or so that the type of access may be changed.
RQACREATE$DIRECTORY	Creates a Named File used to store the names and locations of other Named Files.
RQACREATE$FILE	Creates a data file with the specified access rights.
RQADELETE$CONNECTION	Deletes the Connection to the specified file.
RQAGET$FILE$STATUS	Returns the current status of a specified file.
RQAOPEN	Opens a file for either read, write, or update access.
RQAREAD	Reads a number of bytes from the current position in a specified file.
RQASEEK	Moves the current data pointer of a Named or Physical file.
RQAWRITE	Writes a number of bytes at the current position in a file.
RQ$WAIT$IO	Synchronizes a task with the I/O System by causing it to wait for I/O operation results.

Multi-Terminal Support

The iRMX 86 Terminal Support provides line editing and terminal control capabilities. The Terminal Support communicates with devices through simple drivers that do only character I/O functions. Dynamic terminal reconfiguration is provided so that attributes such as terminal type and line speed may be changed without modifying the application or the Operating System. Dynamic configuration may be typed in, generated programmatically or stored in a file and copied to a terminal I/O connection.

The iRMX 86 Terminal Support provides automatic translation of control characters to specific control sequences for each terminal. This translation enables applications using standard control characters to function with non-standard terminals. The translation requirements for each terminal can be stored in terminal description files and copied to a connection, as described above.

Disk I/O Performance

Figure 4 shows iRMX 86 performance obtained using the iSBC 215 Winchester Disk and iSBX 218A Diskette Controllers under the specified conditions. The vertical axis is a linear scale of throughput in units of 10,000 bytes per second. The horizontal axis is a logrithmic scale showing the transfer size for the reads and writes. Each data point on the graph indicates the time required for a read/write request of 64 Kbytes. Therefore each transfer size on the horizontal scale less than 64K was repeated until a total request of 64K was read or written.

Each device driver can be used to interface to a number of separate and, in some cases, different devices (see Figure 5). The iSBC 215 Device Driver, supplied with the system, is capable of supporting the iSBC 215 Winchester Disk Controller, the iSBC 220 SMD Disk Controller, and the iSBX 218A Flexible Disk Controller (when mounted on an iSBC 215 board). Each device controller may, in turn, control a number of separate device units. In addition, each driver may control a number of like device controllers. This capability allows the use of large storage systems with a minimum of I/O system code to write or maintain.

Extended I/O System

The iRMX 86 Extended I/O System (EIOS) adds a number of I/O management capabilities to simplify access to files. Whereas the BIOS provides users with the basic system calls needed for direct management of I/O resources, many users prefer to have the system perform all the buffering and synchronization of I/O requests automatically. The EIOS allows uses to access I/O devices without having to write procedures for buffering data, or to specify particular devices with constant device names.

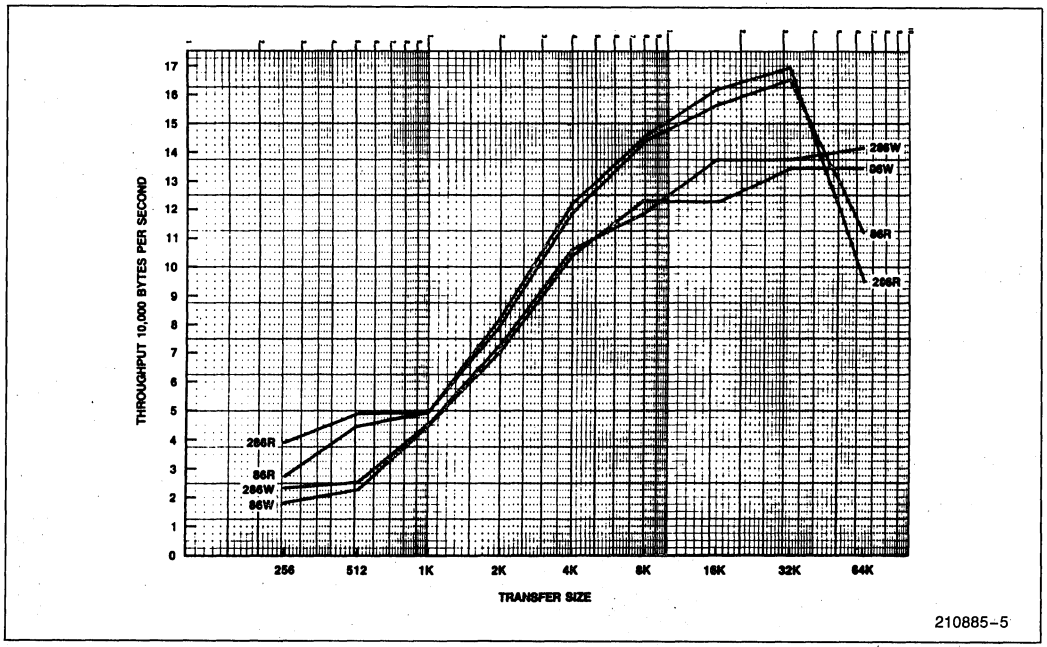
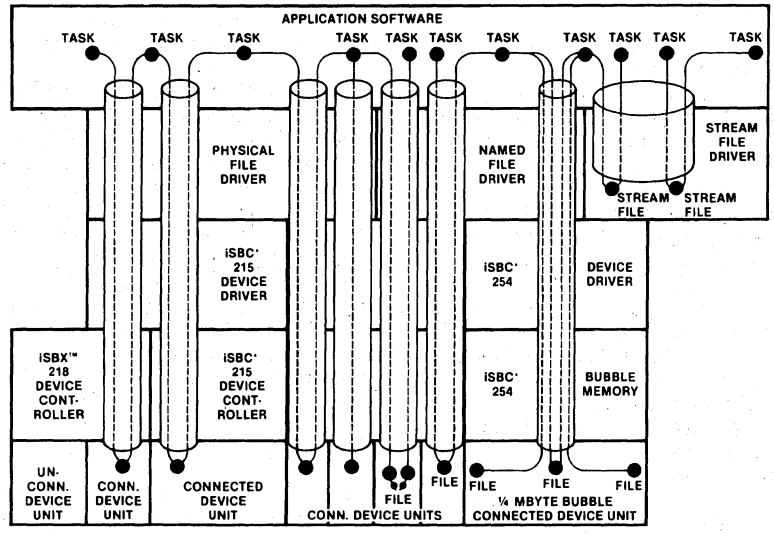


Figure 4. iRMX® 86 Disk I/O Performance



Conduits represent device connections.
Wires in conduits represent file connections.

Figure 5. Device Driver and Controller Relationships

By performing device buffering automatically, the iRMX 86 EIOS optimizes accesses to disks and other devices. Often, when an application task asks the System to READ a portion of a file, the System is able to respond immediately with the data it has read in advance of the request. Similarly, the EIOS will not delay a task for writing data to a device unless it is specifically told to, or if its output buffers are filled.

Logical file and device names are provided by the EOIS to give applications complete file and device independence. Applications may send data to the 'line printer' (:LP:) without needing to know which specific device will be used as the printer. This logical name may, in fact, not be a printer at all, but it could be a disk file that is later scheduled for printing.

The EIOS used the functions provided by the BIOS to synchronize individual I/O requests with results returned by device drivers. Most EIOS system calls are similar to the BIOS calls, except that they appear to suspend the operation of the calling task until the I/O requests are completed.

Two new primitives have been added to the EIOS. These are: RQ$HYBRID$DETACH$DEVICE and RQ$GET$LOGICAL$DEVICE$STATUS.

RQ$HYBRID$DETACH$DEVICE allows a programmer to temporarily detach a device physically so it can be temporarily attached another way.

RQGETLOGICAL$DEVICE$STATUS provides information about a logical device: the physical device name, file driver, number of connections to the device, and the owner of the device.

File Management

The iRMX 86 Oerating System provides three distinct types of files to ensure efficient management of both program and data files: Named Files, Physical Files, and Stream Files. Each file type provides access to I/O devices through the standard device drivers mentioned earlier. The same device driver is used to access physical and named files for a given device.

NAMED FILES

Named files allow users to access information on secondary storage by refering to a file with its ASCII name. The names of files stored on a device are stored in special files called directories. As directories are themselves named files, the iRMX 86 File System allows directories to contain the names of other directories. Figure 6 illustrates the resulting hierarchical file structure. This structure is useful for isolating file names to particular user applications, and for tailoring system data to the requirements of users and applications sharing storage devices. Using different branches on the directory tree, different users do not have to coordinate in naming their files to ensure unique names.

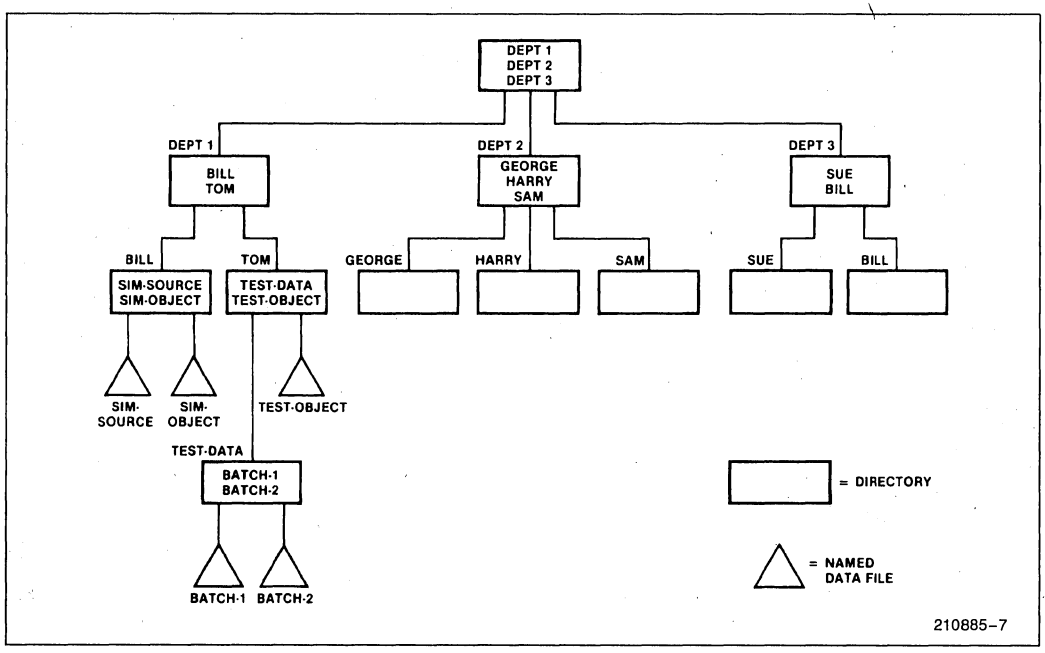


Figure 6. Hierarchical Named File Structure

Whenever a request is made involving a file name, the System will search the appropriate directory in order to find the necessary information about the file's size, access rights, and specific location on the storage device.

The iRMX 86 BIOS uses an efficient format for writing the directory and data information into secondary storage. This standard iRMX 86 format is fully compatible with the ISO Media standard, and other Intel systems such as the iRMX 88 Operating System. This structure enables the system to directly access any byte in a file, often without having to do additional I/O to access space allocation information. The maximum size of an individual file is 4.3 billion bytes.

EASE OF ACCESS

The hierarchical file structure is provided to isolate and organize collections of named files. To give operators fast and simple access to any level within the file tree, an ATTACHFILE command is provided. This command allows operators to create a logical name to a point in the tree so that a long sequence of characters need not be typed each time a file is referred to.

ACCESS PROTECTION

Access to each Named File is protected by the rights assigned to each user by the owner of the file. Rights to read, append, update, and delete may be selectively granted to other users of the system. In general, users of Named Files are classified into one of two categories: User and World. Users are used when different programmers and programs need to share information stored in a file. The World classification is used when rights are to be granted to all who can use the system.

PHYSICAL FILES

Physical Files allow more direct device access than Named Files. Each Physical File occupies an entire device, treated as a single stream of individually accessable bytes. No access control is provided for Physical Files as they are typically used for such applications as driving a printing device, translating from one device format to another, driving a paper tape device, real-time data acquisition, and controlling analog mechanisms.

STREAM FILES

Stream Files provide applications with a method of using iRMX 86 file management methods for data that does not need to go into secondary storage. Stream Files act as direct channels, through system memory, from one task to another. These channels are very useful to programs, for example, wishing to preserve file and device independence allowing data sent to a printer one time, to a disk file another time, and to another program on a different occasion.

BOOTSTRAP AND APPLICATION LOADERS

Two utilities are supplied with the System to load programs and data into system memory from secondary storage devices:

The iRMX 86 Bootstrap Loader can be configured to a size of less than 1K Bytes of P(ROM), and is typically used to load the initial system from the system disk into memory, and begin its execution. Error reporting and debug switch features have been added to the Bootstrap Loader. When the Bootstrap Loader detects errors such as: file does not exist or device not ready, an error message is reported back to the user. The debug switch will cause the Bootstrap Loader to load the system but not begin its execution. Instead the Bootstrap Loader will pass control to the monitor at the first instruction to be executed by the system.

The Application Loader is typically used by application programs already running in the system to load additional programs and data from any secondary storage device. The Human Interface layer, for example, uses the Application Loader to load the non-resident Human Interface Commands. The Application Loader is capable of loading both relocatable and absolute code as well as program overlays.

Human Interface

The flexibility of the interface between computer controlled machines and their users often determines the usability and ultimate success of the machines. Table 11 lists iRMX 86 Human Interface functions giving users and applications simple access to the file and system management capabilities described earlier. The process, interrupt, and memory management functions described earlier, are performed automatically for Human Interface users.

MULTI-USER ACCESS

Using the multi-terminal support provided by the BIOS, the iRMX 86 Human Interface can support several simultaneous users. The real-time nature of the system is maintained by providing a priority for each user, and using the event-driven iRMX 86 Nucleus to schedule tasks. High-performance interrupt response is guaranteed even while users interact with various application packages. For example, multi-terminal support allows one person to be using the iRMX 86 Editor, while another compiles a FORTRAN 86 or PASCAL 86 program, while several others load and access applications.

Each terminal attached to the iRMX 86 multi-user Human Interface is automatically associated with a user, a memory pool, and an initial program to run when the terminal is connected. This association is made using a file that may be changed at any time. Changes are effective the next time the system is initialized.

The initial program specified for each terminal can be a special application program, a custom Human Interface, or the standard iRMX 86 Command Line Interpreter (CLI). For example, you may choose to use the Microsoft Basic Interpreter as this initial program. After system start-up, each terminal user would be able to run the interpreter without asking for it to be loaded. From the BASIC interpreter, an operator, for example, could run a data collection program, written in BASIC, that communicates with several laboratory instruments, and prints charts and reports based on certain test results. When finished entering, changing, or running a BASIC program, the terminal would remain in BASIC for the next user.

Specifying an application program as a terminal's initial program makes the interface between operators and the computer system much simpler. Each operator need only be aware of the function of a particular application; not needing to interact with any unfamiliar functions also available on the application system.

Specifying the standard iRMX 86 Human Interface CLI as the initial program enables users of the terminals to access all iRMX 86 functions. This CLI makes it easy to manage iRMX 86 files, load and execute Intel-supplied and custom programs, and submit command files for execution.

FEATURE OVERVIEW

The iRMX 86 Operating System is well suited to serve the demanding needs of real-time applications executing on complex microprocessor systems. The iRMX 86 System also provides many tools and features needed by real-time system developers and programmers. The following sections describe features useful in both the development and execution environments. The description of each feature outlines the advantages given to hardware and software engineers concerned with overall system cost, expandability with custom and industry standard options, and long-term maintenance of iRMX 86-based systems. The development environment features also describe the ease with which the iRMX 86 Operating System can be incorporated into overall system designs.

Execution Environment Features

REAL-TIME PERFORMANCE

The iRMX 86 Operating System is designed to offer the high performance, multi-tasking functions required by real-time systems. Designers can make use of the latest VLSI devices such as the 8087 or

80287 Numeric Processor Extension. Typical iRMX 86 system performance characteristics are shown in Table 5.

Many real-time systems require high performance operation. To meet this requirement, all of iRMX 86 can be put into zero wait-state P(ROM). This approach eliminates the possibility of disk access times slowing down performance, while allowing system designers to take advantage of high performance memory devices.

CONFIGURABILITY

The iRMX 86 Operating system is configurable by system layer, and by system call within each layer. In addition all the I/O port addresses used by the System are configurable by the user. This flexibility gives designers the freedom to choose configurations of hardware and software that best suit their size and functional requirements. Two example configurations are shown in Figure 7.

Table 5. iRMX™ Real-Time Performance Using iSBC® 86/30 and iSBC® 286/10 Single Board Computers

Real-Time Function	iSBC® 86/30 Execution Time (msec)	iSBC® 286/10 Execution Time (msec)
Suspend Task	1.02	0.83
Interrupt Latency (to handler)	0.29 (Max)	0.20 (Max)
Interrupt Latency (to handler)	0.02 (Typical)	0.03 (Typical)
Context Switch Caused By Interrupt	0.84 (Max)	0.78 (Max)
Send Message (no context switch)	0.32	0.25
Send Message (with context switch)	0.58	0.49
Send Control (no context switch)	0.21	0.16
Send Control (with context switch)	0.64	0.54
Receive Control (no waiting)	0.26	0.19

Context switch times is the time between executing in the context of a task, and the first instruction to execute in the context of another task.
The execution times shown in Column 2 were measured using an 8 MHz iSBC Single Board Computer, 256K on-board RAM, and all program and data stored in on-board RAM.
The execution times shown in Column 3 were measured using a 5 MHz iSBC 286/10 Single Board Computer, no on-board RAM, and all program and data stored in LBX RAM.

Most configuration options are selected during system design stages. Others may be selected during system operation. For example, the amount of memory devoted to queues within a Mailbox can be specified at the time the Mailbox is created. Devoting more memory to the Mailbox allows more messages to be transmitted to other tasks without having to degrade system performance to allocate additional memory dynamically.

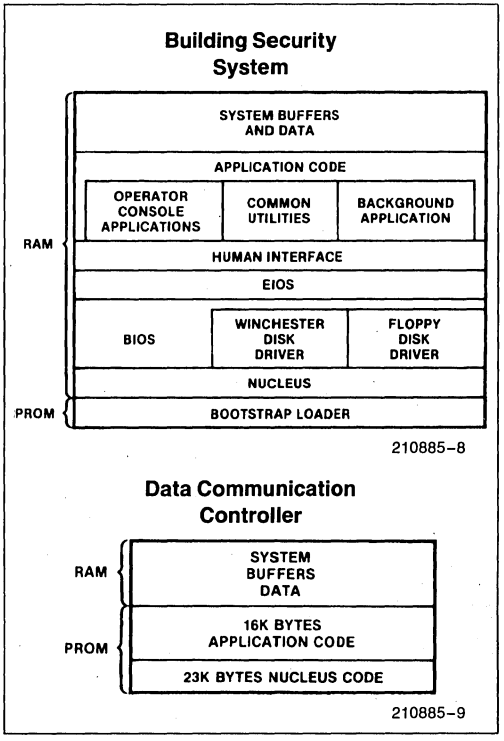


Figure 7. Typical iRMX® 86 Configurations

The chart shown in Table 6 indicates the actual memory size required to support these different configurations of the iRMX 86 System. Systems requiring only Nucleus level functions may require no more than 13 Kbytes for the Operating System. (Use of the 8086/30 requires only 4 Kbytes of RAM, and 23 Kbytes of initialization code in EPROM.) Other applications, needing I/O management functions, may select portions of additional layers that fit their needs and size constraints.

This configurability also applies to the Terminal Handler, Dynamic Debugger, and System Debugger. The Terminal Handler provides a serial terminal interface in a system that otherwise doesn't need an I/O system. Either one of the debuggers need to be included only as debugging tools (usually only during system developement).

Table 6. iRMX™ 86 Configuration Size Chart

System Layer	Min. ROMable Size	Max. Size	Data Size
Bootstrap Loader	1K	1.5K	6K*
Nucleus	10.5K	24K	2K
BIOS	26K	78K	1K
Application Loader	4K	10K	2K
EIOS	10.5K	12.5K	1K
Human Interface	22K	22K	15K
UDI	8K	8K	0
Terminal Handler	3K	3K	0.3K
System Debugger	20K	20K	1K
Dynamic Debugger	28.5K	28.5K	1K
Human Interface Commands			116K
Interactive Configuration Utility			308K

*Usable by System after bootloading.

MULTI-USER ACCESS

Many real-time systems must provide a variety of users access to system control functions and collected data. The iRMX 86 System provides easy-to-use support for applications to access multiple terminals. It also enables multiple and different users to access different applications concurrently.

Figure 8 illustrates a typical iRMX 86 application simultaneously supporting multi-terminal data collection and real-time environments. Shown is a group of terminals used by machinists on a shop floor to communicate with a job management program, a building security system that constantly monitors energy usage requirements, a system operator console capable of accessing all system functions, and a group of terminals in the Production Engineering department used to monitor job costs while developing new device control specifications instructions. The iSBC 544 Intelligent Terminal Interface supports multiple user terminals without degrading system performance to handle character I/O.

EXTENDABILITY

The iRMX 86 Operating System provides three means of extensions. This extendability is essential for support of OEM and volume end user value added features. This ability is provided by: user-defined operating system calls, user-defined objects (similar to Jobs, Tasks, etc.), and the ability to add functions later in the product life cycle. The modular, layered structure of the System easily facilitates later additions to iRMX 86 applications. User-defined objects are supported by the functions listed in Table 7.

Using standard iRMX 86 system calls, users may define custom objects, enabling applications to easily manipulate commonly used structures as if they were part of the original operating system.

EXCEPTION HANDLING

The System includes predefined exception handlers for typical I/O and parameter error conditions. The errors handling mechanism is both configurable and extendable.

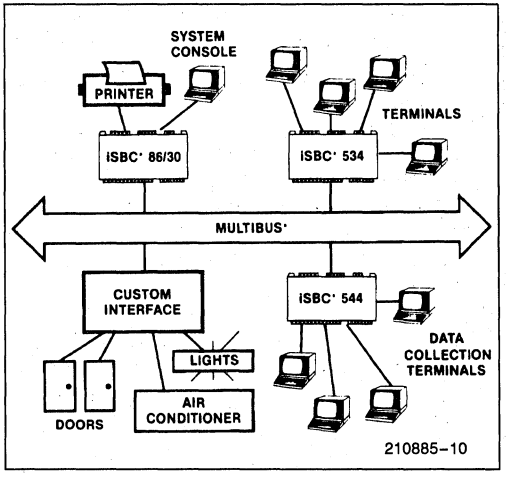


Figure 8. Multi-Terminal and Multi-User Real-Time System

Table 7. User Extension System Calls

System Call	Function Performed
RQ$CREATE$COMPOSITE	Creates a custom object built of previously defined objects.
RQ$DELETE$COMPOSITE	Deletes the custom object, but not the various objects from which it was built.
RQ$INSPECT$COMPOSITE	Returns a list of Token Identifiers for the component objects from which the specified composite object is built.
RQ$ALTER$COMPOSITE	Replaces a component object of a composite object.
RQ$CREATE$EXTENSION	Creates a new type of object and assigns a mailbox used for collecting these objects when they are deleted.
RQ$DELETE$EXTENSION	Deletes an extension definition.

SUPPORT OF STANDARDS

The iRMX 86 Operating System supports the many hardware and software standards needed by most application systems to ensure that commonly available hardware and software packages may be interfaced with a minimum of cost and effort. The iRMX 86 System supports the iSBC family of products built on the Intel MULTIBUS (IEEE Standard 796), and a number of standard software interfaces such as the UDI and the common device driver interface (See Figure 9). The procedural interfaces of the UDI are listed in Table 9.

The Operating System includes support for the proposed IEEE 80-bit extended real-variable format of the 8087 Numeric Data Processor, and the IEEE 796 (MULTIBUS) hardware interface. Other standards such as an Ethernet communication interface are supported by optional software packages available to run on the iRMX 86 System.

SPECTRUM OF CPU PERFORMANCE

The iRMX 86 Operating System supports a broad range of Intel processors. In addition to support for 8086 and 8088 based systems, the iRMX 86 system has been enhanced to support 80186, 80188, and 80286 (Real Address Mode)-based Systems. This new support enables the user to take advantage of the faster speed and higher performance of Intel's 286 based microprocessors such as the iSBC 286/10 single board computer. By choosing the appropriate CPU, designers can choose from a wide range of performance options, without having to change application software.

COMPONENT LEVEL SUPPORT

The iRMX 86 System may be tailored to support specific hardware configurations. In addition to sys-

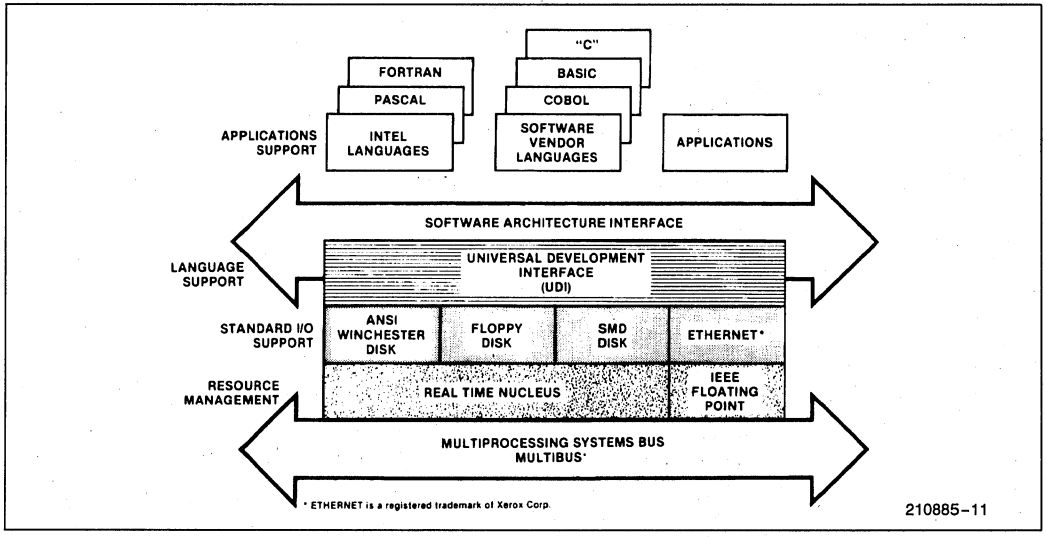


Figure 9. iRMX® 86 Standard Interfaces

tem memory, only an 8086, 8088, 80186, 80188, or 80286 microprocessor, an 8259A Programmable Interrupt Controller (PIC), and either an 8253, 8274, or 82530 Programmable Interval Timer (PIT) are required as follows:

- 8086 and 8088 systems need either:
  — 8253 PIT and 8259A PIC (master) or
  — 80130 firmware (PIC is master)
- 80186 and 80188 systems where 186 PIC is slave, needs either:
  — 8253 PIT and 8259A PIC (master) or
  — 80130 firmware (PIC is master)

  where 186 PIC is master:

  — Use 186 PIT for the system clock; no external PIT is needed
  —Can use either
  186 PIC (master) only or
  8259A/80130 PIC (slave)
- 80286 systems need
  —8253 PIT and 8259A PIC.

For systems requiring extended mathematics capability, an 8087 or 80287 Numeric Data Processor may be added to perform these functions up to 100 times faster than equivalent software. For applications servicing more than 8 interrupt sources, additional 8259A's may be configured as slave controllers.

BOARD LEVEL SUPPORT

The iRMX 86 Operating System includes device drivers to support a broad range of MULTIBUS device controllers. The particular boards and types of devices supported are listed in Table 8. The device controllers all adhere to industry standard electrical and functional interfaces.

In addition to the on-CPU board terminal drivers, the iRMX 80 BIOS includes two iSBD board-level device drivers to support multiple terminal interfaces:

The iSBC 544 Intelligent Four-Channel Terminal Interface Device Driver provides support for multiple controllers each supporting up to four standard RS232 terminals. The iSBC 644 driver takes advantage of an on-board 8085 processor to greatly reduce the system processor time required for terminal I/O by locally managing input and output buffers. The iSBC 544 firmware provided with the operating system can offload the system CPU by as much as 75% when doing character outputting.

The iSBC 534 Four-Channel USART Controller Device Driver also provides support for multiple controller boards each supporting up to four standard RS232 terminals.

The new RAM disk feature in iRMX 86 makes a portion of the memory address space look like a disk drive to the I/O system.

Table 8. Supported Devices

iSBC Device Controller	Description
iSBC 86, 88	Serial Port to CRT, Parallel Port to Centronics-type Printer, Interval Timer and Interrupt Controller.
iSBC 186/03	Small Computer System Interface (SCSI) Supporting All Random Access "Extended Standard" SCSI/SASI hard disk controllers.
iSBC 204	Single Density Diskette.
iSBC 206	Cartidge-Type Hard Disk.
iSBC 208	Single & Double Density, Single & Double Sided, 8" & 5.25" Diskettes.
iSBC 215 (G)	Standard Winchester Disks.
iSBX 218	Single or Double density, Single or Double sided, 8-inch diskettes (when used on an iSBC 215 (G)).
iSBX 218A	Single or Double Density, Single or Double Sided, 8" & 5.25" Diskette (when used on an iSBC 215G Winchester Controller).
iSBC 220	Standard Storage Module Board.
iSBX 251	Bubble Memory Multimodule Board.
iSBC 254(S)	Bubble Memory Board.
iSBX 351	1-Channel Serial Port to CRTs, Modems.
iSBC 534, 544	4-Channel Serial Ports to CRTs, Modems.
iSBX 270	Black and White CRTs and full ASCII keyboards.

NOTES:
(G) = Optional iSBC 215, iSBC 215B, or iSBC 215G
(S) = Optional iSBC 254 or iSBC 254S

Development Environment Features

The iRMX 86 Operating System supports the efficient utilization of programming time by providing important tools for program development. Some of the tools necessary to develop and debug real-time systems are included with the Operating System. Others, such as language compilers, are available from Intel and from leading Independent Software Vendors.

LANGUAGES

The iRMX 86 Operating System supports 31 standard system calls known as the Universal Development Interface (UDI). Figure 9 shows the iRMX 86 standard interfaces to many compilers and language translators, including the 8086 and 8088 Macro Assembler; the PASCAL86/88, PL/M 86/88, FORTRAN 86/88 and C86 compilers available from Intel.

Table 9. UDI System Calls

System Call	Function Performed
MEMORY MANAGEMENT	
DQ$ALLOCATE	Creates a Segment of a specified size.
DQ$FREE	Returns the specified segment to the System.
DQGETSIZE*	Returns the size of the specified Segment.
DQ$RESERVE$IO$MEMORY*	Reserves memory to OPEN and ATTACH files.
FILE MANAGEMENT	
DQ$ATTACH	Creates a Connection to a specified file.
DQ$CHANGE$ACCESS*	Changes the user access rights associated with a file or directory.
DQ$CHANGE$EXTENSION	Changes the extension of a file name in memory.
DQ$CLOSE	Closes the specified file Connection.
DQ$CREATE	Creates a Named File.
DQ$DELETE	Deletes a Named File.
DQ$DETACH	Closes a Named File and deletes its Connection.
DQ$OPEN	Opens a file for a particular type of access.
DQGETCONNECTION$STATUS*	Returns the current status of the specified file Connection.
DQ$FILES$INFO*	Returns data about a file Connection.
DQ$READ	Reads the next sequence of bytes from a file.
DQ$RENAME*	Renames the specified Name File.
DQ$SEEK	Moves the position pointer of a file.
DQ$TRUNCATE	Truncates a file.
DQ$WRITE	Writes a sequence of bytes to a file.
PROCESS MANAGEMENT	
DQ$EXIT	Exits from the current application job.
DQ$OVERLAY*	Causes the specified overlay to be loaded.
DQ$SPECIAL	Performs special I/O related functions on terminals with special control features.
DQ$TRAP$CC	Capture control when CNTRL/C is type.
EXCEPTION HANDLING	
DQGETEXCEPTION$HANDLER	Returns a pointer to the program currently being used to process errors.
DQ$DECODE$EXCEPTION	Returns a short description of the specified error code.
DQ$TRAP$EXCEPTION	Identifies a custom exception processing program for a particular type of error.
APPLICATION ASSISTANCE	
DQ$DECODE$TIME	Returns system time and date in binary and ASCII character format.
DQGETARGUMENT*	Returns the next argument from the character string used to invoke the application program.
DQGETSYSTEM$ID*	Returns the name of the underlying operating system supporting the UDI.
DQGETTIME*	Returns the current time of day as kept by the underlying operating system.
DQ$SWITCH$BUFFER	Selects a new buffer from which to process commands.

*Calls available only through the UDI.

Also included are other Intel development tools, language translators and utilities available from other vendors. The full set of UDI calls (which includes the URI system calls) is required to run a compiler.

These standard software interfaces (the UDI) ensure that users of the iRMX 86 Operating System may transport their applications to future releases of theiRMX 86 Operating System and other Intel and independent vendor software products. The calls available in the UDI are shown in Table 9.

The high performance of the iRMX 86 Operating System enhances the throughput of compilers and other development utilities. Table 10 indicates the average performance of typical development environment functions operating in the same configuration described in Figure 4.

Table 10. Development Environment Performance

Function	Average Execution Time
Directory Command (S Format with 25 files)	5.3s
Load the COPY Command	1.2s
Copy a 1K Byte File (Winchester to Winchester)	1.0s
Copy a 16K Byte File	1.7s
Copy a 64K Byte File	3.9s
Copy a 1K Byte File (Winchester to Diskette)	1.4s
Compile PL/M 86	393 lpm
Compile PASCAL 86 Program	453 lpm

TOOLS

Certain tools are necessary for the development of microcomputer applications. The iRMX 86 Human Interface includes many of these tools an non-resident commands. They can be included on the system disk of a application system, and brought into memory when needed to perform functions as listed in Table 11.

Table 11. Major Human Interface Utilities

Command	Function
BACKUP	Copy directories and files from one device to another.
COPY	Copy one or more files to one or more destination files.

Table 11. Major Human Interface Utilities
(Continued)

Command	Function
CREATEDIR	Create a directory file to store the names of other files.
DIR	List the names, sizes, owners, etc. of the files contained in a directory.
ATTACHFILE	Give a logical name to a specified location in a file directory tree.
PERMIT	Grant or rescind user access to a file.
RENAME	Change the name of a file.
SUBMIT	Start the processing of a series of commands stored in a file.
SUPER	Change operator's ID to that of the System Manager with global access rights and privileges.
TIME	Set the system time-of-day clock.
VERIFY	Verify the structure of an IRMX 86 Named File volume, and check for possible disk data errors.

INTERACTIVE CONFIGURATION UTILITY

The iRMX 86 Operating System is designed to provide OEMs the ability to configure for specific system hardware and software requirements. The Interactive Configuration Utility (ICU) builds iRMX 86 configurations by asking appropriate questions and making reasonable assumptions. It runs on either an Intellec® Series III or IV development system or iRMX 86 development system that includes a hard disk and the UDI. Table 12 lists the hardware and support software requirements of different iRMX 86 development system environments.

Table 12. iRMX® Development Environment

Intellec Series III or IV: MDS 313 PL/M 86/88 Compiler One hard disk and one diskette drive
iRMX 86 Development System: iRMX 860 ASM 86 Assembler and Utilities iRMX 863 PL/M 86/88 Compiler iSDM 86 or 286 System Debug Monitor 512K Bytes of RAM 5M Byte On-Line Storage and one double-density diskette drive
SYSTEM 86/300 or 286/300 Series: Microcomputer System Basic configuration

Figure 10 shows one of the many screen displayed during the process of defining a configuration. It shows the abbreviations for each choice on the left, a more complete description with the range of possible answers in the center, and the current (sometimes default) choice on the right. The bottom of the screen shows three changes made by the operator (lower case lettering), and a request for help on the Exception Mode question. In response to a request for help, the ICU displays an additional screen outlined possible choices and some overall system effects.

The ICU requests only information required as a result of previous choices. For example, if no Extended I/O System functions are required, the ICU will not ask any further questions about the EIOS. Once a configuration session is complete, the operator may save all the information in a file. Later when small changes are necessary, this file can be modified. A completely new session is not required.

REAL-TIME DEBUGGING TOOLS

The iRMX 86 Operating System supports two distinct debugging environments: Static and Dynamic. While the iRMX 86 Operating System does support a multi-user Human Interface, these real-time debugging aids are usually most useful in a single-user environment where modifications made to the system cannot affect other users.

System Debugger

The static debugging aid is the iRMX 86 System Debugger. This debugger is an extension of the iSDM 86 and the iSDM 286 System Debug Monitors. The System Debugger provides static debugging facilities when the system hangs or crashes, when the Nucleus is inadvertently overwritten or destroyed, or when synchronization requirements prevent the debugging of certain tasks. The System Debugger stops the system and allows you to examine the state of the system at that instant, and allows you to:

— Identify and interpret iRMX 86 system calls.
— Display information about iRMX 86 objects.
— Examine a task's stack to determine system call history.

iRMX® 86 Dynamic Debugger

The iRMX 86 Dynamic Debugger runs as part of an iRMX 86 application. It may be used at any time during program development, or may be integrated into an OEM system to aid in the discovery of latent errors. The Dynmic Debugger can be used to search for errors in any task, even while the other tasks in the system are running. The iRMX 86 Dynamic Debugger communicates with the developer via a terminal handler that supports full line editing.

PARAMETER VALIDATION

Some iRMX 86 System Calls require parameters that may change during the course of developing iRMX 86 applications. The iRMX 86 Operating System includes an optional set of routines to validate these parameters to ensure that correct numeric values are used and that correct object types are used where the System expects to manipulate an object. For systems based only on the iRMX 86 Nucleus, these routines may be removed to improve the performance and code size of the System once the development phase is completed.

START-UP SYSTEMS

Two ready-to-run start-up systems are included in the iRMX 86 Operating System package. These iRMX 86 start-up systems are fully configured, iRMX 86 Operating Systems ready to be loaded into memory by the Bootstrap Loader. Both start-up systems are configured to include all of the system calls for each layer and most of the features provided by iRMX 86. iRMX start-up systems include UDI support so that users may run languages such as PL/M-86, Pascal, FORTRAN, and software packages from independent vendors.

```
Nucleus
(ASC)    All Sys Calls [Yes/No]                          Yes
(PV)     Parameter Validation [Yes/No]                   Yes
(ROD)    Root Object Directory Size [0-0FF0h]            0014H
(MTS)    Minimum Transfer Size [0-0FFFFH]                0040H
(DEH)    Default Exception Handler [Yes/No/Deb/Use]      Yes
(NEH)    Name of Ex Handler Object Module [1-32 chs]
(EM)     Exception Mode [Never/Program/Environ/All]      Never
(NR)     Nucleus in ROM [Yes/No]                         No

Enter Changes [Abbreviations ?/ = new-value]:  ASC = N
:pv = no
:rod = 48
:em?
```

Figure 10. ICU Scree for iRMX® 86 Nucleus

The start-up system for the 8086 processor is configured for Intel SYSTEM 86/300 Series microcomputers with a minimum of 384K bytes of RAM. The following devices are supported.

- iSBC 215/iSBX 218 or iSBC 215G/iSBX 218A or iSBC 214
- Line Printer
- 8251A Terminal Driver
- iSBC 544, Terminal Driver

The start-up system for the 80286 processor is configured for Intel SYSTEM 286/300 Series microcomputers with a minimum of 512 Kbytes and a maximum of 896 Kbytes of RAM. The following devices are supported.

- iSBC 208
- iSBC 215/iSBX 218 or iSBC 215G/iSBX 218A
- iSBC 254(S)
- Line Printer for iSBC 286/10
- 8274 Terminal Driver
- iSBC 544 Terminal Driver

Either system will run without hardware or software configuration changes and can be reconfigured on a standard system with at least 512 Kbytes of RAM. Definition files are also included for iSBC 186/03, 186/51 and 188/48 configurations.

This start-up system may be used to run the ICU (if a Winchester disk is attached to the system) to develop custom configurations such as those pictured in Figure 8. As shipped, the Human Interface supports a single user terminal. However, the Start-up System terminal configuration file may be altered easily to support from two to five users.

SPECIFICATIONS

Supported Software Products

iRMX 860	iRMX 86 Development Utilities Package, including the 8086 and 8088 Linker, Locater, Macro Assembler, Librarian, and the iRMX 86 Editor.
iRMX 861	PASCAL 86/88 Compiler
iRMX 862	FORTRAN 86/88 Compiler
iRMX 863	PL/M 86/88 Compiler
iRMX 864	AEDIT Screen-oriented Editor
iRMX PSCOPE 86	High Level Language Debugger

Supported Hardware Products

COMPONENTS

8086 and 8088 Microprocessors
80186 and 80188 Microprocessors
80286 Microprocessors (Real Address Mode Only)
8087 Numeric Data Processor Extension
80287 Numeric Data Processor Extension
8253 and 8254 Programmable Interval Timers
8259A Programmable Interrupt Controller
8251A USART Terminal Controller
8255 Programmable Parallel Interface
8274 Terminal Controller
82530 Serial Communications Controller

iSBC® MULTIBUS BOARD AND SYSTEM PRODUCTS

iSBC 86/12A, 80/05, 86/14, 86/30, 86/35, 88/25, and 88/40 Single Board Computers
- iSBC 186/03 Single Board Computer
- iSBC 186/51 Ethernet Controller
- iSBC 188/48 Communications Controller
- iSBC 286/10 Single Board Computer (Real Address Mode only)

iSBC 204 Diskette Controller
iSBC 206 Hard Disk Controller
iSBC 208 Diskette Controller
iSBC 215(G) Winchester Disk Controller
iSBX 281(A) Flexible Diskette Multi-Module Controller
iSBC 220 SMD Disk Hard Controller
iSBC 254(S) Bubble Memory System
iSBC 534 4-Channel Terminal Interface
iSBC 544 Intelligent 4-Channel Terminal Interface and Controller
iSBX 251 Bubble Memory Multi-Module
iSBX 350 Parallel Port (Centronics-type Printer Interface)
iSBX 351 Serial Communications Port
iSBX 270 CRT Light Pen and Keyboard Interface
SYSTEM 86/300 Family
SYSTEM 286/300 Family

AVAILABLE LITERATURE

The iRMX 86 Documentation Set is comprised of the following five volumes of reference manuals. Order numbers are associated with these five volumes only.

Volume I	iRMX 86 OPERATING SYSTEM USER GUIDES
Volume II	iRMX 86 SYSTEM CALLS
Volume III	iRMX 86 OPERATING SYSTEM UTILITIES
Volume IV	iRMX 86 INSTALLATION AND PROGRAMMER'S GUIDES
Volume V	iRMX 86 INTERACTIVE CONFIGURATION UTILITY REFERENCE GUIDE

Training Courses

The iRMX 86 Operating System

Customer Seminars

Contact local Intel Sales Office for details on available video-tape and slide presentations.

ORDERING INFORMATION

The iRMX 86 Operating System is available under a number of different licensing options as noted here. Reconfigurable object libraries are provided on double density ISIS-formatted diskettes or on either double density, single sided iRMX 86-formatted 8″ diskettes, or double density, double sided, 5.25″ diskettes. ISIS-format diskettes may be used on Intel Intellec Development Systems. The iRMX 86-format may be used on any iRMX 86-based system supporting the appropriate compilers and development environment.

The OEM license options listed here allow users to incorporate the iRMX 86 Operating System into their applications. Each use requires payment of an Incorporation Fee.

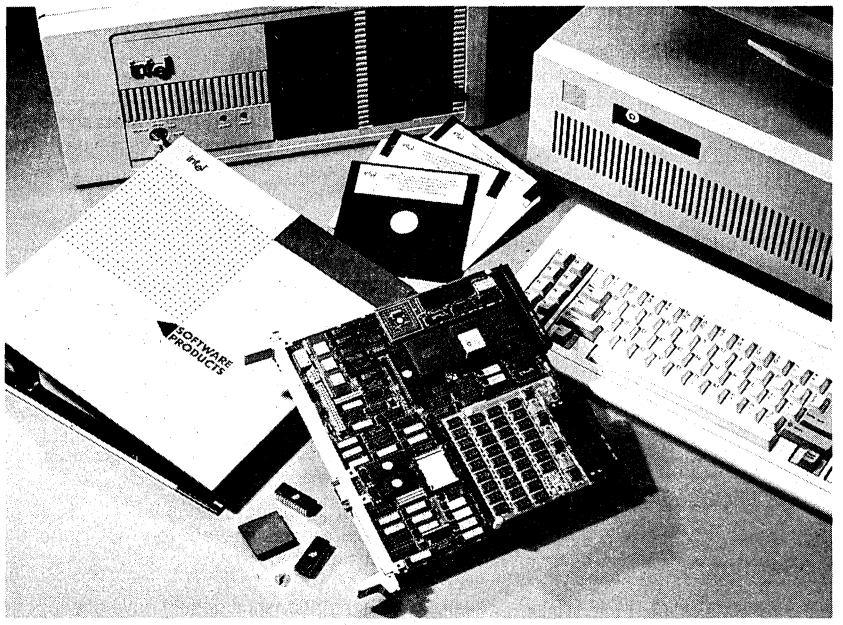
Order Code	Description
iRMX 86 KIT BRO:	Double density, single-sided 8″ ISIS format OEM license
iRMX 86 KIT ERO:	Double density, single sided 8″ iRMX 86-Format OEM license for use on iRMX 86-based environments.
iRMX 86 KIT JRO:	Double density, double sided 5.25″ iRMX 86-Format OEM license for use on iRMX 86-based environments.

Other licensing options include single use rights for a single machine and one year update service extensions.

Each option includes 90 days of support service that provides the quarterly iRMX 86 Technical Report, Software Problem Report Service, and copies of System Updates that occur during this period. All initial licenses include a complete set of iRMX 86 Documentation.

As with all Intel software, purchase on any of these options requires the execution of a standard Intel Master Software License. The specific rights granted to users depends on the specific option and the License signed.

iRMK™ VERSION 1.1 REAL-TIME KERNEL



The iRMK™ Version 1.1 Real-time Kernel is the 32-bit real-time executive developed, sold, and supported by Intel, the 80386 experts. It reduces the cost and risk of designing and maintaining software for numerous real-time applications such as embedded control systems and dedicated real-time subsystems in multiprocessor systems.

FEATURES

- 32-bit real-time multitasking kernel
- Rich set of real-time services
- Designed and optimized for the 80386
- Extremely fast execution with predictable response times for time critical applications
- Compact design, as small as 8K bytes
- Multiprocessor support
- Requires only the 80386; Provides optional support for 80387 and other peripheral devices.
- Works with any bus; Optional MULTIBUS II message passing support provided.
- Designed for easy customization and enhancement
- Easily programmed into PROMs or EPROMs
- Comprehensive development tool support
- Supported by Intel

intel

June, 1987
Order Number: 280613-001

REAL-TIME SOFTWARE FROM THE INDUSTRY LEADER

Intel has been the industry leader in microprocessor-based real-time computing since it invented the microprocessor. No other company supplies the range of real-time solutions that we do. Since 1977, thousands of customers have used our iRMX® real-time operating systems.

Now Intel has put its real-time expertise into a 32-bit kernel that supports the 80386 microprocessor. The iRMK Version 1.1 Kernel saves you the cost of designing, debugging, and maintaining your own executive for real-time systems. You can concentrate on writing your application rather than a kernel.

THE QUICKEST PATH FOR A WIDE RANGE OF REAL-TIME APPLICATIONS

The iRMK Kernel's rich set of real-time services in a fast, compact design makes it ideal for a wide range of real-time applications, including:

Data acquisition and analysis
Continuous process control
Discrete process control
Simulation
Medical instruments
Test instrumentation
Image processing
Automated test
Avionics and navigation
Field command control
Energy and environmental control
Radio control
Satellite communications
Terminals
Graphics work stations
Robotics
Signal processing
Laser printers
Front-end concentrators
Host communications

A RICH SET OF REAL-TIME SERVICES

The iRMK Version 1.1 Kernel provides a rich set of services for real-time applications, including:

- Task management with system calls to create, manage, and schedule tasks in a multitasking environment. The kernel offers pre-emptive priority scheduling combined with optional time-slice (round robin) scheduling.

  The scheduling algorithm used by the iRMK Kernel allows tasks to be rescheduled in a fixed amount of time regardless of the number of tasks. Applications may contain any number of tasks.

  An application can provide optional handlers to customize task management. These handlers can execute on task creation, task switch, task deletion, and task priority change.

- Interrupt management by immediately switching control to user-written interrupt handlers when an interrupt occurs. Response to interrupts is both fast and predictable. Most of the kernel's system calls can be executed directly from interrupt handlers.

- Time management providing single-shot alarms, repetitive alarms, and a real-time clock. The kernel's time management facilities can be used to put tasks to sleep for specified periods of time.

- Mailboxes and semaphores for intertask synchronization and communication. Either data or pointers to memory can be sent using mailboxes. The kernel allows messages of any length.

  Semaphores can be binary or counting. Dynamic task priority adjustment is supported. Tasks waiting for messages or semaphores can be queued by priority or first-in, first-out ordering.

- Memory pool manager that provides fixed and variable block allocation. The memory manager works with flat, segmented, and paged addressing. Users can write their own memory manager to provide different memory management policies or to support virtual memory.

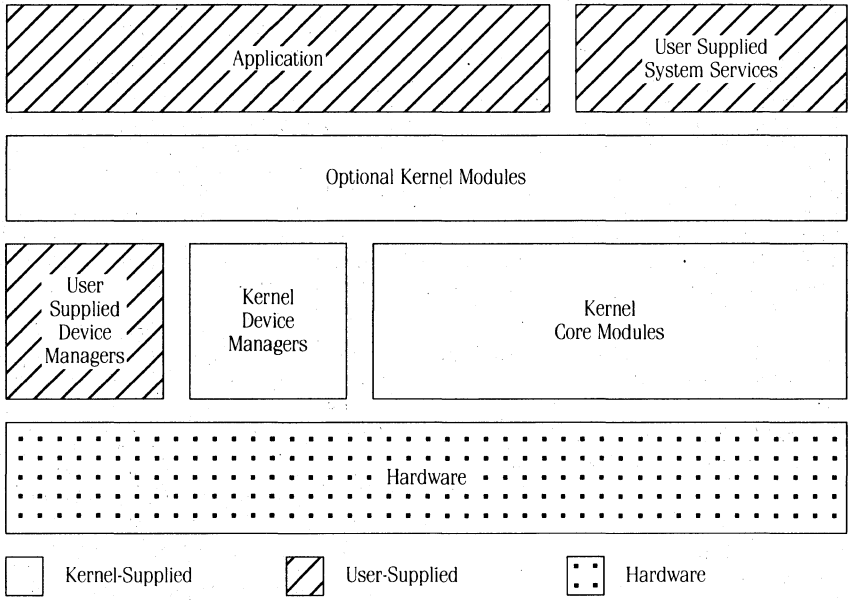


Figure 1: iRMK™ Version 1.1 Real-Time Kernel System Structure

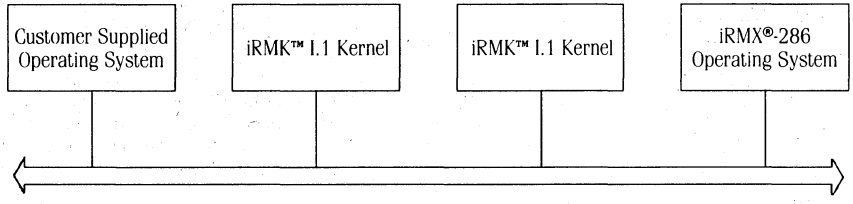


Figure 2: The optional MULTIBUS® II message passing modules give the iRMK 1.1 Version Kernel full multiprocessing capabilities for distributing applications among processors and interoperating with other operating systems.

SUPPORT FOR MULTIPROCESSING VIA MULTIBUS® II

Two optional modules allow iRMK applications to make full use of the MULTIBUS® II architecture. The first module implements message passing using Intel's MULTIBUS II transport protocol. The second implements interconnect space access.

These modules can be used to implement high performance multiprocessor designs that:

- Distribute an application that's too large for a single processor between several processors
- Provide redundancy
- Dedicate processors to specific tasks
- Provide interoperation with any operating system which uses Intel's MULTIBUS II transport protocol, including the iRMX™ 286, iRMK I.1, and UNIX operating systems

HARDWARE REQUIREMENTS AND SUPPORT

The iRMK Kernel requires only an 80386 microprocessor and sufficient memory for itself and its application. Its design, however, recognizes that many systems use additional programmable peripheral devices and coprocessors. The kernel provides optional device managers for:

- The 80387 Numeric Coprocessor
- The 8254 Programmable Interval Timer
- The 8259A Programmable Interrupt Controller

An application can supply managers for other devices and coprocessors.

The iRMK Kernel was designed to be easily programmed into PROM or EPROM, making it easy to use in embedded designs.

The iRMK Kernel can be used with any system bus including the MULTIBUS I and MULTIBUS II busses. The optional MULTIBUS II message passing and Interconnect Space access modules use the Message Passing Coprocessor and the 82258 Advanced DMA controller.

SUPPORT FOR THE 80386 ARCHITECTURE

The iRMK Kernel provides 32-bit, protected mode 80386 operation. By default, the kernel and its application execute in a flat memory space of up to 4 gigabytes and in a single privilege level. Applications can add support for any mixture of additional protected mode features including:

- Any model of segmentation
- Memory paging
- Virtual memory
- Multiple privilege levels
- Call and trap gates

The iRMK Kernel provides an optional Descriptor Table manager that simplifies descriptor table management.

COMPREHENSIVE DEVELOPMENT TOOL SUPPORT

Intel provides a complete line of 80386 development tools for writing and debugging iRMK Kernel applications. These tools include:

Languages:	PL/M 386
	C 386
	ASM 386[1]
	80386 Utilities
Debuggers:	ICE™ 86
	P-MON 386
	D-MON 386

These tools run on IBM[2] PC AT systems and compatibles running PC-or MS-DOS[3] 3.X. The iRMK Version I.1 Kernel software is available on IBM PC format 5¼", 360K byte diskettes.

INTEL SUPPORT, CONSULTING, AND TRAINING

With the iRMK Kernel you get the 80386 and real-time expertise of Intel's customer support engineers. They provide phone support, on- or off-site consulting, troubleshooting guides, and updates. The kernel includes 90 days of Intel's Technical Information Phone Service (TIPS). Extended support and consulting are also available.

[1] Available in August 1987.
[2] IBM is a registered trademark of the International Business Machines Corporation.
[3] MS-DOS is a trademark of Microsoft Corporation.

iRMK™ VERSION 1.1 KERNEL SYSTEM CALLS[4]

KERNEL INITIALIZATION

KN_initialize	Initialize kernel

OBJECT MANAGEMENT

KN_token_to_ptr	Returns a pointer to area holding object

TASK MANAGEMENT

KN_create_task	Create a task
KN_delete_task	Delete a task
KN_suspend_task	Suspend a task
KN_resume_task	Resume a task
KN_set_priority	Change priority of a task
KN_get_priority	Return priority of a task

INTERRUPT MANAGEMENT

KN_set_interrupt	Specify interrupt handler
KN_stop_scheduling	Suspend task switching
KN_start_scheduling	Resume task switching

TIME MANAGEMENT

KN_sleep	Put calling task to sleep
KN_create_alarm	Create and start virtual alarm clock
KN_delete_alarm	Delete alarm
KN_get_time	Get time
KN_set_time	Set time
KN_tick	Notify kernel that clock tick has occurred

INTERTASK COMMUNICATION AND SYNCHRONIZATION

KN_create_semaphore	Create a semaphore
KN_delete_semaphore	Delete a semaphore
KN_send_unit	Add a unit to a semaphore
KN_receive_unit	Receive a unit from a semaphore
KN_create_mailbox	Create a mailbox
KN_delete_mailbox	Delete a mailbox
KN_send_data	Send data to a mailbox
KN_receive_data	Request a message from a mailbox

MEMORY MANAGEMENT

KN_create_pool	Create a memory pool
KN_delete_pool	Delete a memory pool
KN_create_area	Create a memory area from a pool
KN_delete_area	Return a memory area to a memory pool
KN_get_pool_attributes	Get a memory pool's attributes

DESCRIPTOR TABLE MANAGEMENT

KN_get_descriptor_attributes	Get a descriptor's attributes
KN_set_descriptor_attributes	Set a descriptor's attributes
KN_initialize_LDT	Initialize local descriptor table (LDT)
KN_null_descriptor	Overwrite a descriptor with the null descriptor
KN_linear_to_ptr	Convert a linear address to a pointer
KN_ptr_to_linear	Convert a pointer to a linear address
KN_get_data_selector	Get the selector for the data segment
KN_get_code_selector	Get the selector for the code segment

8259A PIC MANAGEMENT

KN_initialize_PICs	Initialize the 8259A PICs
KN_mask_slot	Mask out interrupts on a specified slot
KN_unmask_slot	Unmask interrupts on a specified slot
KN_send_EOI	Signal the PIC that the interrupt on a specified slot has been serviced
KN_new_masks	Change interrupt masks
KN_get_slot	Return the most important active interrupt slot

8254 PIT MANAGEMENT

KN_initialize_PIT	Initialize an 8254 PIT
KN_start_PIT	Start PIT counting
KN_get_PIT_interval	Return PIT interval

80387 NUMERIC COPROCESSOR MANAGEMENT

KN_initialize_NDP	Initialize an 80387 Numeric Coprocessor

MULTIBUS® II MESSAGE PASSING MANAGEMENT

KN_initialize_message_passing	Initialize the message passing module
KN_send_tp	Send a transport message
KN_attach_receive_mailbox	Attach a receive mailbox
KN_cancel_tp	Cancel a solicited message or request-response transaction
KN_send_dl	Send a data link message
KN_attach_protocol_handler	Attach a protocol handler
KN_cancel_dl	Cancel a data link buffer request

MULTIBUS® II INTERCONNECT SPACE MANAGEMENT

KN_initialize_interconnect	Initialize the interconnect module
KN_get_interconnect	Get the value of an interconnect register
KN_set_interconnect	Set the value of an interconnect register
KN_local_host_ID	Get the host ID of the local host

[4]System calls Copyright © 1987 Intel Corporation.

ORDERING INFORMATION

Order Code	*Product*	*Contents*
RMKI1	iRMK Version I.1 development software	iRMK Version I.1 Kernel Software
RMKI1DEV-P[5] RMKI1DEV-C[5]	iRMK Version I.1 Kernel Developer's Kit	iRMK Version I.1 Kernel Software PL/M 386 or C 386 ASM 386 80386 Utilities
RMKI1MBI-P[5] RMKI1MBI-C[5]	iRMK Version I.1 Kernel Starter Kit Can be used for MULTIBUS I or custom designs	iRMK Version I.1 Kernel Software iSBC 386/21 PL/M 386 or C 386 ASM 386 80386 Utilities P-MON 386
RMKI1MBII-P[5] RMKI1MBII-C[5]	iRMK Version I.1 Kernel Starter Kit Can be used for MULTIBUS II or custom designs	iRMK Version I.1 Kernel Software iSBC 386/116M01 iSBX 351 PL/M 386 or C 386 ASM 386 80386 Utilities P-MON 386
	Technical Information Phone Support	Phone support, *;Comments* Magazine, Troubleshooting Guides
CONSULT/DAILY CONSULT/LT	On- or off-site consulting on iRMK I.1 Kernel or other Intel products by Intel systems engineer. Available on a daily or long term basis.	
	80386 Programming Using ASM 386	Customer Training Workshop
	80386 System Software	Customer Training Workshop
	80386 System Hardware Design	Customer Training Workshop

[5] Expected availability: September 1987.
Information subject to change without notice.

iRMX® 286 Release 2.0 Operating System

The iRMX® 286 Release 2.0 Operating System is system software designed specifically for real time applications. The product of ten years of real time expertise by Intel, the iRMX 286 Release 2.0 Operating System provides high performance response to external events, excellent support of special purpose hardware, and sophisticated real time programming facilities.

ADVANCED FEATURES AVAILABLE TODAY

- 80286 and 80386 microprocessor support
- 80287 and 80387 numeric coprocessor support
- 16 megabyte memory addressability
- Multiple tasks and multiple jobs
- Multiple users
- Priority based and/or round robin scheduling
- Object oriented architecture

A COMPLETE REAL TIME OPERATING SYSTEM, NOT JUST A KERNEL

- Major functions of the iRMX 286 Release 2.0 Operating System include:
  - —Nucleus
  - —File System
  - —Basic I/O System including device drivers for many Intel Multibus I/O boards
  - —Extended I/O System
  - —Bootstrap Loader
  - —Application Loader
  - —Human Interface supporting on target development and end user reprogramming
  - —System Debugger
  - —Optional networking to systems running the MS-DOS, VAX/VMS, XENIX*, iNDX, iRMX 86 Release 7.0, and iRMX 286 Release 2.0 Operating Systems

SOFTWARE WITH A FUTURE

- The leading real time microprocessor software with over 6000 licenses sold
- An active iRMX Users Group (iRUG) with over 40 chapters worldwide, a regular newsletter, and an annual technical convention.
- Future 8086 family processors will be supported by iRMX operating systems.
- Highly compatible with the iRMX 86 Release 7.0 Operating System

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*MS-DOS is a trademark of Microsoft Corporation. XENIX is a trademark of Microsoft Corporation. UNIX is a trademark of Bell Laboratories. VAX and VMS are trademarks of Digital Equipment Corporation.

June, 1987
Order Number: 280618-001

SUPPORT FOR THE FULL RANGE OF REAL TIME APPLICATIONS

The iRMX 286 Release 2.0 Operating System supports the full range of real time applications, from embedded control designs, to reprogrammable systems which require dynamic creation, deletion, and prioritization of tasks. This flexibility makes it possible to save substantial staff retraining and software maintenance costs by using a single operating system for many different real time systems and subsystems. The iRMX 286 Release 2.0 Operating System is ideal for such applications as:

avionics
communications
communication concentrators
data acquisition and analysis
energy management
factory automation
financial trader workstations
Image processing
machine control
manufacturing test
medical instruments
military
process control
railroad control
rockets
satellite communications
simulation
SCADA systems
transaction processing

REAL TIME SOFTWARE FOR REAL TIME APPLICATIONS

Real Time Applications are easier to develop with special software. Operating Systems designed for general business use typically lack essential real time features, so real time application development is often expensive, difficult, or even impossible. In contrast, the iRMX 286 Release 2.0 Operating System is real time software designed to make the development of real time applications easy and successful.

- **High performance.**
  For real time applications, the iRMX 286 Release 2.0 Operating System is typically 100 times faster than general purpose operating systems. This high performance enables applications based on the iRMX 286 Release 2.0 operating system to keep up with the rapid data and control flow of machine and communication interfaces.

- **A rich set of real time programming facilities.**
  The iRMX 286 Release 2.0 Operating System includes a rich set of real time programming facilities that are usually missing in whole or in part from non-real time operating systems. These facilities include:
  —interrupt management with custom exception handlers
  —support for multiple tasks
  —preemptive, priority based scheduling with round robin (time slice) scheduling within a priority level
  —intertask communication through mailboxes and semaphores

- **Easily programmed into PROM.**
  Real time applications built on the iRMX 286 Release 2.0 Operating System are easily programmed into PROM's or EPROM's for highly reliable embedded systems which do not require disks. A complete set of languages which support reentrant code are available for use with the iRMX 286 Release 2.0 Operating System.

- **Excellent Support for special purpose hardware.**
  Most real time applications involve some special purpose hardware, and general purpose operating systems are often relatively monolithic and difficult to interface to this hardware. In contrast, the iRMX 286 Release 2.0 Operating System is a highly configurable, modular software system which easily supports custom hardware. Support for special purpose hardware includes:
  —the ability to configure the operating system by layer
  —hooks for user written handlers at key points
  —the ability to add operating system extensions.
  —standard device driver interfaces

- **Support for designs based on Intel systems, single board computers, and components.**

Central Processing Unit Support

Systems— Bootable preconfigured software is included for:
Intel System 310 AP family
Intel System 320 family

Single Board Computers—Preconfigured software is included for:
iSBC 286/10A, iSBC 286/12
iSBC 386/2X

Component Designs—Minimum required hardware to run the iRMX 286 Release 2.0 Operating System:
80286 or 80386 microprocessor
8259A Programmable Interrupt Controller
8254 or 8253 Programmable Interrupt Handler
Necessary memory

A COMPLETE REAL TIME OPERATING SYSTEM, NOT JUST A KERNEL

With comparable performance, the iRMX 286 Release 2.0 operating system provides many features that are extra cost items, or simply unavailable, in real time kernels. These features make the development of real time applications much easier and faster, but do not add unneccessary overhead. In fact, all functional layers except the nucleus are optional in the iRMX 286 Release 2.0 operating system. This flexibility allows you to include only those features that your application requires.

The following is a brief description of the major functional groups within the iRMX 286 Release 2.0 Operating System.

A COMPLETE REAL TIME OPERATING SYSTEM (continued)

Nucleus
The Nucleus is the heart of the operating system and controls all resources available to the system. The nucleus provides key real time features including:

- support of multiple tasks
- priority based and/or time slice scheduling
- dynamic priority adjustment
- memory management with 16 megabyte addressability
- intertask communication and synchronization using mailboxes and semaphores
- interrupt management with custom exception handlers
- descriptor table management
- time management
- object management
- the addition of custom Operating System extensions.

Basic I/O System (BIOS)
The Basic I/O System (BIOS) provides primitives to read from and write to peripherals, as well as the ability to buffer I/O. The BIOS also sets up the file structures used by the system and provides access to all required peripherals through a standard device driver interface. Many device drivers are provided with the iRMX 286 Release 2.0 Operating System, and custom device drivers and file drivers may be added by the user.

Device Drivers Included with the iRMX® 286 Release 2.0 Operating System

Terminal Communications	Supports Terminal Communications for the iSBC 188/56, iSBC 546, iSBC 547, and iSBC 548 single board computers
iSBC 208	Flexible Disk Controller
iSBC 220	SMD Disk Controller
iSBC 214	Multi-Peripheral Controller
iSBC 215G	Winchester Disk Controller
iSBX™ 218A	Flexible Disk Controller
iSBX 217C	Tape Controller
iSBX 350	Parallel Port (Centronix-type Printer Interface)
iSBC 534	4 Channel Terminal Interface
iSBC 544A	Intelligent 4 Channel Terminal Interface and Controller
8251A	Serial Communications Port
iSBX 354	2 Channel Serial Port
82530	Serial Communications Controller
RAM	Memory Driver

Extended I/O System (EIOS)
The Extended I/O System (EIOS) provides similar services to the BIOS, with simplified calls that give less explicit control of device behavior and performance. The EIOS also provides a logical-to-physical device connection, and allows a program to specify a logical address for output.

Universal Development Interface (UDI)
The Universal Development Interface provides an easy to use interface with a standard set of system calls to allow programs and languages to be easily transported to or from the iRMX 286 Release 2.0 Operating System to other operating systems which support the UDI standard.

Application Loader
The Application Loader is used to load programs from mass storage into memory, where they execute. Programs may be loaded under program or operator control.

Bootstrap Loader
The Bootstrap Loader is used to load the operating system or an application system from mass storage into memory, and then to begin the system's execution.

System Debugger
The System Debugger is used to debug applications and give a view into the system itself.

Human Interface
The Human Interface allows multiple users to effectively develop applications, maintain files, run programs, and communicate with the operating system. It consists of a set of system calls, a set of commands, and a Command Line Interpreter. Commands are available for file management, device management, and system status. The Command Line Interpreter is a sophisticated tool for program development and system design. Its features include dynamic logon, full line editing, user extensions, and support for background jobs. In addition, the Command Line Interpreter may be replaced for special applications. For example, a Computer Aided Tomography (CAT) scanner controlled by the iRMX 286 Release 2.0 Operating System could use a custom Command Line Interpreter to allow the operator to direct the movement of the scanner.

iRMX®-Net Networking software (available separately)
The iRMX 286 Release 2.0 Operating System is designed to work with iRMX-NET networking software to provide transparent file access to systems running the iRMX 86 Release 7.0, iRMX 286 Release 2.0, MS-DOS, XENIX, iNDX, and VAX/VMS operating systems. iRMX-NET is ISO standard networking software for ethernet local area networks.

iRMX networking allows your real time application to communicate effectively with general purpose computer systems as well as other real time systems.

iRMX® 286 Release 2.0 Configuration Size*

System Layer	Code Size	Data Size
Nucleus	30KB	2KB
BIOS	86KB	112 bytes
EIOS	18KB	16 bytes
UDI	8KB	32 bytes
Application Loader	10KB	100 bytes
System Debugger	31KB	1KB
Human Interface	83KB	224 bytes

*All layers are optional except the nucleus.

ON TARGET DEVELOPMENT—A BETTER WAY TO DEVELOP REAL TIME APPLICATIONS

Designers familiar with both cross development and on target development agree that on target development is the easier, more reliable method for developing applications. Testing is greatly simplified, and you need become comfortable with only one operating system. Furthermore, a whole set of bugs is avoided by eliminating the transition from one operating system to another.

The iRMX 286 Release 2.0 Operating System provides solid on target development capability—a capability entirely missing from other real time software for microprocessors.

Developers can use the full rich feature set of the iRMX 286 Release 2.0 Operating System for development, but then include only a minimum set of iRMX functions in their final application. As a result, your final application receives the benefits of on target development without the overhead that general purpose operating systems incur.

Development facilities included with the iRMX 286 Release 2.0 Operating System:

- a Human Interface supporting multiple users
- 37 Human Interface commands for system status, device management, and file management
- a sophisticated Command Line Interpreter supporting background jobs and full line editing
- Interactive Configuration Utility (ICU)—
  a utility for assisting an iRMX developer in the configuration process. The Interactive Configuration Utility prompts the user for system parameters and requirements, then builds a command file to compile, assemble, build, and bind necessary files.
- Hardware traps to catch up to 90% of typical programming errors
- System Debugger (requires the iSDM Monitor)
- Bootstrap loader with debug option
- Parameter and Data validation
- Universal Development Interface
- Numerous device drivers for Intel Multibus boards

Development facilities available separately for use with the iRMX 286 Release 2.0 Operating System:

- Reentrant languages—PL/M 286, PASCAL 286, FORTRAN 286, and C 286
- AEDIT—a menu-driven, screen-oriented text editor
- iSDM R3.0 System Debug Monitor—
  Allows downloading from an iRMX 286 Release 2.0 host to an iRMX 286 Release 2.0 or iRMX 86 Release 7.0 target
- Soft-Scope 286 debugger—
  a tasking debugger
- ASM286—an 80286 Development Utilities Package including the 80286 Macro Assembler, Builder, Binder, Librarian and Mapper
- ASM86—an 8086 Development Utilities Package including the 8086 Macro Assembler, Linker, Locator, Librarian, and line editor
- iRMX-NET Networking—allows your development effort to be shared over several systems. Includes support for both the iSBC 186/51 and the iSBC 552A Ethernet Controllers
- VDI™ 720—Graphics software for the iSBC™ 186/78A graphics controller
- iPAT—a Performance Analysis Tool, hosted on an IBM PC-AT or equivalent, to aid in the performance optimization of an iRMX application.
- In Circuit Emulators—hosted on an IBM PC-AT or equivalent, to aid in hardware debugging and software tracing
- a variety of user supplied utilities and special software are available from the iRMX Users Group (iRUG)

SOFTWARE WITH A FUTURE

With over 6000 OEM and development licenses outstanding, the iRMX operating systems are far and away the leading real time software for microprocessors. The iRMX community has grown so that today there is an active iRMX Users Group (iRUG) with over 40 chapters worldwide, an annual technical convention, and a regular newsletter. In addition major universities such as the University of North Carolina, Cornell University, and the University of California at Berkeley use iRMX software and/or teach real time programming courses featuring the iRMX operating systems.

This year Intel celebrates the 10th anniversary of the iRMX operating system family. Over the last decade, Intel has steadily improved the performance and functionality of the iRMX operating systems. You can count on continued improvements in the future.

The iRMX 286 Release 2.0 Operating System runs compatibly on 80286 and 80386 microprocessors, and iRMX operating systems will run on future advanced microprocessors from Intel. **Over the last four years the performance of Intel's 8086 family microprocessors has increased 400%.** When you're using the iRMX operating systems, you benefit from these tremendous performance improvements with a high degree of real time application portability.

OUTSTANDING TECHNICAL SUPPORT

With the iRMX 286 Release 2.0 Operating System you're not alone when you're developing a real time application. Intel has the best technical sales support in the real time business. If you run into a snag; training, consulting, and design advice are available close at hand.

iRMX 286 RELEASE 2.0 SYSTEM CALLS

Nucleus

Job Management

RQ$CREATE$JOB	Creates a job (whose memory pool is limited to 1 MB) with a task
RQE$CREATE$JOB	Creates a job (whose memory pool is up to 16 MB) with a task
RQ$DELETE$JOB	Deletes a job
RQ$OFFSPRING	Provides tokens of the child jobs of the specified jobs
RQE$OFFSPRING	Provides a list of tokens for the child jobs of the specified job in a user supplied data structure

Task Management

RQ$CREATE$TASK	Creates a task
RQ$DELETE$TASK	Deletes a task that is not an interrupt task
RQGETPRIORITY	Returns the static priority of a task
RQSETPRIORITY	Changes a task's priority
RQGETTASK$TOKENS	Returns to the caller a token for the specified task
RQ$SUSPEND$TASK	Increases a task's suspension depth by one; suspends the task if it is not already suspended
RQ$RESUME$TASK	Decreases a task's suspension depth by one; resumes the task if the suspension depth becomes zero
RQ$SLEEP	Places the calling task in the asleep state for a specified amount of time

Mailbox Management

RQ$CREATE$MAILBOX	Creates a mailbox
RQ$DELETE$MAILBOX	Deletes a mailbox
RQ$SEND$DATA	Sends a message to a mailbox
RQE$RECEIVE$DATA	Allows the calling task to receive a message from a mailbox; the task can wait
RQ$SEND$MESSAGE	Sends an object to a mailbox
RQ$RECEIVE$MESSAGE	Allows the calling task to receive an object; the task can wait if no objects are present

Semaphore Management

RQ$CREATE$SEMAPHORE	Creates a semaphore
RQ$DELETE$SEMAPHORE	Deletes a semaphore
RQ$SEND$UNITS	Adds a specific number of units to a semaphore
RQ$RECEIVE$UNITS	Asks for a specific number of units from a semaphore

Segment and Memory Pool Management

RQ$CREATE$SEGMENT	Creates a segment
RQ$DELETE$SEGMENT	Returns a segment to the memory pool from which it was allocated
RQGETSIZE	Returns the size of a segment
RQSETPOOL$MIN	Changes the minimum size of the memory pool of the caller's job
RQGETPOOL$ATTRIB	Returns memory pool attributes of the caller's job
RQEGETPOOL$ATTRIB	Returns information about a job with more than 1 megabyte of memory

Descriptor Management

RQE$CREATE$DESCRIPTOR	Creates a descriptor in the Global Descriptor Table describing a segment
RQE$DELETE$DESCRIPTOR	Removes a descriptor entry from the Global Descriptor Table
RQE$CHANGE$DESCRIPTOR	Changes the physical address or size of a segment by modifying its descriptor in the Global Descriptor Table

Object Management

RQ$CATALOG$OBJECT	Places an object in an object directory
RQ$UNCATALOG$OBJECT	Removes an object from an object directory
RQ$LOOKUP$OBJECT	Returns a token for the catalogued name of an object
RQEGETOBJECT$ACCESS	Returns the access type of an object
RQE$CHANGE$OBJECT$TYPE	Changes the access type of an object
RQEGETADDRESS	Returns the physical address of an object
RQGETTYPE	Returns the type code of an object

Nucleus

Exception Handler Management

RQGETEXCEPTION$HANDLER	Returns the current values of the caller's exception handler
RQSETEXCEPTION$HANDLER	Sets exception handler and exception mode attributes

Interrupt Management

RQ$ENABLE	Enables an interrupt level
RQ$DISABLE	Disables an interrupt level
RQSETINTERRUPT	Assigns an interrupt handler and an interrupt task to an interrupt level
RQ$RESET$INTERRUPT	Deletes the interrupt task for an interrupt level
RQGETLEVEL	Returns the interrupt level of highest priority which an interrupt handler has started but not completed
RQENDINIT$TASK	Informs root task that a synchronous initialization process has completed
RQ$ENTER$INTERRUPT	Sets up a data segment base address for an interrupt handler
RQ$SIGNAL$INTERRUPT	Used by interrupt handlers to invoke interrupt tasks
RQ$EXIT$INTERRUPT	Used by interrupt handlers to send an end-of-interrupt signal to hardware
RQE$TIMED$INTERRUPT	Puts the calling interrupt task to sleep until it is awakened by an interrupt handler, or a specified time period elapses
RQ$WAIT$INTERRUPT	Puts the calling interrupt task to sleep until it is awakened by an interrupt handler

Composite Object Management

RQ$CREATE$COMPOSITE	Creates a composite object
RQ$DELETE$COMPOSITE	Deletes a composite object
RQ$ALTER$COMPOSITE	Replaces components of composite objects
RQ$INSPECT$COMPOSITE	Returns a list of the component tokens contained in a composite object

Extension Object Management

RQ$CREATE$EXTENSION	Creates a new object type
RQ$DELETE$EXTENSION	Deletes an extension object and all composites of that type

Deletion Control Management

RQ$DISABLE$DELETION	Makes an object immune to ordinary deletion
RQ$ENABLE$DELETION	Makes an object susceptible to ordinary deletion
RQ$FORCE$DELETE	Deletes objects whose disabling depths are zero or one

Operating System Extension Management

RQESETOS$EXTENSION	Attaches the entry point address of a user written Operating System extension to a call gate or deletes such an entry
RQ$SIGNAL$EXCEPTION	Used by Operating System extensions to signal the occurrence of an exception

Region Management

RQ$CREATE$REGION	Creates a region
RQ$DELETE$REGION	Deletes a region
RQ$SEND$CONTROL	Relinquishes control to the next task waiting at the region
RQ$ACCEPT$CONTROL	Causes the calling task to accept control from a region if control is immediately available
RQ$RECEIVE$CONTROL	Causes the calling task to wait at the region until the task receives control

BASIC I/O SYSTEM

Job Level

RQSETDEFAULT$PREFIX	Set default prefix for job
RQGETDEFAULT$PREFIX	Inspect default prefix
RQSETDEFAULT$USER	Set default user for job
RQGETDEFAULT$USER	Inspect default user
RQ$ENCRYPT	Encodes user password

Device Level

RQAPHYSICAL$ATTACH$DEVICE	Asynchronous attach device
RQAPHYSICAL$DETACH$DEVICE	Asynchronous detach device
RQASPECIAL	Asynchronous perform device-level function

File Level

RQACREATE$FILE	Asynchronous data file creation
RQACREATE$DIRECTORY	Asynchronous create a directory
RQADELETE$FILE	Asynchronous delete a data file or a directory
RQAATTACH$FILE	Asynchronous attach file
RQADELETE$CONNECTION	Asynchronous delete file connection
RQACHANGE$ACCESS	Asynchronous change access rights to a file
RQARENAME$FILE	Asynchronous rename file
RQATRUNCATE	Asynchronous truncate file
RQAOPEN	Asynchronous open file
RQACLOSE	Asynchronous close file
RQAREAD	Asynchronous read file
RQAWRITE	Asynchronous write file
RQASEEK	Asynchronous move file pointer
RQAUPDATE	Asynchronous finish writing to output device
RQ$WAIT$IO	Synchronous wait for status after Input/Output

Status/Attribute

RQAGET$CONNECTION$STATUS	Asynchronous get connection status
RQAGET$DIRECTORY$ENTRY	Asynchronous inspect directory entry
RQAGET$FILE$STATUS	Asynchronous get file status
RQAGET$PATH$COMPONENT	Asynchronous obtain path name from connection token

User Objects

RQ$CREATE$USER	Create a user object
RQ$DELETE$USER	Delete a user object
RQ$INSPECT$USER	Get IDs in a user object

Extension Data

RQASET$EXTENSION$DATA	Asynchronous store a file's extension data
RQAGET$EXTENSION$DATA	Asynchronous receive a file's extension data

Time/Date

RQSETTIME	Set date/time value in internally-stored format
RQGETTIME	Get date/time value in internally-stored format
RQSETGLOBAL$TIME	Sets the battery backed-up hardware clock to a specified time
RQGETGLOBAL$TIME	Obtains the time of day from the battery backed-up hardware clock

Logical to Physical Address Conversion

RQ$BIOS$GET$ADDRESS	Returns the physical address of a selector

EXTENDED I/O SYSTEM

Input/Output Jobs

RQ$CREATE$IO$JOB	Creates an I/O job with a memory pool of up to 1M bytes
RQE$CREATE$IO$JOB	Creates an I/O job with a memory pool of up to 16M bytes
RQ$START$IO$JOB	Starts (makes ready) the initial task in an I/O job
RQ$EXIT$IO$JOB	Sends a message to a mailbox and deletes the calling task

Logical Names

RQ$LOGICAL$ATTACH$DEVICE	Creates and catalogs a logical name for a device
RQ$HYBRID$DETACH$DEVICE	Temporarily removes the correspondence between a logical name and a physical device established via LOGICAL$ATTACH$DEVICE
RQ$LOGICAL$DETACH$DEVICE	Deletes a logical name created with LOGICAL$ATTACH$DEVICE
RQSCATALOG$CONNECTION	Creates a logical name for a connection
RQSLOOKUPCONNECTION	Searches through an I/O job's object directories to find the connection associated with a logical name
RQSUNCATALOG$CONNECTION	Deletes a logical name from the object directory of a job

Files

RQSCREATE$DIRECTORY	Creates a new directory
RQSCREATE$FILE	Creates a new physical, stream, or named data file
RQSDELETE$FILE	Deletes a stream, physical, or named file
RQSATTACH$FILE	Creates a connection to an existing file
RQSDELETE$CONNECTION	Deletes a file connection.
RQSOPEN	Opens a connection to a file
RQSCLOSE	Closes an open connection to a file
RQSREAD$MOVE	Reads a number of bytes from a file to a buffer
RQSWRITE$MOVE	Writes a collection of bytes from a buffer to a file
RQSSEEK	Moves the file pointer
RQSTRUNCATE$FILE	Removes information from the end of a named data file
RQSCHANGE$ACCESS	Changes the access list for a named file
RQSRENAME$FILE	Changes the path of a named file

Special Devices

RQSSPECIAL	Allows a task to perform functions that are peculiar to a specific device

Status

RQGETLOGICAL$DEVICE$STATUS	Provides status information about logical devices
RQSGET$CONNECTION$STATUS	Provides status information about file and device connections
RQSGET$FILE$STATUS	Allows a task to obtain information about a file

Users

RQGETUSER$IDS	Returns the user ID as defined in the User Definition File
RQ$VERIFY$USER	Verifies a user's name and password

APPLICATION LOADER

RQALOAD	Loads object code or data into memory
RQALOADIOJOB	Creates an I/O job asynchronously with a memory pool of up to 1M bytes, loads the job's code, and causes the job's task to run
RQEALOADIOJOB	Creates an I/O job asynchronously with a memory pool of up to 16M bytes, and loads the job's code, and causes the job's task to run
RQSLOADIOJOB	Creates an I/O job synchronously with a memory pool of up to 1M bytes, loads the job's code, and causes the job's task to run
RQESLOADIOJOB	Creates an I/O job synchronously with a memory pool of up to 16M bytes, loads the job's code, and causes the job's task to run
RQSOVERLAY	Loads an overlay into memory

UNIVERSAL DEVELOPMENT INTERFACE

Program Control

DQ$EXIT	Exits from the current application job
DQ$OVERLAY	Causes the specified overlay to be loaded
DQ$TRAP$CC	Captures control when CONTROL-C is typed

Files

DQ$ATTACH	Creates a connection to a specified file
DQ$CHANGE$ACCESS	Changes access rights associated with a file or directory
DQ$CHANGE$EXTENSION	Changes the extension of a file name in memory
DQ$CLOSE	Closes the specified file connection
DQ$CREATE	Creates a file for use by the application
DQ$DELETE	Deletes a file
DQ$DETACH	Closes a file and deletes its connection
DQ$FILE$INFO	Returns data about a file connection
DQGETCONNECTION$STATUS	Returns status of a file connection
DQ$OPEN	Opens a file for a particular type of access
DQ$READ	Reads the next sequence of bytes from a file
DQ$RENAME	Renames the specified file
DQ$SEEK	Moves the current position pointer of a file
DQ$SPECIAL	Sets terminal line-edit/transparent mode
DQ$TRUNCATE	Truncates a file to the specified length
DQ$WRITE	Writes a sequence of bytes to a file

Memory Management

DQ$ALLOCATE	Requests a memory segment of a specified size
DQ$FREE	Returns a memory segment to the system
DQGETMSIZE	Returns the size of the specified memory block
DQGETSIZE	Returns the size of the specified segment
DQ$MALLOCATE	Requests a logically contiguous memory segment of a specified size
DQ$MFREE	Returns memory allocated by DQ$MALLOCATE to the Free Space Pool
DQ$RESERVE$IO$MEMORY	Requests memory to be set aside for overhead to be incurred by I/O operations

Exception Handling

DQ$DECODE$EXCEPTION	Converts an exception numeric code into its equivalent mnemonic
DQGETEXCEPTION$HANDLER	Returns a pointer to the address of the program currently being used to process errors
DQ$TRAP$EXCEPTION	Identifies a custom exception processing program for a particular type of error

Utility and Command Parsing

DQ$DECODE$TIME	Returns system time and date in both binary and ASCII-character format
DQGETARGUMENT	Returns an argument from a STRING
DQGETSYSTEM$ID	Returns the identity of the environment for the UDI
DQGETTIME	Obsolete: included for compatibility
DQ$SWITCH$BUFFER	Selects a new buffer from which to process commands

HUMAN INTERFACE

I/O Processing

RQCGET$INPUT$CONNECTION	Return an EIOS connection for the specified input file
RQCGET$OUTPUT$CONNECTION	Return an EIOS connection for the specified output file

Command Parsing

RQCBACKUP$CHAR	Move the parsing buffer pointer back one byte
RQCGET$CHAR	Get a character from the command line
RQCGET$INPUT$PATHNAME	Parse the command line and return an input pathname
RQCGET$OUTPUT$PATHNAME	Parse the command line and return an output pathname
RQCGET$PARAMETER	Parse the command line for the next parameter and return it as a keyword name and a value
RQCSET$PARSE$BUFFER	Parse a buffer other than the current command line
RQCGET$COMMAND$NAME	Return the command name by which the current command was invoked

Message Processing

RQCFORMAT$EXCEPTION	Create a default message for an exception code
RQCSENDCORESPONSE	Send a message to the command output (CO) and read a response from the command input (CI)
RQCSENDEORESPONSE	Send a message to the operator's terminal and return a response from that terminal

Command Processing

RQCCREATE$COMMAND$CONNECTION	Create a command connection
RQCDELETE$COMMAND$CONNECTION	Delete a command connection
RQCSEND$COMMAND	Concatenate command lines into the data structure created by CREATE$COMMAND$CONNECTION and then invoke the command

Program Control

RQCSET$CONTROL$C	Changes a calling task's CONTROL-C exchange to the semaphore specified by the call

iRMX® 286 RELEASE 2.0 COMMANDS

SYSTEM DEBUGGER COMMANDS

VC Display system call information
VD Display a job's object directory
VH Display help information
VJ Display job hierarchy
VK Display ready and sleeping tasks
VO Display objects in a job
VR Display I/O Request/Result Segment
VS Display stack and system call information
VT Display any iRMX 286 object
VU Display system calls in a task's stack

HUMAN INTERFACE

Command Line Interpreter Commands

!	Recalls a specified command line
Alias	Assigns an abbreviation to a command
Background	Causes a command to be executed in background mode
Changeid	Changes the current user ID to any value between 0 and 65535
Dealias	Cancels the abbreviation assigned by Alias
Exit	Leaves the Super mode
History	Recalls the last 40 lines entered at the terminal
Jobs	Displays a list of background jobs by their job identification number
Kill	Cancels a background job
Logoff	Ends a user session at a dynamic logon terminal
Set	Alters the Command Line Interpreter environment by allowing on-line changes to the terminal name, minimum and maximum background memory pool size, the memory for alias tables, or the prompt string
Submit	Reads, loads, and executes a string of commands from a secondary storage file instead of from the keyboard
Super	Changes the operator to the system manager by changing the user ID

HUMAN INTERFACE

Commonly Used System Programs

File Management Commands

Attachfile	Associates a logical name with an existing file
Copy	Copies files specified in an input list to files specified in an output list
Createdir	Creates one or more new directories
Delete	Deletes data files and empty directories from a secondary storage device
Detachfile	Removes the association of a logical name with a file
Dir	Lists a directory's filenames and file attributes
Downcopy	Copies files from an iRMX 286 volume to an Intellec Development System via the iSDM monitor
Permit	Grants or rescinds user access to a file
Rename	Changes the names of files or directories
Upcopy	Copies files, via the iSDM monitor, from an Intellec Development System to an iRMX 286 volume

Volume Management Commands

Addloc	Combines the output of LOCDATA and an iRMX 286 bootloadable file. The output of ADDLOC is another iRMX 286 bootloadable file
Attachdevice	Attaches a new physical device to the system and catalogs its logical name in the root job's object directory
Backup	Copies named files to a backup volume
Detachdevice	Removes a physical device from system use and deletes its logical name from the root job's object directory
Diskverify	Verifies the data structures of named and physical volumes
Format	Writes format information on an iRMX 286 volume
Locdata	Reads the specified data and creates a "located" file that can be processed by the ADDLOC command
Restore	Copies files from a backup volume to a named volume

System Management Commands

Accounting	Tracks activities of dynamic logon users
Initstatus	Displays the initialization status of Human Interface terminals
Jobdelete	Deletes a running interactive job
Lock	Prevents the Human Interface from automatically creating an interactive job
Logoff	Ends a user session for users with a customized Command Line Interpreter
Password	Changes passwords for dynamic logon users and creates new users when invoked by the system manager
Super	Changes the operator's user ID into that of the system manager (user ID 0) for users who are using a custom Command Line Interpreter
Unlock	Permits the Human Interface to create an interactive job, after the terminal has been locked by the LOCK command

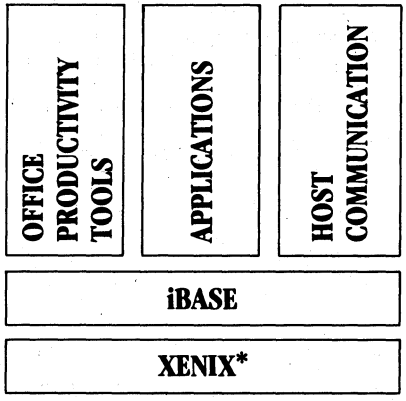
General Utility Commands

Date	Sets or resets the system date, or displays the current date
Debug	Transfers control to the iSDM monitor to debug an iRMX 286 application program
Logicalnames	Lists all the logical names available to the user
Memory	Displays the memory available to the user
Path	Shows the pathname fo a file
Shutdown	Provides an orderly shutdown of the system
Submit	Reads, loads, and executes a string of commands from secondary storage instead of from the keyboard for users with a custom Command Line Interpreter
Time	Sets or resets the system clock, or displays the current system time
Version	Displays the version numbers of commands
Whoami	Displays the current ID associated with the user
Zscan	Lists the ZAPs (updates) applied to an object module, library, or bootloadable file

PRODUCT CODES—iRMX 286 RELEASE 2.0 OPERATING SYSTEM

RMX286JSC	iRMX 286 Release 2.0 Operating System on 5¼" Double Sided Double Density flexible diskettes
RMX286CTSC	iRMX 286 Release 2.0 Operating System on cartridge tape
SYR286JSC	iRMX 286 Release 2.0 Operating System on 5¼" Double Sided Double Density Flexible diskettes plus basic utilities and languages (PL/M 286, ASM286, ASM86, and AEDIT software)
SYR286CTSC	iRMX 286 Release 2.0 Operating System on cartridge tape plus basic utilities and languages (PL/M 286, ASM286, ASM86, and AEDIT software)

Information subject to change without notice.



iBASE — BASE APPLICATION SOFTWARE ENVIRONMENT

- *Friendly, easy-to-use menus*
- *Menu-driven system and network administration*
- *Platform for integrated and independently provided application software*
- *Peripheral resource administration and allocation*
- *File management*
- *Electronic mail and directory*
- *PC and host mainframe communication options*
- *OpenNET™ local area network compatible*

■ iBASE BASE APPLICATION SOFTWARE ENVIRONMENT

iBASE is an easy-to-use software platform which serves as a menu-driven environment for system administration, network administration and application software access. In addition, iBASE provides electronic mail, electronic personal calendar and on-line help facilities as well as data conversion tools for facilitating communication with both mainframe hosts and PCs.

Easy-to-use menus. The menus provide quick and user-friendly access to capabilities of the system without the need to learn the underlying operating system. Because it is easy to learn, the user can quickly select desired activities such as application packages, mail, remote operation, system administration, or tools for application development. The menus may be customized and enhanced with the optional iMENU menu development package.

Electronic mail. The electronic mail service, an enhanced version of the XENIX electronic mail, is an office automation tool that supports the timely exchange of business messages in a multiuser and network environment. The mail service can be integrated with a wordprocessor to easily compose longer messages.

Electronic directory. The built-in electronic directory provides an on-line listing of the system and network users. Information includes system addresses for electronic mail as well as standard phone book information. Directory facilities include phonetic lookup capabilities when users are not sure of exact spellings.

Electronic personal calendar. The electronic personal calendar is an office automation tool which works with electronic mail to provide an automatic reminder of future appointments.

File management. The file management system provides the capability to view, edit, print and copy files between the various system work areas. Conversion routines facilitate file format translations among popular applications.

On-line help facility. The help facility, a comprehensive on-line documentation feature, is accessible from the menu system so the user need not constantly refer to manuals when using integrated applications. With the optional iMENU facility, an experienced user can extend or modify the help facility to specify help information for other applications.

Remote operations access. iBASE provides menu-driven access to host communications subsystems. By adding the optional Virtual Protocol Machine (iVPM) facility and corresponding protocols, users can access remote mainframe hosts. Also, local users can appear as a terminal to a remote system using the TTY-Passthrough feature provided in iBASE.

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■ SYSTEM ADMINISTRATION

Defining users and work areas. The System Administration features of iBASE allow the administrator to quickly and easily add additional users to the system. Each user can be customized for access to software and various system resources. In addition, the administrator can establish user work areas and default text editors. This tailoring of the system enables multiple users to operate as groups and share certain files while maintaining security on other files.

User-specific resource allocation. The system administrator can specify access permissions for physical devices and software features. Thus, users can be assigned to devices based on workloads, physical proximity, and job-specific needs.

Archiving. The system provides two levels of archiving. The administrator can selectively backup individual, group and public work areas. This grouping capability simplifies the task for the administrators. While restoring information, the administrator can read either the whole archive or specific units. Additionally, individuals can backup and restore their own information on authorized resource devices.

■ NETWORK ADMINISTRATION

Network setup. The Network Administration features of iBASE provide network node setup. The network nodes can be identified as application vehicles or public servers providing resources and other capabilities. In this way, the network administrator can optimize network resource utilization.

Network resource definition and assignments. iBASE extends the concepts of a system resource by allowing the administrator to view the network as a larger system. Thus, users with proper authorization can perform tasks such as printing or archiving on remote nodes independent of physical location.

Extending system tasks across the network. Electronic office capabilities which were useful on a single multiuser system take on a new dimension when extended across the network. Electronic mail is easily routed to individuals and groups of individuals across the network in a timely manner. Many of the day-to-day administrative tasks for multiple nodes can be accomplished from a single network node. This increased convenience for the operators improves productivity and ensures more timely execution of the administration function.

■ APPLICATION DEVELOPMENT TOOLS AND SYSTEM FACILITIES

iMENU menu development. The optional iMENU facility, a version of /menus from Schmidt Associates, allows users to create integrated, friendly, menu-driven interfaces to XENIX applications. Programmers and users can apply the iMENU facility in maintaining or creating menus, forms or help screens for new and existing applications.

Remote file transfer. The iXTRACT remote-file transfer facility enables bidirectional transfer of a "flat file" to/from a mainframe host or a PC and converts the file to/from the iDB relational database format. iXTRACT is included in iBASE.

iBPC iBASE PC extensions. The optional iBPC extensions provide the XENIX portion of PC connection software, a menu-driven terminal emulation, file conversion and file transfer facility. iBPC enables file sharing between PCs and multiuser XENIX systems. The user can convert database and spreadsheet files from standard PC formats (including Lotus 1-2-3, dBASE-II, and Multiplan) to relational database formats during the two-way file transfer. The package can be used in four distinct modes: terminal emulation, local MS-DOS control, passthrough host sessions, and file transfer/transform operations. The PC connection operates either over serial lines (direct or remote) or across the OpenNET local area network. The MS-DOS portion of the PC connection software is provided by the optional DOS-NET Virtual Terminal software.

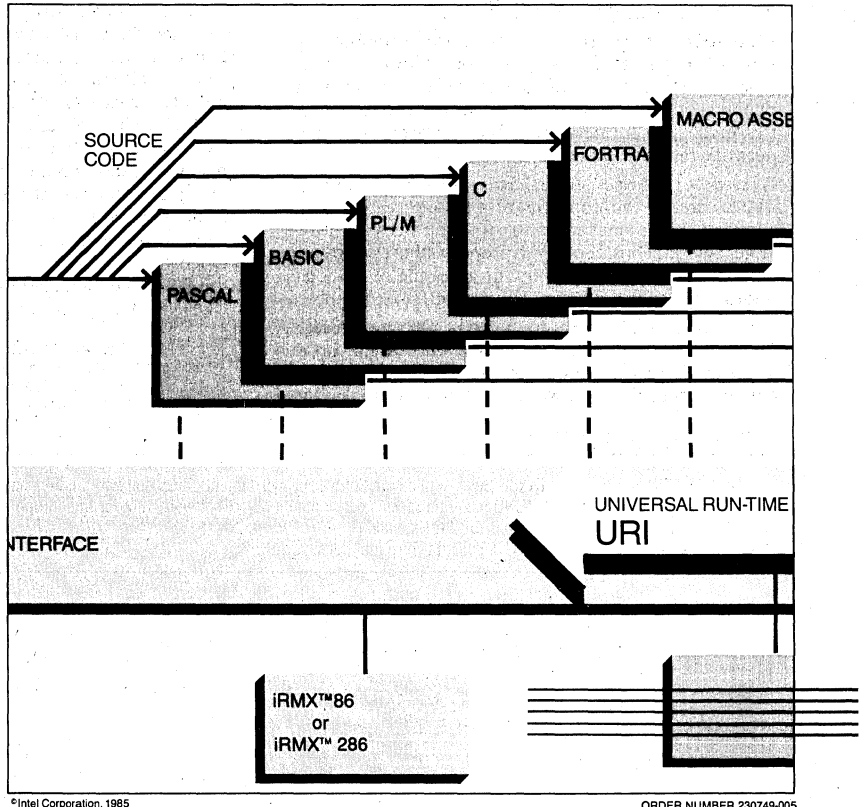
/menus is a trademark of Schmidt Associates
Lotus is a registered trademark of Lotus Development Corporation
dBASE II is a registered trademark of Ashton Tate
Multiplan and MS are trademarks of Microsoft Corporation

ORDERING INFORMATION

XNXIBASKERI	iBASE Base Application Software Environment object software and documentation (includes iXTRACT)
XNXIMENUKRI	iMENU menu and forms development object software and documentation
XNXIBPCKRI	iBPC iBASE PC Extensions
DOSNETVTSKRI	DOS-NET Virtual Terminal (formerly iPC)

iRMX™ LANGUAGES

- Industry-standard languages and utilities for developing applications on iRMX-based systems. Includes FORTRAN, Pascal, C, BASIC, PL/M, Macro assembler, AEDIT text editor
- Complete set of utilities to create and manage object modules
- Mix languages on single application system with UDI standard
- Intel 8087 and 80287 math coprocessor support
- 8086 and 80286 compatibility
- Worldwide post-sales service and support organization



ORDER NUMBER 230749-005

Full Language Support for iRMX™-Based Systems

Intel's iRMX™ 86 and iRMX™ 286-based systems are completely supported by a wide variety of popular languages and utilities with which to build fast, real-time, multi-tasking applications. Included are the latest versions of FORTRAN, Pascal, BASIC, PL/M and Macro Assembler for Intel's 8086 and 80286 processors. Previously developed applications using any of these languages port easily to iRMX-based systems with minimal source code modifications.

In addition to the wealth of languages available, iRMX-based systems are complemented by utilities with which to create and manage object modules. For the iRMX 286 system, utilities which allow system programmers to initialize and manage the memory protection features of the 80286 transparently to the applications programmer are provided. This latitude in configurability allows programmers to team their efforts in order to achieve a shorter development time than would otherwise be possible.

Because the high-level languages are actually resident on the iRMX-based system, OEMs can pass application software directly on to end users. End users may then tailor the OEM's system to better meet application needs by writing programs using the same languages.

Language-Independent Application Development

Intel's Universal Development Interface (UDI) and Object Module Format (OMF) enable several users to write different modules of an application, in different languages, then link them together.

The OMF provides users with the ability to mix languages on a single application system, affording the luxury of choosing exactly the right language tools for specific pieces of the application, rather than compromising specialized tasks for the sake of one, project-wide language.

iRMX languages are fully compatible with the Intel Series III/IV Development System, should the user choose to develop applications on a specialized development system. Applications are easily moved to the final target system for test, debug and minor redevelopment.

Fast, Lean Programs for Rapid Processing

The iRMX language products enable programmers to write the smallest, fastest programs available in high-level languages, due to the compiler's superior ability to optimize code.

It is also possible to make iRMX operating system calls directly from FORTRAN, PASCAL, C and PL/M. This means that application developers can take full advantage of the iRMX multi-tasking capability, whereby multiple applications execute concurrently on the operating system. Multi-tasking, a requirement of most real-time systems, is sometimes as necessary in application software development as in an operating system environment.

Standardized REALMATH Support

All the iRMX languages (except BASIC and C) support the REALMATH floating point standard. This ensures universal consistency in numeric computation results and enables the user to take advantage of the Intel 8087 and 80287 Numeric Data Processor or iSBX™ 337 MULTIMODULE™ boards, which boost performance two to four times over that possible on a mini-computer.

Complete Set of Program Linkage and System Building Utilities

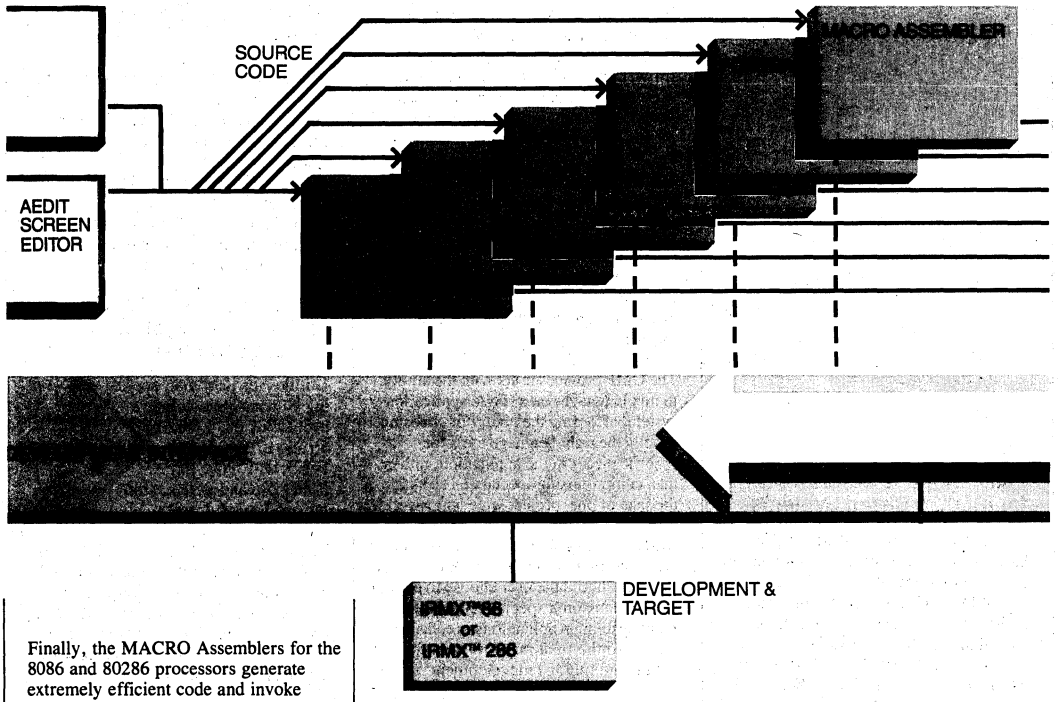
Utilities for iRMX 86 operating systems include Intel's own LINK 86, LOCATE 86 and LIBRARIAN. For iRMX 286 systems, BIND 286 and BUILD 286 replace Link & Locate.

Using the LINK 86 or BIND 286 programs, users may combine individually compiled object modules to form a single, relocatable object module. This provides the ability to merge work from several programmers into one cohesive application system.

The LOCATE 86 utility maps relocatable object code into the processor memory segments, allowing user definition of module/memory type allocation. For example, often-used portions of an application may be mapped to (P)ROM.

The BUILD 286 utility provides the major capabilities of LOCATE 86 plus allows the system programmer to specify the memory protection scheme for the 80286 system.

The LIBRARIAN object code library manager affords easy creation, collection and maintenance of related object code to reduce the overhead of separately maintained modules.



Finally, the MACRO Assemblers for the 8086 and 80286 processors generate extremely efficient code and invoke 8086/8087 or 80286/287 machine instructions.

iRMX™ Pascal

iRMX Pascal meets the proposed ISO language standard and implements several microcomputer extensions. A compile-time option checks conformance to the standard, making it easy to write uniform code. Industry-standard specifications contribute to portability of application programs and provide greater reliability.

iRMX Pascal supports extensions, such as an interrupt-handler and direct port I/O extension, that allow programs to be written specifically for microcomputers. Separate module compilation allows linkage of Pascal modules with modules written in other high-level languages.

iRMX™ FORTRAN

The iRMX FORTRAN compiler provides total compatibility with FORTRAN 66 language standards, plus most new features provided by the FORTRAN 77 language standard including complex numbers. iRMX FORTRAN includes extensions specifically for microcomputer application development. Programming is simplified by relocatable object libraries, which provide run-time support for execution time activities.

iRMX FORTRAN 86 supports the 8087 math coprocessor and iRMX FORTRAN 286 supports the 80287 for the most powerful microcomputer solutions available in number-intensive applications.

iRMX™ PL/M

PL/M offers full access to micro-computer architecture while simultaneously offering all the benefits of a high-level language. Invented by Intel in 1976, PL/M 80 was the first microcomputer-specific, block-structured, high-level language available. Since then, thousands of users have generated code for millions of microcomputer-based systems using PL/M 80, PL/M 86, and PL/M 286.

Software written for 8-bit processors (PL/M 80) are easily ported to the more powerful 16-bit (PL/M 86) environment. The same portability is available for the 80286 (PL/M 286).

iRMX™ BASIC

Intel's offering of Microsoft BASIC 86 is a standardized version of the most popular high-level language in the world. Existing BASIC programs are easily ported to iRMX-based systems. BASIC is an excellent pass-through language by which an OEM can offer customers the ability to write and modify their own applications.

iRMX™ C Compiler

The popular programming language C, is fully supported on iRMX-based systems. iRMX C offers both small and large segmentation models, enabling applications to be written efficiently. The iRMX C compilers combine assembly language efficiency with high-level language convenience; it can manipulate on a machine-address level while maintaining the power and speed of a structured language.

The iRMX C compiler affords easy portability of existing C programs to iRMX-based systems.

iRMX™ AEDIT Text Editor

The iRMX AEDIT Text Editor is screen-oriented, menu-driven and easy to learn. Guided by the menu of commands always before him, the user can edit text and programs easily and efficiently.

iRMX AEDIT Text Editor allows the simultaneous edit of two files. This allows easy transferral of text between files and use of existing material in the creation of new files. Creating macros, strings of frequently-used commands, is also very simple. The editor "remembers" the selected commands and allows the user to re-use them repeatedly. The iRMX 286 version also supports operating system level command execution.

iRMX™ 286 Soft-Scope* 286 High Level Language Debugger

The Soft-Scope 286 debugger allows debugging programs running on the iRMX 286 Operating System. Programs written in PL/M 286, FORTRAN 286, PASCAL 286, and C 286 can be debugged using source code listings.

Worldwide Service and Support

All iRMX systems are completely supported by Intel's worldwide staff of trained hardware and software engineers. Support available includes Hotline (telephone) Support, Software Updates, and a Subscription Service.

Complete documentation is provided for all operating system and application software languages, as well as for system hardware components. An Intel system is not a collection of hardware and software pieces as much as a cohesive whole that is supported and serviced as such.

Intel Has Total Solutions for Real-Time Systems

iRMX 86 and iRMX 286 are the fastest, most powerful operating systems available for multi-tasking, multi-user, real-time applications. Complemented by a wide range of industry-standard languages and utilities, the iRMX-based systems are highly flexible and configurable.

Application development for iRMX-based systems is possible at the board or the system level. OEMs can integrate functionality at the most profitable level of product design, using one system for both development and target use. Intel's choice of industry standard high-level languages enables the end user to extend OEM-provided functionality even further, if desired.

Who is better qualified to write and supply software for Intel VLSI than Intel? Today you have the ability to tap into hundreds of available application software packages, languages and utilities, peripherals and controllers and MULTIBUS® boards.

Tomorrow, and ten years down the road, you will be able to tap into the latest, high-performance VLSI—without losing today's software investment.

Soft-Scope is a registered trademark of Concurrent Sciences, Inc.

Specifications

Required Hardware

- Any 8086/286/386 based or iSBC 86/286/386 based system including Intel's System 86/300, 286/300 and 386/300 family. In addition, object code from the 8086 compilers will run on 8088, 80186 or 80286 based systems.
- 700KB of memory
- Two iRMX compatible floppy disks or one hard disk
- One 5.25" double-density floppy disk drive for distribution of software
- System console device

Required Software

The iRMX 86 Operating System Release 7 or later including the Nucleus, Basic I/O System, Extended I/O System and Human interface layers.

— or —

The iRMX 286 Operating System including the Nucleus, Basic I/O System, Extended I/O System and Human Interface.

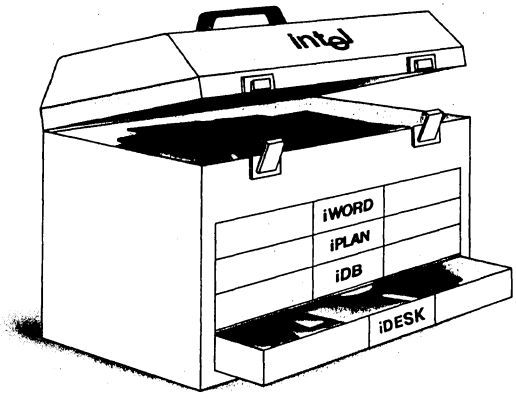
Purchasing of any iRMX 86-resident language requires signing of Intel's Software License Agreement (SLA). A software license is shipped with each iRMX 286-resident language.

Data Sheets

- 8086 Compilers:
  8086/88/186/188 Software Packages (Intel order number 210689)
- 80286 Compilers:
  80286 Software Development Tools (Intel order number 231665)

Ordering Information

iRMX 86 LANGUAGES		iRMX 286 LANGUAGES	
ASM 86, Utilities	R86 ASM 86	ASM 286, Utilities	R286 ASM 286
FORTRAN 86	R86 FOR 86	ASM 86, Utilities	R286 ASM 86
PL/M 86	R86 PLM 86	AEDIT Text Editor	R286 EDI 286
AEDIT Text Editor	RMX 864	PL/M 286	R286 PLM 286
BASIC 86	RMX 865	FORTRAN 286	R286 FOR 286
Pascal 86	R86 PAS 86	Pascal 286	R286 PAS 286
C 86	R86 C 86	C 286	R286 C 286
		Soft-Scope* 286	R286 SSC 286



OFFICE PRODUCTIVITY TOOLS

- *Friendly, easy-to-use*
- *Applications access from menus*
- *Integrated office productivity tools with on-line help facility*
- *Fully relational DBMS option with report writer and forms input*
- *Wordprocessor*
- *Spreadsheet*
- *Enhanced electronic mail*
- *Personal calendars with group scheduling*
- *OpenNET ™ local area network compatible*

■ INTEGRATED OFFICE PRODUCTIVITY TOOLS

Intel offers an integrated set of office productivity tools consisting of a database management system, wordprocessor, desktop organizational utilities and spreadsheet. Data can be interchanged among the iWORD Wordprocessor, the iPLAN Spreadsheet and the iDB Database System. These, together with the on-line help facility, provide an easy-to-use powerful set of decision support, analysis and productivity tools.

■ iDB DATABASE MANAGER AND REPORT WRITER

The iDB database management system is a full-function, mainframe-caliber relational DBMS that supports an interactive query/update language which is a functional superset of IBM's SQL. The Report Writer package included with iDB allows users to prepare custom reports quickly. iDB, Intel's version of the Empress* database management system from Rhodnius, Inc., also features a user-prompting data entry and update subsystem, a bulk loading and unloading utility for rapid transfer of data among files and databases, extensive on-line help facilities, and programmatic interfaces to the C language and XENIX† shell.

■ iWORD WORDPROCESSOR

The iWORD package, a version of the Latitude** Wordprocessor from LatiCorp, Inc., is a powerful full-function wordprocessor with mailmerge, spell checking and an integrated tabulator (spreadsheet). The wordprocessor supports all standard text editing, storage and formatting functions. File management and editing concepts are very easy for beginning users yet powerful enough for experienced users. The software allows users to visually format documents and print them as they are displayed on the screen.

■ iDESK DESKTOP ORGANIZATIONAL UTILITIES

The iDESK Desktop Organizational Utilities, a version of SYNC**: The Executive Desk from LatiCorp Inc., provides an enhanced set of office automation capabilities. iDESK provides an enhanced electronic mail interface, additional calendar capabilities including group scheduling, reminders and telephone message facilities. iWORD is a prerequisite of iDESK.

*EMPRESS IS A TRADEMARK OF RHODNIUS, INC.
†XENIX IS A REGISTERED TRADEMARK OF MICROSOFT CORPORATION

JUNE, 1986
ORDER NUMBER: 270211-001
**LATITUDE IS A REGISTERED TRADEMARK OF LITICORP, INC.,
SYNC IS A TRADEMARK OF LATICORP, INC.

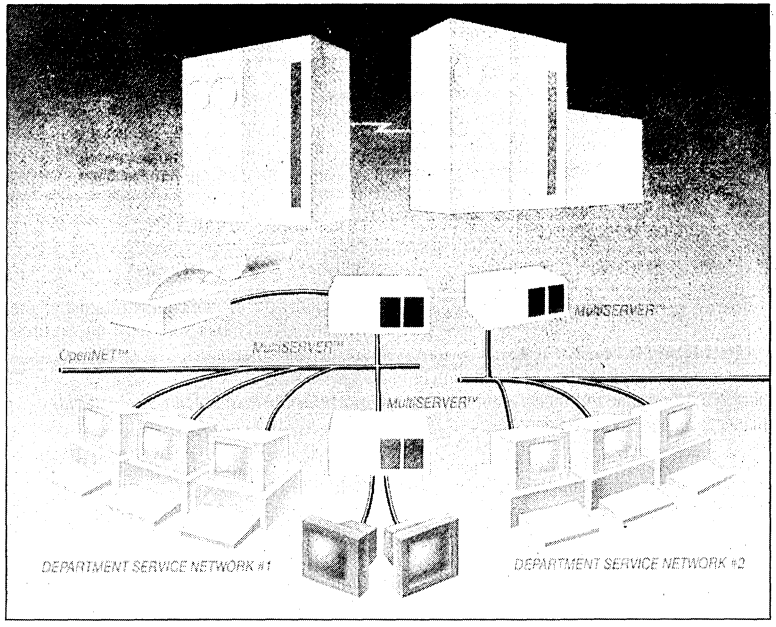
■ iPLAN SPREADSHEET

The iPLAN Spreadsheet, a version of Microsoft's Multiplan†, is a powerful easy-to-use "electronic worksheet" that supports 'what-if' decision modeling using simple English commands. This two-dimensional matrix can be tailored to a variety of applications including financial modeling, tabulations and formula calculations. Up to eight windows are available for both vertical and horizontal scrolling and as many as eight interrelated worksheets can be linked and updated. iDB SQL queries can be embedded in iPLAN cells to ensure spreadsheet analysis utilizes current database data.

†Multiplan is a registered trademark of Microsoft Corporation.

ORDERING INFORMATION

XNXIBASEKRI	iBASE Base Application Software Environment object software and documentation (includes iXTRACT)
XNXIDBKRI	iDB relational database management and report writer object software and documentation
XNXIWORDKRI	iWORD word processor object software and documentation
XNXIDESKKRI	iDESK desktop organization utilities object software and documentation
XNXIPLANKRI	iPLAN spreadsheet object software and documentation



HIGH PERFORMANCE MULTISERVER™

MultiSERVER is an effective way to link PC's, terminals, minicomputers, mainframes and applications into an organizationally productive departmental services system. Intel combines the power of its high performance System 320, its complete network service software and its comprehensive customer support capabilities to deliver, install and maintain a complete DEPARTMENT SERVICE NETWORK.

MultiSERVER™ SYSTEM 320 FEATURES

- Complete Department Service Network
  - File Services
  - Print Services
  - Communication Services
  - Network Application Services
  - Administrative Services
  - Compute Services
- Complete Installation, Service and Support
- Range of Configurations

June, 1987
Order Number: 280501-001

ONE SERVER—MULTIPLE SERVICES

MultiSERVER delivers to "work groups" and individuals a comprehensive, fully integrated set of services which extend the computing and information resources of an entire enterprise.

FILE SERVICES: Provide data, application and message sharing transparently among PC users as well as across peer level networks.

PRINT SERVICES: Provide cost effective and controlled access to multiple print devices.

COMMUNICATION SERVICES: Provide controlled access to higher level mini and mainframe computers to download data as well as utilize existing applications.

NETWORK APPLICATION SERVICES: Provide access to mail and messages, allow remote scheduling of events, and allow PC's to become terminals virtually connected to higher level computing resources.

ADMINISTRATION SERVICES: Provide a single, integrated point to install and maintain the entire Department Service Network.

COMPUTE SERVICES: Provide the development or execution of complex multitasking applications such as database, inventory and/or accounting.

INSTALLATION SERVICE AND SUPPORT

The Intel MultiSERVER System 320 is backed by Intel's worldwide service and support organization. Installation is available to quickly get your system up and running. Total hardware and software support is available, including a hotline number for when you need help fast. Intel also provides hands-on training workshops to give the user a thorough understanding of the MultiSERVER System 320. These workshops are conducted at Intel training centers or customer sites worldwide.

MultiSERVER™ CONFIGURATIONS

Intel offers a range of configurations for the MultiSERVER System 320. Contact your local Intel representative for further information.

APPROVED PRINTER AND TERMINAL LIST

PRINTERS	TERMINALS
C. Itoh D300	C. Itoh CI 414A
C. Itoh D600	C. Itoh CI 467
C. Itoh F10-40	Kimpro KT-67
C. Itoh F10-55	Wyse WY-50
C. Itoh 3500	Wyse WY-75
Tally 1602	Wyse 350

SPECIFICATIONS

ENVIRONMENT

Operating Temperature	10°C to 40°C
Wet Bulb Temperature	26°C maximum
Relative Humidity	85% at 40°C
Altitude	Sea level to 10,000 feet

REGULATIONS

Meets or exceeds the following requirements:

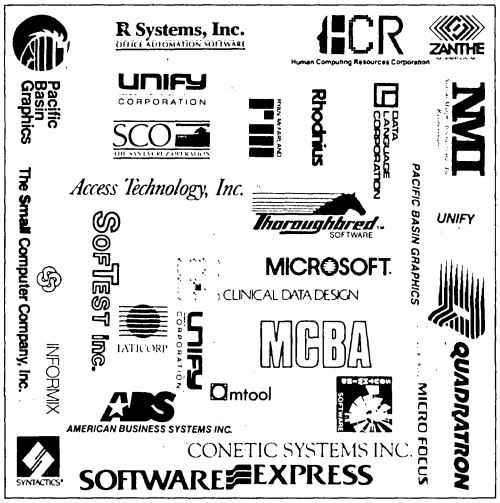
Safety	
US	UL 478
Canada	CSA C22.2
Europe	IEC 435
EMI/RFI	
US	FCC Class B Computing Device
Europe	VDE Limit Class B

ELECTRICAL

DC Power Output	435 watt maximum
AC Power Input	88-132 VAC or 176-264 VAC, 47-63 Hz, single phase

DIMENSIONS

Height	8"
Width	17.5"
Depth	22.25"
Weight	Approx. 55 lbs



XENIX 286 APPLICATION AND DEVELOPMENT SOFTWARE

- *Choice of packages in most application areas*
- *Choice of application development tools*
- *Major software packages available directly from Intel*
- *Worldwide support available for many software packages*

CATEGORY	PRODUCT NAME	VENDOR
Accounting	MCBA Accounting	MCBA
	BACS Accounting	American Business Systems
	Conetic Accounting	Conetic Systems
	Thoroughbred Accounting	Concept Omega
	Open Systems Accounting	Open Systems
	MBSI RealWorld Accounting	Megascore
Application Tools	APPGEN Application Generator	Software Express
	APPGEN Query Language	Software Express
	* iMENU	Intel
Communications	Fusion	Network Research Company
Database Management	PROGRESS	Data Language
	C-ISAM	Relational Database Systems
	File IT!	Relational Database Systems
	* Informix	Relational Database Systems
	Informix SQL	Relational Database Systems
	C/Tools	Conetic Systems
	* iDB (Mistress)	Intel
	MDBS III	Micro Data Base Systems
	Unify	Unify
	ZIM	Zanthe
	FoxBASE	Santa Cruz Operation
Graphics	* PBG200	Pacific Basin Graphics
	* PBG Subroutine Libraries	Pacific Basin Graphics
	* High Tech Business Graphics	High Tech Marketing
	GraphHopper	Data Business Vision
	Grafsman	Southwind Software

JANUARY, 1987
ORDER NUMBER: 270128-003

CATEGORY	PRODUCT NAME	VENDOR
Languages	* ASM286 Assembler/RL286	Intel
	* ASM386 Cross Assembler	Intel
	* Mark Williams 'C'	Intel
	* Fortran-286	Intel
	* MicroFocus Cobol	Intel
	* Microsoft Basic	Intel
	* cENGLISH	cLINE
	* dBASE II to cENGLISH	cLINE
	* PL/M-286	Intel
	* PL/M-386 Cross Compiler	Intel
	CCS Basic	Control C
	DB/C (Databus Compiler)	Subject Wills & Company
	DBL (Dibol)	DISC
	Microsoft Fortran	Microsoft
	Pascal	Human Computing Resources
	RM Cobol	Ryan McFarland
	RM Fortran	Ryan McFarland
	* Softbol	Omtool
	Thoroughbred Basic	Concept Omega
	UX Basic	Human Computing Resources
	Unilisp	R/L Group
Manufacturing	Manufacturing Control Systems	Micro Manufacturing
Medical	MDX	Clinical Data Design
Office Automation	* iWORD	Intel
	* Q-Office	Quadratron
	R Office	R Systems
	Lex86	SofTest
	Sofgram	SofTest
	CrystalWriter	Syntactics
	* Lyrix	Santa Cruz Operation
Personnel	Personnel Searcher	NMI
Project Management	VUE	National Information Systems
Publishing	Circulation Management	NMI
	SofType	SofTest
Spreadsheet	* iPLAN (Multiplan)	Intel
	20/20	Access Technology
	UltraCalc	Olympus Software
	SCO Professional	Santa Cruz Operation

intel®

APPLICATION NOTE

AP-405

May 1987

Software Migration From iRMX® 86 to iRMX® 286

MAYNE MIHACSI
OSD Technical Marketing

Order Number 280608-001

INTRODUCTION

The iRMX® 286 operating system represents the evolution of the iRMX® 86 operating system to the protected-mode 80286 and 80386 microprocessors. Therefore, the iRMX 286 operating system has most of the same features of its 8086 counterpart.

Many Intel customers are going to migrate their software from iRMX 86 to iRMX 286. Most customers should be pleasantly surprised at the ease of migration between the two operating systems. This compatibility between the two operating systems was a key objective of the iRMX 286 project. Thus in the majority of cases, an iRMX user should encounter no changes or only trivial changes when porting their software to iRMX 286. In the other cases, iRMX users with a little patience, work, and the help of this paper, should quickly have their application running on iRMX 286.

Before reading this migration note, it is strongly suggested that readers acquaint themselves with the fundamentals of the 80286 architecture.

iRMX® 286 SYSTEM ARCHITECTURE

There are inherent differences between iRMX 86 and iRMX 286 due to the differences in microprocessor architectures. To take advantage of some unique 80286 features additional system calls have been added in the iRMX 286 operating system. These new calls can be identified by an RQE$ in their preface, with the E denoting "extended", to take advantage of the 80286's 16MB addressability.

Figure 1 lists the differences for each layer of iRMX 286.

iRMX® Layer	iRMX® 286 Changes
Nucleus	– 16MB address space – New hardware traps – Descriptor management – Privilege management – Round robin scheduling – Interrupt management – New calls
BIOS	– Memory buffer protection
EIOS	– New calls – Memory buffer protection
Application Loader	– Only loads 80286 OMF records – Only loads STL modules – New calls
Human Interface	– Enhanced CLI – New commands
UDI	– New calls
Bootstrap Loader	– New third stage interface
ICU	– Single stage ICU

Figure 1. iRMX® 286 Architectural Differences

iRMX® 286 NUCLEUS

16 Megabyte Address Space

Today's applications have pushed beyond the 1MB memory limitation of the 8086 architectures. Many Intel customers have chosen iRMX 286 simply because of its ability to address 16MB of memory. While the 80286 architecture allows for accessing 24 physical address lines, to yield 16MB physical and 16MB virtual addressability, the operating system is not automatically allowed the same abilities. As further generations of CPUs become available and memory becomes cheaper, operating systems will strive toward hardware independence. One method used is accessing memory logically, not physically. In the iRMX 286 operating system all memory addresses are logical addresses available via a descriptor table. A logical address may be thought of as a pointer consisting of a selector and an offset. The selector will point to an entry in a descriptor table containing the 24-bit physical address. Therefore, tokens are affected by containing selectors that reference an entry in the descriptor table. No longer do tokens contain the physical address of an object.

New Hardware Traps

Because the 80286 processor detects several types of exceptions and interrupts from exceptions, iRMX 286 also alerts programs generating these exception conditions. These hardware traps will be generated from the following conditions:

INTERRUPT VECTOR	FUNCTION
8	Double exception
9	Processor extension segment overrun
10	Invalid task state segment *
11	Segment not present *
12	Stack segment overrun or not present
13	General protection

*Seldom seen

Users porting iRMX 86 code to iRMX 286 should be aware that the working code in iRMX 86 might still contain errors that will be "trapped" in iRMX 286.

Descriptor Management

While the 80286 CPU is in Protected Virtual Address Mode (PVAM), all application programs deal exclusively with logical addresses. That is, the programs do not directly access actual physical addresses generated by the processor. Instead, a memory-resident table, called a descriptor table, records the mapping between the segment address and the physical locations allocated to each segment. Whenever the 80286 decodes a logical address, translating a full 32-bit pointer into a corresponding 24-bit physical address, it implicitly references one of several descriptor tables. One table is called the Global Descriptor Table (GDT) and provides a complete description of the global address space. Another table is provided, the Local Descriptor Table (LDT), to describe the local address space for one or more tasks. To the application programmer, much of the internal operation and management of the descriptor tables are transparent. However, the systems programmer will need to manage the descriptors to:

A. Gain access to undefined or allocated memory areas, and

B. Add device drivers to the system.

Several new calls were added to help manage descriptor tables:

1. RQE$CREATE$DESCRIPTOR
2. RQE$CHANGE$DESCRIPTOR
3. RQE$DELETE$DESCRIPTOR

For the applications programmer several features are available in iRMX 286.

1. Of the maximum 8K objects available, all are indexed in the GDT with the operating system using the LDT.
2. While using an iRMX 86-style task switch, iRMX 286 runs as one 80286 hardware task.

Privilege Management

Some means of protection is required to prevent programs from improperly using code or data that belongs to the operating system. The four privilege levels of the 80286 are numbered from 0 to 3, where 0 is the most trusted level. The privilege level is an attribute assigned to all segments in a hierarchical fashion. Operating system code and data segments are placed at the most privileged level (0) which is where iRMX 286 operates. (See Figure 2.)

The privilege levels apply to tasks and three types of descriptors:

1. Main memory segments
2. Gates
3. Task state segments (not used in iRMX 286)

Of particular interest to discussions concerning iRMX 286 is the gate descriptor and its usage in application programs.

Of the four types of gates in the 80286 processor, iRMX 286 uses call gates. Once invoked, control is transferred using only the selector portion. This address becomes fixed, allowing any program to invoke another. This prohibits tasks that have not used these entry points from jumping into the middle of the operating system. The use of gates is fundamental to the 80286 architecture and is reflected in other areas of iRMX 286.

All iRMX 286 system calls go through a call gate in order to invoke a given service procedure. In the iRMX 86 operating system, all calls were through software interrupts, invoking an operating system extension handler, then finally the service procedure. For iRMX code that was written for the iRMX 86 operating system, this will have little impact until it comes time to build the system, unless a conflict exists between the old and new nucleus calls. (See next section.) Analogous to the iRMX 86 operating system having a software interrupt at each level, iRMX 286 possesses call gates for each system call at each layer of the operating system, eliminating the need for an operating system extension handler. Call gates can be specified through system calls and the Interactive Configuration Utility (ICU). (See the example for RQESETOS$ EXTENSION.)

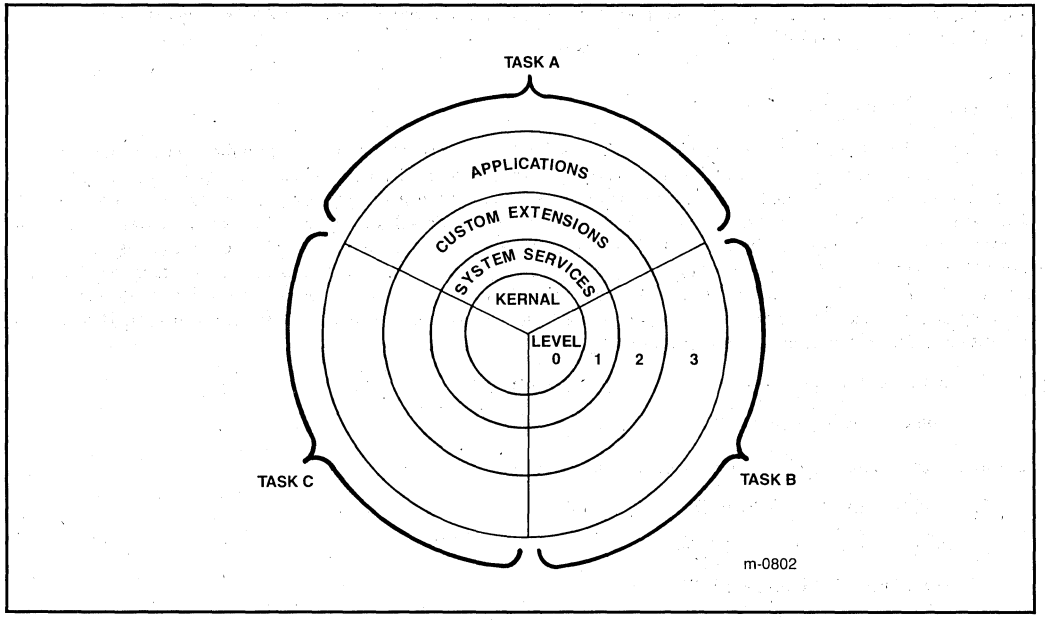
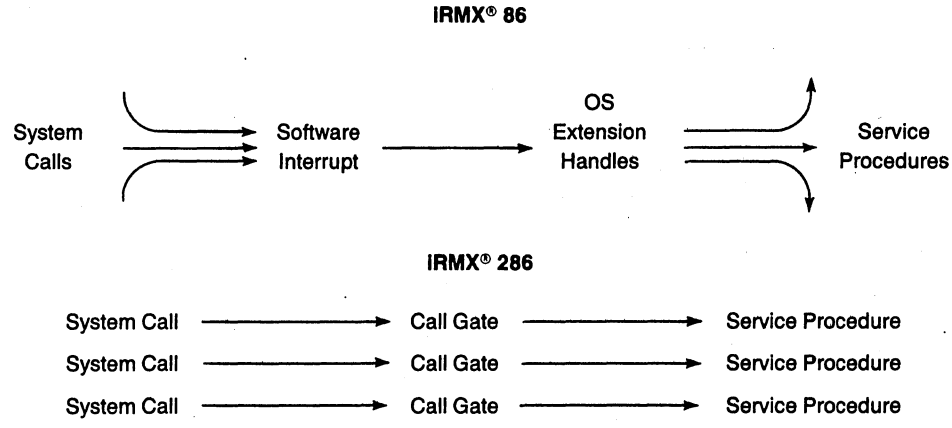


Figure 2. Example Privilege Level Assignments



Call Gates vs. Software Interrupts

Round Robin Scheduling

The iRMX 286 operating system schedules tasks based upon tasks competing for CPU resources. To prevent the occurrence of one or more tasks waiting indefinitely, round robin scheduling is available on the iRMX 286 operating system. One area that could benefit from this scheduling scheme is multi-user environments.

Round robin scheduling will permit equal priority tasks a finite time they may have control of the processor. Once the time expires, the task with the same priority and ready will gain CPU control. Hardware interrupts and higher-priority tasks can still bump any of the lower-priority tasks from running. This scheme allows all equal priority tasks an opportunity to execute.

This scheduling is determined in the "nucleus" screen of the Interactive Configuration Utility (ICU). (See the iRMX 286 Interactive Configuration Utility Reference Manual for details.)

Interrupt Management

In the iRMX 286 operating system interrupt management has changed. In the iRMX 86 operating system an interrupt vector table contains the address of an interrupt handler. In the iRMX 286 operating system this table has been called the Interrupt Descriptor Table (IDT) and is very similar to the GDT and LDT, except that it is referred to only when an interrupt occurs. Interrupt addresses can be entered into the IDT when using the iRMX 286 SET$INTERRUPT nucleus system call. Entering interrupts is still identical for both operating systems, however, with PL/M 286 not having a SET$INTERRUPT built in, interrupts have become easier to use. (See the section on PL/M 286.) The following is a description of the allocated interrupt entries. (Also see the section on BUILD 286 for another way to set interrupts.)

Entry Number	iRMX® 286 Interrupt Allocation Description
0	Divide by zero
1	Single step (used by iSDM™ 286)
2	Power failure (non-maskable interrupt, used by iSDM™ 286)
3	One-byte interrupt instruction (used by iSDM 286)
4	Interrupt on overflow
5	Run-time array bounds error
6	Undefined opcode
7	NPX not present/NPX task switch
8	Double fault
9	NPX segment overrun
10	Invalid TSS
11	Segment not present
12	Stack exception
13	General protection
14-15	<Reserved>
16	NPX error
17-55	<Reserved>
56-63	8259A PIC master
64-127	8259A PIC slaves
128-255	* Available to users *

New Calls

GENERAL RULES

IMPORTANT

Here are some general rules to apply.

1. All iRMX 286 system calls beginning with RQ$... are 100% compatible with iRMX 86.
2. All iRMX 286 system calls beginning with RQE$... are new to iRMX and exist only in iRMX 286.
   a. All iRMX 86 system calls beginning with RQ$... for which there is a like iRMX 286 system call beginning with a RQE$... use the function procedure of the RQE$... call.
3. All iRMX 286 system calls and user extensions use call gates.
4. All iRMX 86 BIOS, EIOS, and loader calls are 100% compatible with iRMX 286 calls.
5. All objects are identified by 16-bit tokens which represent an entry in the Global Descriptor Table (GDT).
6. The iRMX 286 system call RQESETOS$EXTENSION must be used in place of RQSETOS$EXTENSION. This call dynamically attaches an operating system extension to a call gate.

A few specific system calls merit further discussion.

RQESETOS$EXTENSION

This system call as mentioned in Rule 6 above will find the following usage.

```
DECLARE
        . Typical PL/M 286 statements
MY$OS$EXT: PROCEDURE EXTERNAL;

        . Typical PL/M 286 statements

END MY$OS$EXT;

CALL RQE$SET$EXTENSION (0141H, @MY$OS$EXT, @STATUS);
```

Where: 0141H represents the entry number of the call gate from the GDT. This parameter is named GATE$NUMBER.

: @MYOSEXT represents the pointer to first instruction of MYOSEXT. This parameter is named START$ADDR.

: @STATUS represents a pointer to a word containing the condition code for this call. This parameter is named EXCEPT$PTR.

A user-written operating system extension can also be attached to a call by the Interactive Configuration Utility (ICU).

Example of an ICU screen:

```
OS Extension
(GSN) GDT slot number                    [0140H-01FFEH] 0141H
(OCN) entry point name                   [1-45 characters] MY$OS$EXT

Enter changes [Abbreviation ?/= NEW_VALUE]:
Do you need any more O.S. extensions?
```

This causes the GDT slot 141H to be configured as a call gate whose entry point is MYOSEXT.

RQE$CREATE$JOB

This call is an example of Rule 2a where two calls perform nearly the same function. In this case the extended versions of POOL$MIN and POOL$MAX parameters are DWORDS instead of WORDS. This is to allow a memory pool of up to 16MB for tasks and objects. While RQ$CREATE$JOB will create a memory pool of up to 1MB, it will use the same function procedure as RQE$CREATE$JOB. This is possible because the RQ$CREATE$JOB interface procedure changes the word pool parameters to DWORDS by padding them with zeros, then calling the RQE$CREATE$JOB function procedure.

RQ$CREATE$SEGMENT

This call's first parameters, SIZE, yields a different value than in iRMX 86.

In iRMX 86: Segment = RQ$CREATE$SEGMENT (SIZE, EXCEPT$PTR);

Where: SIZE is a word containing the size, in bytes, of the requested segment in MULTIPLES OF 16 BYTES.

In iRMX 286: SEGMENT = RQ$CREATE$SEGMENT (SIZE, EXCEPT$PTR);

Where: SIZE is a word containing the actual memory size in bytes.

RQGETPOOL$ATTRIB

In this case more parameters have been added.

In iRMX 86: RQGETPOOL$ATTRIB (ATTRIB$PTR, EXCEPT$PTR);

Where: ATTRIB$PTR is a pointer to the following structure.

```
Structure  (POOLMAX WORD,
            POOLMIN WORD,
            INITIAL$SIZE WORD,
            ALLOCATED WORD,
            AVAILABLE WORD);
```

In iRMX 286: RQEGETPOOL$ATTRIB has a different structure though everything else is the same

```
Structure  (TARGET$JOB TOKEN,
            PARENT$JOB TOKEN,
            POOLMAX DWORD,
            POOLMIN DWORD,
            INITIAL$SIZE DWORD,
            ALLOCATED DWORD,
            AVAILABLE DWORD,
            BORROWED DWORD);
```

RQSETINTERRUPT

Users should also be aware of the following when using this call in iRMX 286. When specifying interrupts in iRMX 286, a special descriptor table called the Interrupt Descriptor Table (IDT) is located at a user-specified address in memory. This table is accessible through an entry in the Global Descriptor Table (GDT). This makes an interrupt procedure entry point to be directly accessed via a jump to the specific SELECTOR:OFFSET pointer in the IDT. All interrupts will have a SELECTOR:OFFSET address just as in the iRMX 86 operating system. Therefore, the system calls syntax will remain the same, except the parameter called INTERRUPT$HANDLER as shown below:

Example: iRMX 286

```
CALL RQ$SET$INTERRUPT (LEVEL, INTERRUPT$FLAGS, INTERRUPT$HANDLER,
                       INT$HANDLER$DS, EXCEPT$PTR);
```

Where INTERRUPT$HANDLER, the entry point to the interrupt handler, should be coded directly, i.e., @MY$HANDLER.

By referencing a handler directly, all other intermediate steps are unnecessary. (See the example in the PL/M 286 section.)

BASIC INPUT/OUTPUT SYSTEM (BIOS)

The BIOS of the iRMX 86 operating system is nearly identical to the iRMX 86 operating system BIOS. The same system calls are available with no changes or additions. The significant differences between the two BIOS's are the 16MB addressability and memory protection available in the iRMX 286 operating system.

Protection

The memory protection offered by the iRMX 286 operating system BIOS protects the code and data by preventing any task from reading or writing a segment of memory unless explicit access has been granted. It also prevents memory reads or writes from crossing segment boundaries. Therefore any task using the A$READ or A$WRITE BIOS system calls must have read or write access privileges.

Device Drivers

Not all iRMX 86 operating system device drivers have been included in the iRMX 286 operating system. Consult the following list or the iRMX 286 Interactive Configuration Utility for the specific Intel-supplied drivers.

Intel Device Drivers Supplied With iRMX® 286 R. 2.0

- iSBC® 215G
- iSBC 214
- iSBX™ 218A
- iSBX 217C
- iSBC 220
- iSBC 208
- iSBX 251
- iSBC 264
- iSBX 350 Line Printer
- Line Printer for 286/10
- iSBC 534
- iSBC 544
- Terminal Comm Cntlr
  - to include:
    - iSBC 188/48
    - iSBC 188/56
    - iSBC 546
    - iSBC 547
- iSBC 548
- 8274
- 8251A
- 82530
- RAM disk
- iSBC 286/10
- iSBC 286/10A
- iSBC 286/1X
- iSBC 386/2X

Not included are the following device drivers:

- iSBC 204
- iSBC 206
- SCSI
- iSBC 226

EXTENDED INPUT/OUTPUT SYSTEM (EIOS)

The EIOS of the iRMX 286 operating system is nearly identical to the iRMX 86 operating system EIOS. The same system calls are available with few changes and additions. The significant differences between the two EIOS's are the 16MB addressability and memory protection available in the iRMX 286 operating system.

Protection

The memory protection offered by the iRMX 286 operating system EIOS protects the code and data by preventing any task from reading or writing a segment of memory unless explicit access has been granted. It also prevents memory reads and writes from crossing segment boundaries. The system calls S$READ$MOVE and S$WRITE$MOVE are two calls that will send an exception code called EBADBUFF whenever this occurs.

Extended Memory Pool

Since the iRMX 286 operating system supports the 16MB addressability of the 80286 processor, the memory pools created by I/O jobs can also be as large as 16MB. The new system call providing this feature is called RQE$CREATE$IO$JOB.

New Calls

Several new system calls have been added to the iRMX 286 operating system EIOS layer. They are:

1. RQE$CREATE$IO$JOB
   POOLMIN and POOLMAX parameters changed to DWORDS for 16MB addressability.
2. RQSGETDIRECTORY$ENTRY
   Retrieve name of any file in a directory.
3. RQSGETPATH$COMPONENT
   Retrieve name of any file as it is known in its parent directory.

iRMX® 286 APPLICATION LOADER

80286 OMF

Two utilities are supplied with the iRMX 286 operating system to load programs and data into system memory from secondary storage devices. They are the bootstrap loader and the application loader. Typically the bootstrap loader is used to load the initial system and begin its execution. The application loader will typically be called, by programs running in the system, to load additional programs. The application loader can load I/O jobs up to 16MB. These programs must be in the 80286 Object Module Format (OMF). This differs from the iRMX 86 operating system, which loads only 8086 OMF records. Further, the 80286 records must be in STL format. (See a later section called BND 286 for a discussion of STL format.)

New Calls

RQEALOADIOJOB

This calls memory pools changed to DWORD values from word. (See RQE$CREATE$JOB call in the Nucleus section.)

RQESLOADIOJOB

Same as above.

HUMAN INTERFACE

Enhanced Command Line Interpreter (CLI)

The new CLI provides line-editing features, as well as its own set of commands. With CLI commands, aliases can be created, background programs ran, output redirected or redefined for a terminal in the configuration file. The commands are:

!	ALIAS	BACKGROUND	CHANGEID	DEALIAS	EXIT	
HISTORY	JOBS	KILL	LOGOFF	SET	SUBMIT	SUPER

To include or customize features in the CLI, user extensions have been added to the Human Interface.

New Calls

ADDLOC	LOGOFF	SHUTDOWN	LOCK	UNLOCK	ZSCAN

Old Calls

The following Human Interface commands have been revised:

BACKUP	DISKVERIFY	FORMAT	LOCDATA	RESTORE

UDI

New System Calls

The iRMX 286 UDI contains three system calls not contained in the iRMX 86 UDI. They are:

DQ$MALLOCATE

DQ$MFREE

DQGETMSIZE

All of the calls have their counterparts in the iRMX 86 UDI, however, the new system calls use full pointers instead of selectors and DWORD instead of WORD for memory block start address and size specifications, respectively.

These three calls are only supported in programs compiled in the compact or large segmentation models. Also, earlier versions of these calls cannot be mixed. For example:

After using DQ$MALLOCATE to allocate memory, do not use DQ$FREE to free it.

Use DQ$MFREE instead.

BOOTSTRAP LOADER

Two Stage Loader

To facilitate loading an application so that it may execute has been known as "pulling it up by its bootstraps" or simply "booting" the application. iRMX bootstrap loaders have been divided into stages, each possessing a unique purpose and role.

In the iRMX 86 operating system, the bootstrap loader exists as only two stages. The first stage resides in PROM located on the CPU's board. If supplied by Intel, it will occupy less than 8Kb of memory within the PROM. Once running, it will identify the applications name and location, then load part of the second stage, passing control to it. The second stage finishes loading itself, loads the application into memory, then passes control to the application. While the first stage is user-configurable, the second stage is not. The second stage is only supplied by Intel and is present on all iRMX formatted, named volumes.

New Third Stage

In the iRMX 286 operating system, the bootstrap loader exists as three stages. The extra stage was added to be able to load 80286 OMF files. This will also permit loading 8086 OMF files with just the first and second stages. This means either system can be booted without compromising the other. To allow for this, some files have to be renamed and some new conventions adopted. (See below and Figure 3.)

1. All 80286 OMF bootloader application systems must have the extension ".286".
2. The third stage bootstrap loader must have the same name as the application, less the extension.
3. The third stage bootstrap loader must reside in the same directory as the bootloadable system.

File Name Conventions

Third Stage	System to be Loaded
/SYSTEM/RMX86	/SYSTEM/RMX86.286
/SYSTEM/RMX	/SYSTEM/RMX.286
/BOOT/RMX286	/BOOT/RMX286.286

This chart indicates to those wanting to boot the iRMX 86 operating system that their file /SYSTEM/RMX86 had better be renamed to avoid confusion.

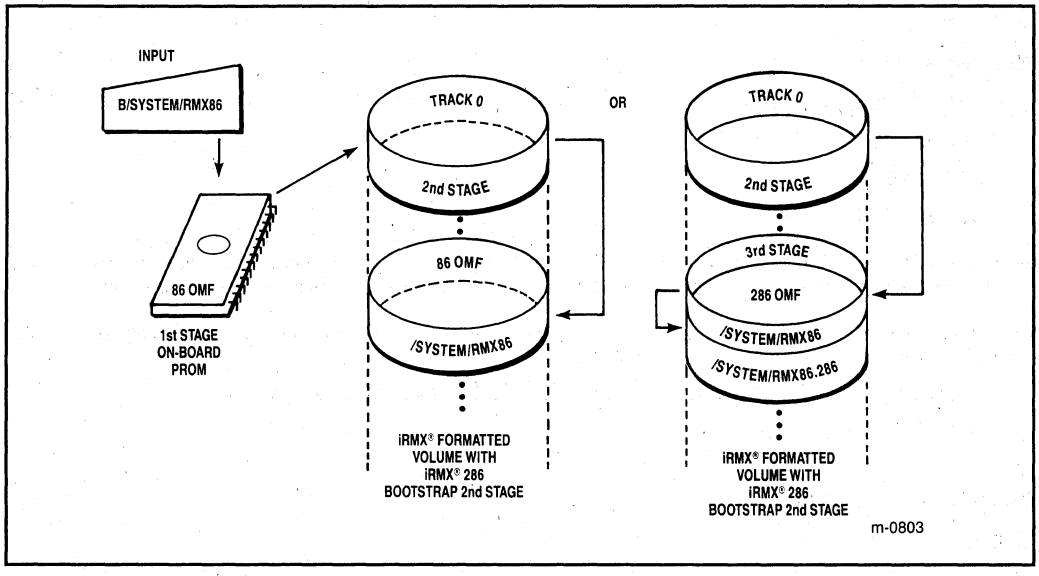


Figure 3.

When installing the iRMX 286 operating system on a system containing the iRMX 86 operating system, the "BS" option of the format command will install ONLY the new second stage bootstrap loader on track 0 of the hard disk. The installation process will also add new directories as required by the iRMX 286 operating system.

Memory Locations of the Three Stages

Bootstrap Loader Locations

Description	Default	Approx. Size	Config. File
1st STAGE CODE	Application dependent	12KB	BS1.CSD
2nd STAGE CODE 1st/2nd DATA and STACK	0B8000H	8KB	BS1.CSD
3rd STAGE (specific) CODE DATA and STACK	0BC000H	16KB	BS3.CSD
3rd STAGE (generic) CODE	0BC000H	8KB	BG3.CSD
3rd STAGE (generic) DATA and STACK	0B8000H	—	BG3.csd

CONFIGURATION SIZE CHART

Operating System Layer	iRMX® 286 Memory Requirements	iRMX® 86* Code Size	iRMX® 286* Code Size	iRMX® 86* Data Size	iRMX® 286* Data Size
Nucleus	34K	24K	27K	2K	3.5K
BIOS	95K	78K	67K	1K	19.5K
EIOS	19K	12.5K	16K	1K	16.75K
Application Loader	12K	10K	11K	2K	2K
HI	36K	22K	26K	15K	1K
UDI	11K	8K	9.4K	0K	0.1K
Bootstrap Loader	—	1.5K	32K	6K	6K
ICU	—	—	—	308K	384K

*These numbers reflect actual memory size required to support the different configurations of the operating systems.

FILE STRUCTURE

The file system of the iRMX 286 operating system provides for the same types of files as are on the iRMX 86 operating system. In fact, both file systems can exist on the same volume using the same hierarchical file structure. This is made possible through the installation of the iRMX 286 bootstrap loader's second stage onto the iRMX 86 operating system's volume. This second stage will allow either operating system to be booted from the same volume. One fact should be remembered: iRMX 286 uses the 80286 OMF, while iRMX 86 uses the 8086 OMF. This stops either operating system from loading and executing the other's files or programs. Copying, deleting or other maintenance operations can still be accomplished across the volume. iRMX 286 operating system will also read iRMX 86 back-up format files from another volume. The following Figure 4 shows a file system with both operating systems installed, including the changes to its structure. Remember, iRMX 286 can reside by itself or with iRMX 86 on the same volume.

Conventions

New file conventions have been adopted to differentiate between several types of files. They are:

*.P28 — PL/M 286 source files
*.P86 — PL/M 86 source files
*.A28 — ASM 286 source files
*.A86 — ASM 86 source files
*.GAT — Gate definition files
*.BLD — Build, file for BLD 286
*.286 — Bootable iRMX 286 system file
*.86 — Bootable iRMX 86 system file

After booting iRMX 286, the following assignments are assumed:

: SYSTEM : = /SYS286
: UTIL : = /UTIL286
: LANG : = /LANG286

After booting iRMX 86, the following still apply:

: SYSTEM : = /SYSTEM
: UTIL : = /UTILS
: LANG : = /LANG

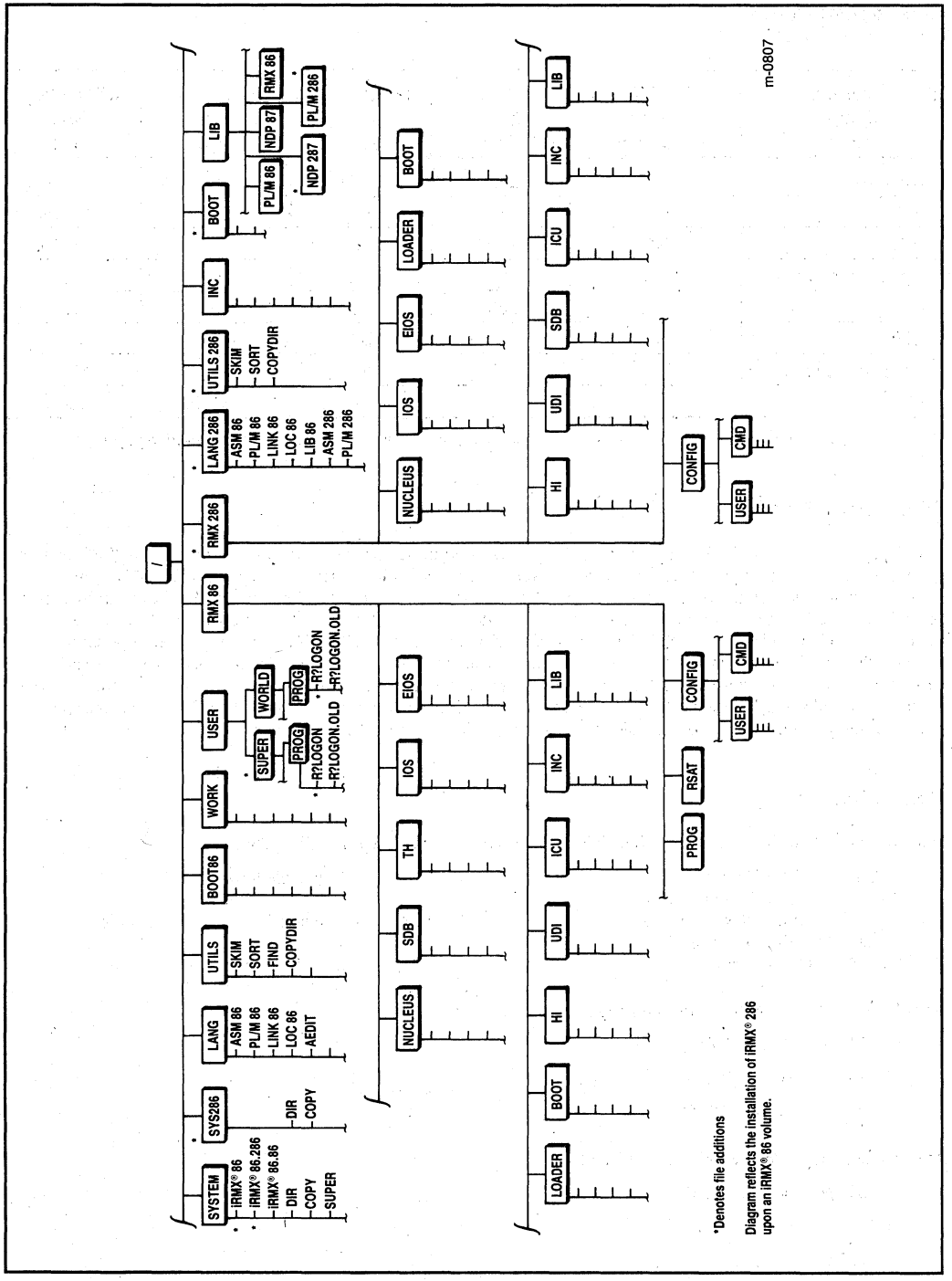

/
SYSTEM
iRMX® 86
iRMX® 86.286
iRMX® 86.86
DIR
COPY
SUPER
SYS286
DIR
COPY
LANG
ASM 86
PL/M 86
LINK 86
LOC 86
AEDIT
UTILS
SKIM
SORT
FIND
COPYDIR
BOOT86
WORK
USER
SUPER
WORLD
PROG
PROG
R?LOGON
R?LOGON.OLD
R?LOGON
R?LOGON.OLD
RMX 86
NUCLEUS
SDB
TH
IOS
EIOS
LOADER
BOOT
HI
UDI
ICU
INC
LIB
PROG
RSAT
CONFIG
USER
CMD
RMX 286
LANG 286
ASM 86
PL/M 86
LINK 86
LOC 86
LIB 86
ASM 286
PL/M 286
UTILS 286
SKIM
SORT
COPYDIR
INC
BOOT
LIB
PL/M 86
NDP 87
RMX 86
NDP 287
PL/M 286
NUCLEUS
IOS
EIOS
LOADER
BOOT
HI
UDI
SDB
ICU
INC
LIB
CONFIG
USER
CMD
m-0807
*Denotes file additions
Diagram reflects the installation of iRMX® 286 upon an iRMX® 86 volume.

Figure 4.

LANGUAGES: ASM 286

Because ASM 286 supports the 80286 in protected mode, ASM 286 has more changes than other languages. Often users converting their programs to ASM 286 from ASM 86 will assemble the programs in ASM 286 and store the error messages generated and change the code accordingly. A few notable changes are listed below.

Group Directive

ASM 286 does not possess a group directive as in ASM 86. By giving the segments the same name, they will be grouped together into one segment at link time.

Example: ASM 86

```
DATAGRP GROUP DATA1, DATA2
DATA1 SEGMENT
ABYTE DB 0
DATA1 ENDS

DATA2 SEGMENT
AWORD DW 0
DATA2 ENDS
ASSUME DS:DATAGRP

: ASM 286

DATA1 SEGMENT RW PUBLIC
ABYTE DB 0                    } In one module
DATA1 ENDS

DATA1 SEGMENT RW PUBLIC
AWORD DW 0                    } In another module
DATA1 ENDS
ASSUME DS:DATA1
```

Segment Directive

The fields of the SEGMENT directive are also different. ASM 286 does not use anything but para-aligned and access-type.

Example: ASM 86

```
NAME SEGMENT [ALIGN-TYPE] [COMBINE-TYPE]
  WHERE [ALIGN-TYPE] = PARA, BYTE, WORD, PAGE, INPAGE,
                       OR NONE

ASM 286

NAME SEGMENT [ACCESS-TYPE] [COMBINE-TYPE]
  WHERE SEGMENT IS ALWAYS PARA-ALIGNED AND
    [ACCESS-TYPE] = READ-ONLY (RO),
                    EXECUTE-ONLY (EO),
                    EXECUTE-READ (ER), or
                    READ-WRITE (RW)
```

Class name is also not present in ASM 286

Stack Segment

In ASM 286, stack segments are defined using the STACKSEG directive.

Example: ASM 286

```
PROG_STACK STACKSEG 10;                    /* MEANS 10 BYTES ON STACK */
```

The operator STACKSTART is used to define a label at the beginning of the stack to initialize the Stack Pointer (SP).

Example: ASM 286

```
MOV SP, STACKSTART PROG_STACK
```

Selector Access

In ASM 286 the selectors used for the DS, SS, and ES in the ASSUME directive must have certain access types.

Example: ASM 286

```
ASSUME DS:EDATA
EDATA SEGMENT RW PUBLIC
        WHERE DB 0
EDATA ENDS
```

Further, the ASSUME directive will not accept an assume for the code segment. The current code segment being assembled is automatically assumed into the CS. For more information regarding other changes in ASM 286 consult: *ASM 286 Reference Manual* (Appendix G), order #122671

LANGUAGES: PL/M 286

Users migrating their code to PL/M 286 should be aware of the following:

Pointer and Selector Variables

Pointer and selector variables cannot be assigned absolute values. All values must be assigned by reference to another variable or through based-variables.

Example: PL/M 86

```
Declare
   A$POINTER     POINTER;

Start: DO;
       A$POINTER = 0;
```

Example: PL/M 286

```
Declare
   A$POINTER     POINTER;

Start: DO;
       A$POINTER = NIL;
```

Similarly selectors can be assigned values as follows:

Example: PL/M 86

```
Declare token literally 'WORD',
        A$TOKEN     TOKEN;

Start: DO;
       A$TOKEN = 0;
```

Example: PL/M 286

```
Declare token literally 'SELECTOR',
        A$TOKEN     TOKEN;

Start: DO;
       A$TOKEN = SELECTOR$OF(NIL);
```

The only relational operations allowed in PL/M 286 for pointers and selectors are "equals" and "not equals".

Models of Compilation

In PL/M 86 the default is SMALL

In PL/M 286 the default is LARGE

Interrupt Vectors

In PL/M 286 all interrupt numbers on all interrupt procedures must be deleted. The required interrupt vectors will be assigned by the 80286 system builder if not already defined by the iRMX 286 operating system call RQSET INTERRUPT.

Consequently the PL/M 86 built-ins SET$INTERRUPT and INTERRUPT$PTR are unavailable in PL/M 286 and should be removed. Also, all calls to interrupt procedures are not allowed. As the conversion process takes shape, all of these changes turn out better than initially expected as the following example shows.

Example: PL/M 86

```
 1. DECLARE      ZERO      LITERALLY      '00001000b',
 2.              INTERRUPT_HANDLER POINTER;
                          .
                          . TYPICAL PL/M 86 STATEMENTS
                          .
 6. INTERRUPT_HANDLER : PROCEDURE INTERRUPT 56 PUBLIC REENTRANT;
                          .
                          . TYPICAL PL/M 86 STATEMENTS
                          .
10.                       CALL RQ$SIGNAL$INTERRUPT (ZERO, @STATUS);
11. END INTERRUPT_HANDLER;

12. INTERRUPT_TASK    : PROCEDURE PUBLIC REENTRANT;
                          .
                          . TYPICAL PL/M 86 STATEMENTS
                          .
16.          INTERRUPT_HANDLER = INTERRUPT$PTR (INTERRUPT_HANDLER);
17.                       CALL RQ$SET$INTERRUPT (ZERO, 1, INTERRUPT_HANDLER,
                                    DATA$SEG$ADDRESS.BASE, @STATUS);
                          .
                          . TYPICAL PL/M 86 STATEMENTS
                          .
21.                       CALL RQ$WAIT$INTERRUPT (ZERO, @STATUS);
22.     END INTERRUPT_TASK;
```

Comments

Line Number	Description
2.	INTERRUPT_HANDLER was defined as a pointer
6.	Interrupt entry 56 was "hard-coded"
16.	INTERRUPT_HANDLER was assigned the location (address) of the first instruction of the handler via the PL/M 86 built-in "INTERRUPT$PTR"
17.	This call could have looked like: RQSETINTERRUPT (ZERO, 1, INTERRUPT_PTR(INTERRUPT_HANDLER), etc eliminating lines 2 and 16.

Example: PL/M 286

```
1. DECLARE     ZERO     LITERALLY        '00001000b';
                        .
                        . TYPICAL PL/M 286 STATEMENTS
                        .
5. INTERRUPT_HANDLER  : PROCEDURE INTERRUPT PUBLIC REENTRANT;
                        .
                        . TYPICAL PL/M 286 STATEMENTS
                        .
9.                      CALL RQ$SIGNAL$INTERRUPT (ZERO, @STATUS);
10.   END INTERRUPTHANDLER;

11. INTERRUPT_TASK    : PROCEDURE PUBLIC REENTRANT;
                        .
                        . TYPICAL PL/M 286 STATEMENTS
                        .
15.                     CALL RQ$SET$INTERRUPT (ZERO, 1, @INTERRUPT_HANDLER,
                                                DATA$SEG$ADDRESS.BASE, @STATUS);
                        .
                        . TYPICAL PL/M 286 STATEMENTS
                        .
19.                     CALL RQ$WAIT$INTERRUPT (ZERO, @STATUS);
20.     END INTERRUPT_TASK;
```

Comments

Line Number	Description
5.	Notice PL/M 286 does not need to identify the interrupt in this statement
15.	The third parameter becomes simply a pointer to the first instruction of the handler.

DEVELOPMENT TOOLS — BND 286

All iRMX 86 programs linked using LINK 86 will instead have to be bound using BND 286. BND 286 is used to create all single-task application programs that will be dynamically loaded. (See Figure 5.) The following are tasks of the binder.

1. Creates a linkable or loadable module by combining input modules with other bindable modules.
2. Checks the type of variables and procedures.
3. Selects modules from libraries to resolve all symbolic references.
4. Combines logical segments by name, attribute, and privilege levels into physical segments that the processor can manipulate efficiently.
5. Can create a module the application loader can load.

Linkable Modules

In a process called incremental linking, BND 286 combines linkable object modules, including library modules, output by translators. The result is a file containing a linkable module.

Loadable Modules

A dynamically loadable module created by BND 286 is an executable module created by the combination of one or more linkable modules. Loadable modules can be of two types:

1. Single-task loadable (STL)
2. Variable-task loadable (VTL)

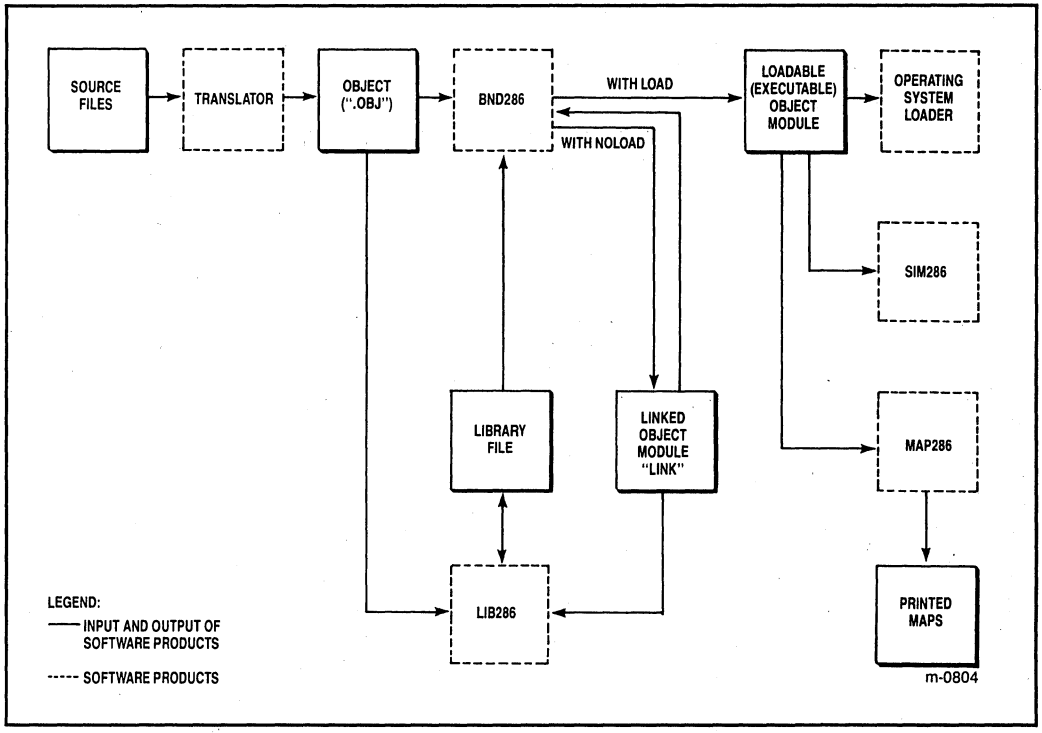


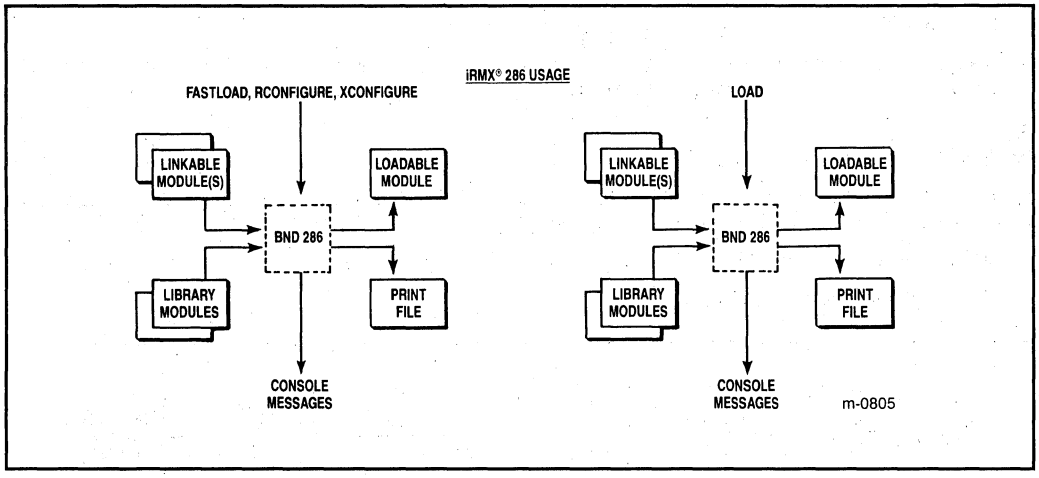
Figure 5. BND 286 Application Program Development

STL Modules

These modules are functionally similar to LTL-format records in the 8086 OMF. STL modules are designed to optimize loader execution time because each contains only one executable task. iRMX 286 and XENIX 286 operating systems will execute only files containing STL modules. BND 286 outputs STL modules when the FASTLOAD, RCONFIGURE, and XCONFIGURE controls are specified. In iRMX 286 only, the RCONFIGURE control is used.

VTL Modules

VTL modules are designed, when provided by BND 286, to also contain a single executable task, but in a format structured for multiple tasks. BND 286 outputs VTL modules when the LOAD control is specified.

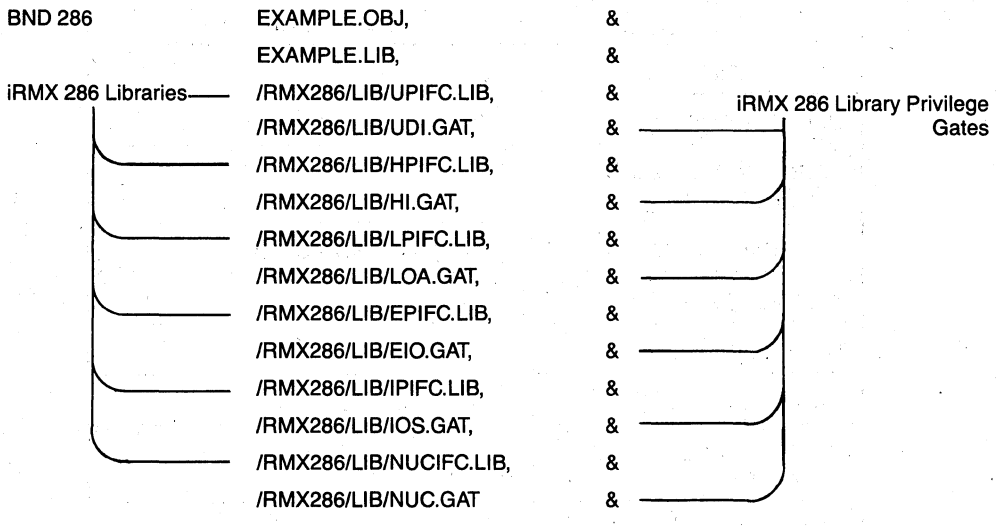


BND 286 TO LINK 86 COMPARISON

BND 286 CONTROLS	LINK 86 CONTROLS
CONTROLFILE (pathname)	—
DEBUG/NODEBUG	SYMBOLS/NOSYMBOLS
ERRORPRINT (pathname)/ NOERRORPRINT	—
FASTLOAD/NOFASTLOAD	FASTLOAD/NOFASTLOAD
*LDTSIZE ([+] number)	—
LOAD/NOLOAD	—
NAME (modulename)	NAME (modulename)
OBJECT (pathname)/ NOOBJECT	—
PACK/NOPACK	—
PRINT (pathname)/ NOPRINT	PRINT (pathname)/ NOPRINT
PUBLICS/NOPUBLICS	PUBLICS/NOPUBLICS/PUBLICSONLY
RCONFIGURE (dm,m)	BIND and MEMPOOL
RENAMESEG (old to new)	—
RESERVE (number)	—
SEGSIZE (name(size))	SEGSIZE (name(size))
*TASKPRIVILEGE ( )	—
TYPE/NOTYPE	TYPE/NOTYPE
*XCONFIGURE	—

*Not used in iRMX 286

The following is an example of BND 286 for a simple human interface Commonly Used System Program (CUSP) used on an iRMX 286 Release 1.0 system.



The following is an example of BND 286 for a simple human interface Commonly Used System Program (CUSP) on an iRMX 286 Release 2.0 system. Notice all of the .GAT files and many of the .LIB files are gone. All of these "missing" files are now contained in the files RMXIFC.LIB and UDIIFC.LIB for convenience.

```
BND 286                    EXAMPLE.OBJ,                    &
                           EXAMPLE.LIB,                    &
                           /RMX286/LIB/UDIIFC.LIB,         &
                           /RMX286/LIB/RMXIFC.LIB,         &
                           RCONFIGURE (DM(10000H,10000H))
(Analogous to BIND & MEMPOOL)
                           SEGSIZE (STACK(1024))
(Analogous to SEGSIZE)
                           OBJECT (EXAMPLE)
(A new control)
```

iRMX(R) XXX.BLD File

```
system_bld;
segment
        nucdat.code(dpl = 0),
        nucdat.data(dpl = 0),
memory
        (reserve = (0..0001FFFH,
         003A000H..0FFFFFFh));
        .
        .
gate
        Gate_CreateJob (entry =
             RqCreateJob, dpl = 0, wc = 0),
        .
        .
table
        ldt1 (limit = 00600h,dpl = 0,
        reserve = (2..2, 4..4AH,
        4CH..4EH, 51H..59h,
        122H..005FFh),
        entry = ( 0:nucdat.escape_ss,
                   3:nucdat.stack,
                  75:nucdat.jobdat,
                  79:nucdat.escape_ss,
                  80:nucdat.entry_code) );
task
        rmxtask (dpl = 0,object = nucdat,
                  ldt = ldt1, no ie);

table
        gdt (limit = 00600H, dpl = 0,
        reserve = (3..3BH, 3DH..4EH,
        51H..53H, 55H..59H, 0C1H..0C7H,
        0E3H..0E5H,0EAH..0EFH,
        101H..103H, 00137h..00140h),
        entry = (60:nucdat.data,
                  79:rmxtask,
                  80:nucdat.code,
                  84:ldt1,
                  90:Gate_AcceptControl,
                  91:Gate_AlterComposite,
                .
                .
                308:sdbcnf.code,
                309:sdbcnf.data,
                310:sdbcnf.newstack,
                291:bios_code,
                292:bios_data,
                .
                .
table
        idt(limit = 00080h, dpl = 0);
end
```

DEVELOPMENT TOOLS — BLD 286

BLD 286 exceeds LOC 86 in capability and versatility. In many cases the use of BLD 286 is transparent to iRMX 286 users, due to the ICU 286 automatically generating the BUILD file. All iRMX 286 users, however, should possess an understanding of the following key functions:

A. Assigns physical addresses to entities, sets segment limits and access rights. (See XXX.BLD file)

B. Allows memory ranges to be reserved or allocated for specific entities. (See XXX.BLD file)

C. Creates one Global Descriptor Table (GDT), one Interrupt Descriptor Table (IDT), and one Local Descriptor Table (LDT). (See XXX.BLD file)

D. Creates gates. (See XXX.BLD file)

E. Creates task state segments and (task gates). (See XXX.BLD file)

F. Creates a bootloadable module. (See XXX.BLD file)

G. Creates object files containing exported system entries. (See XXX.BLD file)

H. Selects required modules from specified libraries automatically, as needed to resolve symbolic references.

I. Performs reference-resolution and typechecking.

J. Detects and reports errors and warnings found during processing (in the XXX.MP2 file)

See Figure 6 for an example of BLD 286 program development.

Usage

BLD 286 is primarily used for building an application program that deals extensively with system interfaces to a hardware environment. This could include configuring gates and/or segments that provide this interface, then place these interfaces in a separate file for later exportation.

The types of executable output produced by BLD 286 are bootloadable, loadable, or incremental-built. Bootloadable modules are absolutely-located object modules that are booted via a simple loader. Loadable modules consist of single- or multiple-task modules used for dynamic loading. Incrementally-built modules are non-executable modules used interactively to build large systems.

Many users will only use BLD 286 when they produce a new configuration using the ICU. ICU 286 generates a file called ICUBLD.CSD which invokes the builder using the file XXX.BLD as the builder definition file.

The following is a typical example of the contents of ICUBLD.CSD:

```
BLD 286,                                    &
        NUCLUS.LNK,                         &
        SDB.LNK,                            &
        IOS.LNK,                            &
        EIOS.LNK,                           &
        LOADER.LNK,                         &
(Produced by BND 286)
        HI.LNK,                             &
        UDI.LNK                             &
        OBJECT (/BOOT/***.286)              &   ( Where to put the
                                                  bootloadable file)
        NODEBUG NOTYPE                      &
        BUILDFILE (***.BLD)                     ( Where to obtain the
                                                  build information)
```

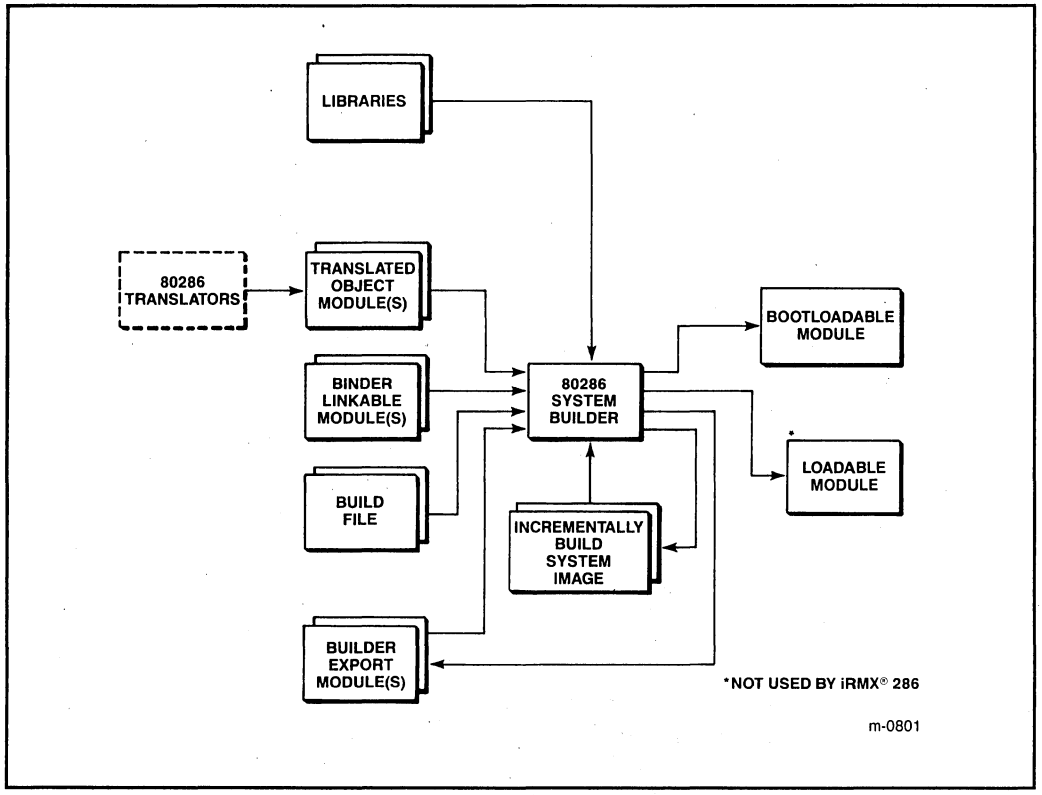


Figure 6. BLD 286 Application Program Development

The build file contains a specific language used by BLD 286 to produce the system or system program. BLD 286 takes all linked input modules and assigns all of the access and protection attributes for each subsystem. A build file is created to specify the characteristics of the relationships among the subsystems. Segment attributes, gates, descriptor tables, aliases, and memory allocation are also described in the build file and read by BLD 286.

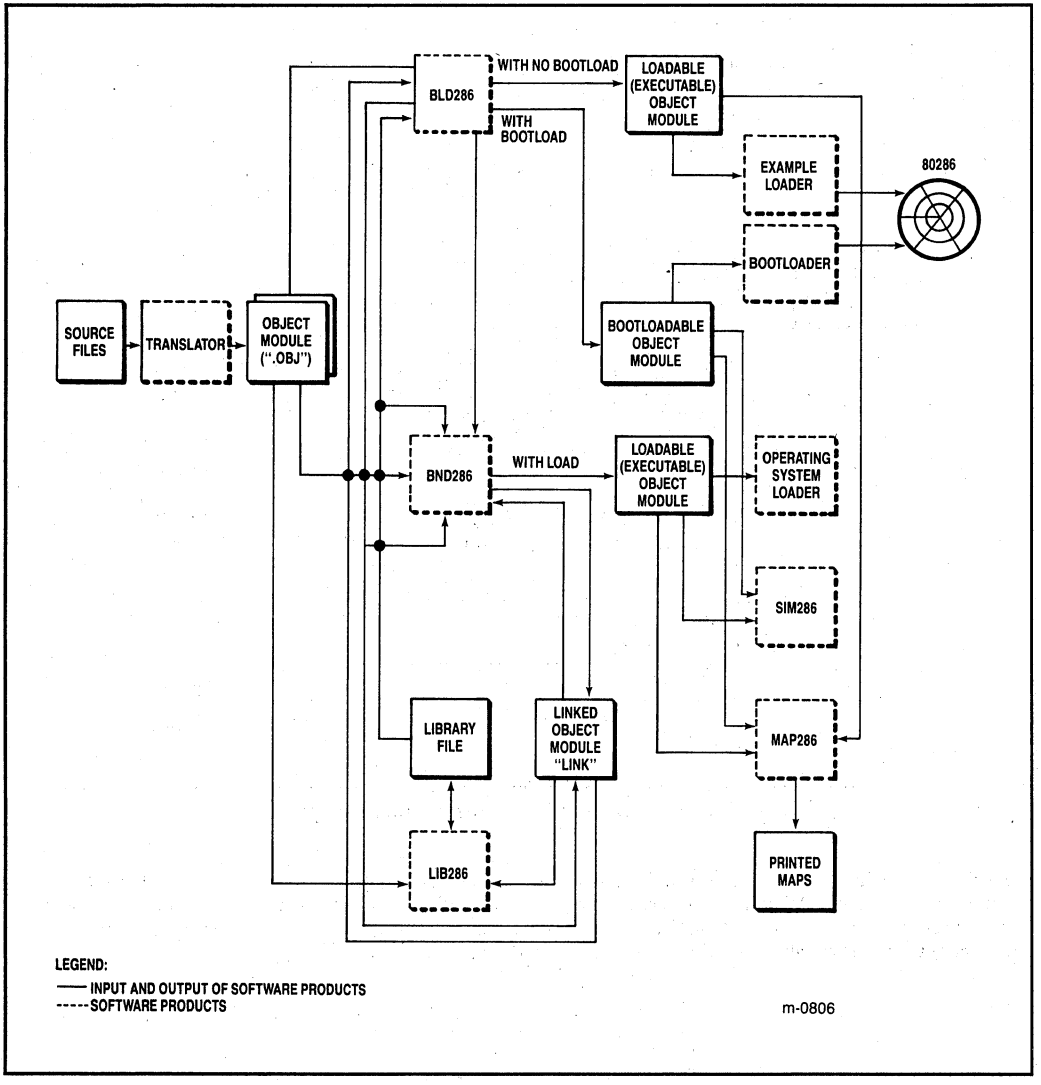

BLD286
WITH NO BOOTLOAD
WITH BOOTLOAD
LOADABLE (EXECUTABLE) OBJECT MODULE
EXAMPLE LOADER
80286
BOOTLOADER
SOURCE FILES
TRANSLATOR
OBJECT MODULE (".OBJ")
BOOTLOADABLE OBJECT MODULE
BND286
WITH LOAD
LOADABLE (EXECUTABLE) OBJECT MODULE
OPERATING SYSTEM LOADER
SIM286
LIBRARY FILE
LINKED OBJECT MODULE "LINK"
MAP286
LIB286
PRINTED MAPS
LEGEND:
—— INPUT AND OUTPUT OF SOFTWARE PRODUCTS
-----SOFTWARE PRODUCTS
m-0806

Figure 7.

MAP 286

The 80286 mapper is a noninteractive utility that generates object module information that BND 286 and BLD 286 do not produce. The utility is offered separately instead of having the builder and binder performing identical functions. The user should note that if debug information is contained in the invocation file, all of the maps will be produced.

MAP 286 will accept the following input:

A. Executable files containing a single executable module, and only one per invocation of MAP 286.

B. Executable files containing a single bootloadable module.

C. One or more linkable or library files.

MAP 286 produces the following output maps:

For executable input files:

A. An output object file with or without debug information.

B. Table MAP, segment MAP, gate MAP, public MAP, symbol MAP, task MAP, and crossreference MAP.

For linkable input files:

A. Only a cross reference map including a module list.

In iRMX 286 the following is a typical invocation of the mapper on an executable file called

```
MAP    286    MYPROG    <CR>
```

If debug information is in "MYPROG" all of the maps will be produced.

iRMX® 86 OPERATING SYSTEM PROGRAM MIGRATION

Compiling in PL/M 286

The following is an example of converting an iRMX 86 Commonly Used System Program (CUSP) called NOTE. To assist readers, all of the conversion steps will be described.

Source Program

The program NOTE is written in PL/M 86 for use on iRMX 86 operating system. When invoked, the utility will echo a line of keyboard input to the console.

The source code file name for NOTE is NOTE.P86. To adhere to PL/M 286 and iRMX 286 operating system file naming conventions, the file should be renamed to NOTE.P28. Next, the file has to be changed to reflect changes in PL/M 286 and iRMX 286 library files. Finally the file is compiled and bound with BND 286. See the following examples for further explanation.

STEP 1

Copy NOTE.P86 to NOTE.P28 <CR>

STEP 2

The NOTE.P28 file has to be edited to change

A. All '0' pointers to 'NIL'

B. All '0' selectors to 'SELECTORS$OF(NIL)'

Also notice all of the include files assume an iRMX 86 operating system and have to be changed to iRMX 286 libraries.

STEP 3

The new NOTE.P28 program is compiled and any errors are corrected.

```
$title('iRMX 86 HI NOTE command')
$subtitle('module header')
/*************************************************************************
 TITLE: note
 ABSTRACT:
  This module contains the main routine for the HI note command.

    NOTE  message

  Message will be printed on EO.
*************************************************************************/
hnote: DO;

$include(:sd:inc/hstand.lit)
$include(:sd:rmx86/inc/hgtchr.ext)
$include(:sd:rmx86/inc/hsneor.ext)
$include(:sd:inc/hutil.ext)

DECLARE
 version(*) BYTE  DATA( 'program_version_number=F001',
       'program_name=Note',0);

1  main: DO;
    /* local variables */
2 DECLARE
3  excep   WORD,
4  char    BYTE,
5  count   WORD,

6  msg  STRUCTURE(
7       length    BYTE,
8       char(STRING$MAX) BYTE);

9     count = 0;
10    char = rq$C$get$char( @excep);
11    DO WHILE( (char := rq$C$get$char( @excep)) <> 0);
12   IF  count < LAST(msg.char)  THEN
13    DO;
14     msg.char(count) = char;
15     count = count + 1;
16    END;
17     END;
18     msg.char(count) = cr;
19     count = count + 1;
20     msg.char(count) = lf;
21     count = count + 1;
22     msg.length = count;
23    CALL rq$C$send$EO$response( 0, 0, @msg, @excep);

    /* exit from command */

24    CALL cusp$error( excep, @(0), @(0), ABORT);
25   END main;

END hnote;
```

THIS POINTER NEEDS CHANGING.

PLM 86 Example

```
$title('iRMX 286 HI NOTE command')
$subtitle('module header')
/*************************************************************************
 TITLE: note
 ABSTRACT:
  This module contains the main routine for the HI note command.

    NOTE  message

  Message will be printed on EO.
*************************************************************************/
hnote: DO;

$include(:sd:inc/hstand.lit)
$include(:sd:rmx86/inc/hgtchr.ext)
$include(:sd:rmx86/inc/hsneor.ext)
$include(:sd:inc/hutil.ext)

DECLARE
 version(*) BYTE  DATA( 'program_version_number=F001',
       'program_name=Note',0);

1  main: DO;
    /* local variables */
2 DECLARE
3  excep   WORD,
4  char   BYTE,
5  count   WORD,

6  msg  STRUCTURE(
7       length    BYTE,
8       char(STRING$MAX) BYTE);

9   count = 0;
10   char = rq$C$get$char( @excep);
11   DO WHILE( (char := rq$C$get$char( @excep)) <> 0);
12  IF  count < LAST(msg.char)  THEN
13   DO;
14    msg.char(count) = char;
15    count = count + 1;
16   END;
17   END;
18    msg.char(count) = cr;
19    count = count + 1;
20    msg.char(count) = lf;
21    count = count + 1;
22   msg.length = count;
23   CALL rq$C$send$EO$response( NIL, 0, @msg, @excep);

    /* exit from command */

24    CALL cusp$error( excep, @(0), @(0), ABORT);
25  END main;

END hnote;
```

THIS IS OK NOW.

PLM 286 Version Example

Binding an iRMX® 286 Application

STEP 1

If a program was previously linked in iRMX 86, we then examine the original LINK file used and notice the following:

```
PLM86 %0.P86 COMPACT ROM OPTIMIZE(3) NOTYPE PW(132)
;
LINK86      %0.obj,                          &
   /rmx86/hi/hutil.lib,          &
   /lib/plm86/plm86.lib,         &
   /rmx86/lib/hpifc.lib,         &
   /rmx86/lib/epifc.lib,  &
   /rmx86/lib/ipifc.lib,  &
   /rmx86/lib/rpifc.lib  &
   to %.86
   bind  mempool(10000,0B0000H)
   nosb noty
```

1. The library names will change
2. The pathnames to access the libraries will change
3. BIND and MEMPOOL will change

STEP 2

The following is the iRMX 286 Release 1.0 version of the file in Step 4. Remember the libraries have changed names between iRMX 286 Release 1.0 and 2.0.

```
PLM286 %0.p28 COMPACT ROM OPTIMIZE(3) NOTYPE PW( 132)
;
bnd286   %0.obj,                                          &
         /rmx286/lib/hutil.lib,                           &
         /rmx286/lib/plm286.lib,                          &
         /rmx286/lib/hpifc.lib, /rmx286/lib/hi.gat,       &
         /rmx286/lib/epifc.lib, /rmx286/lib/eio.gat,      &
         /rmx286/lib/ipifc.lib, /rmx286/lib/ios.gat,      &
         /rmx286/lib/nucifc.lib, /rmx286/lib/nuc.gat      &
         renameseg(hi_code to code, hi_data to data) segsize (stack(1000H)) &
         object(%0) rc(dm(12000,1000000))
         nodebug noty
```

STEP 3

This is an example of the Step 4 file modified to run on iRMX 286 Release 2.0. Notice the reduction of library statements.

```
PLM286 %0.p28 COMPACT ROM OPTIMIZE(3) NOTYPE PW( 132)
;
bnd286   %0.obj,                              &
         /RMX286/hi/hutil.lib,                &
         /RMX286/lib/plm286/plm286.lib,       &
         /RMX286/lib/rmxifc.lib               &
         renameseg(hi_code to code, hi_data to data) segsize (stack(1000H)) &
         object(%0)  rc(dm(12000,1000000))
         nodebug noty
```

Though these few migration examples reflect trivial modifications, larger and more complex applications might require a little more attention.

SUMMARY

The purpose of this application note is to provide insight and direction to those individuals contemplating using the iRMX 286 operating system. For those already familiar with the iRMX 86 operating system, this paper's focus is to provide the pathway to a superior product.

The iRMX 286 operating system is a vast improvement over its previous counterpart. Some notable changes are round robin scheduling, hardware-enforced protection, hardware-assisted debugging, and access to the 80386 processor. With this operating system the capabilities of the 80286 processor can be fully utilized for multiple environments.

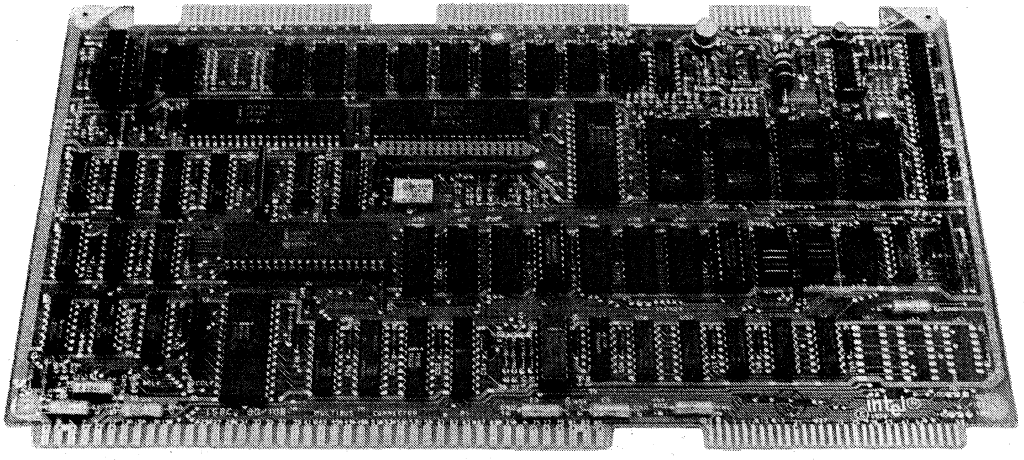
Since the iRMX product line was introduced, many applications, programs, and lines of code have been written to support a tangible demand for real-time processing; in manufacturing, in medicine, and in finance, to name a few. As a result more time is being spent on designing, writing, and testing software than ever before. The iRMX 286 operating system is the preferred product for generating error-free programs while utilizing the highest CPU technology available in the OEM modules market.

Single Board Computers 3

iSBC® 80/10B
SINGLE BOARD COMPUTER

- **8080A CPU Used as Central Processing Unit**
- **One iSBX™ Bus Connector for iSBX™ MULTIMODULE™ Board Expansion**
- **1K Byte of Read/Write Memory with Sockets for Expansion up to 4K Bytes**
- **Sockets for up to 16K Bytes of Read Only Memory**
- **48 Programmable Parallel I/O Lines with Sockets for Interchangeable Line Drivers and Terminators**
- **Programmable Synchronous/ Asynchronous Communications Interface with Selectable RS232C or Teletypewriter Compatiblity**
- **Single Level Interrupt with 11 Interrupt Sources**
- **Auxiliary Power Bus and Power-Fail Interrupt Control Logic for RAM Battery Backup**
- **1.04 Millisecond Interval Timer**
- **Limited Master MULTIBUS® Interface**

The Intel iSBC 80/10B board is a member of Intel's complete line of OEM microcomputer systems which take full advantage of Intel's LSI technology to provide economical, self-contained computer-based solutions for OEM applications. The iSBC 80/10B board is a complete computer system on a single 6.75 x 12.00-inch printed circuit card. The CPU, system clock, iSBX bus interface, read/write memory, read only memory sockets, I/O ports and drivers, serial communications interface, bus control logic, and drivers all reside on the board.



280217-1

September 1987
Order Number: 280217-002

FUNCTIONAL DESCRIPTION

Intel's powerful 8-bit n-channel MOS 8080A CPU, fabricated on a single LSI chip, is the central processor for the iSBC 80/10B board. The 8080A contains six 8-bit general purpose registers and an accumulator. The six general purpose registers may be addressed individually or in pairs, providing both single and double precision operators. A block diagram of iSBC 80/10B board functional components is shown in Figure 1.

iSBX™ Bus MULTIMODULE™ Board Expansion

The new iSBX bus interface brings an entirely new dimension to system design offering incremental on-board expansion with small iSBX boards. One iSBX bus connector interface is provided to accomplish plug-in expansion with any iSBX MULTIMODULE board. iSBX boards are available to provide expansion equivalent to the I/O available on the iSBC 80/10B board or the user may configure entirely new functionality such as math directly on-board. The iSBX 350 programmable I/O MULTIMODULE board provides 24 I/O lines using an 8255A programmable peripheral interface. Therefore, the iSBX 350 module together with the iSBC 80/10B board may offer 72 lines of programmable I/O. Alternately, a serial port may be added using the iSBX 351 serial I/O multimodule board or math may be configured on-board with the iSBX 332 floating point math MULTIMODULE board.

The iSBX board is a logical extension of the on-board programmable I/O and is accessed by the iSBC 80/10B single board computer as common I/O port locations. The iSBX board is coupled directly to the 8080A CPU and therefore becomes an integral element of the iSBC 80/10B single board computer providing optimum performance.

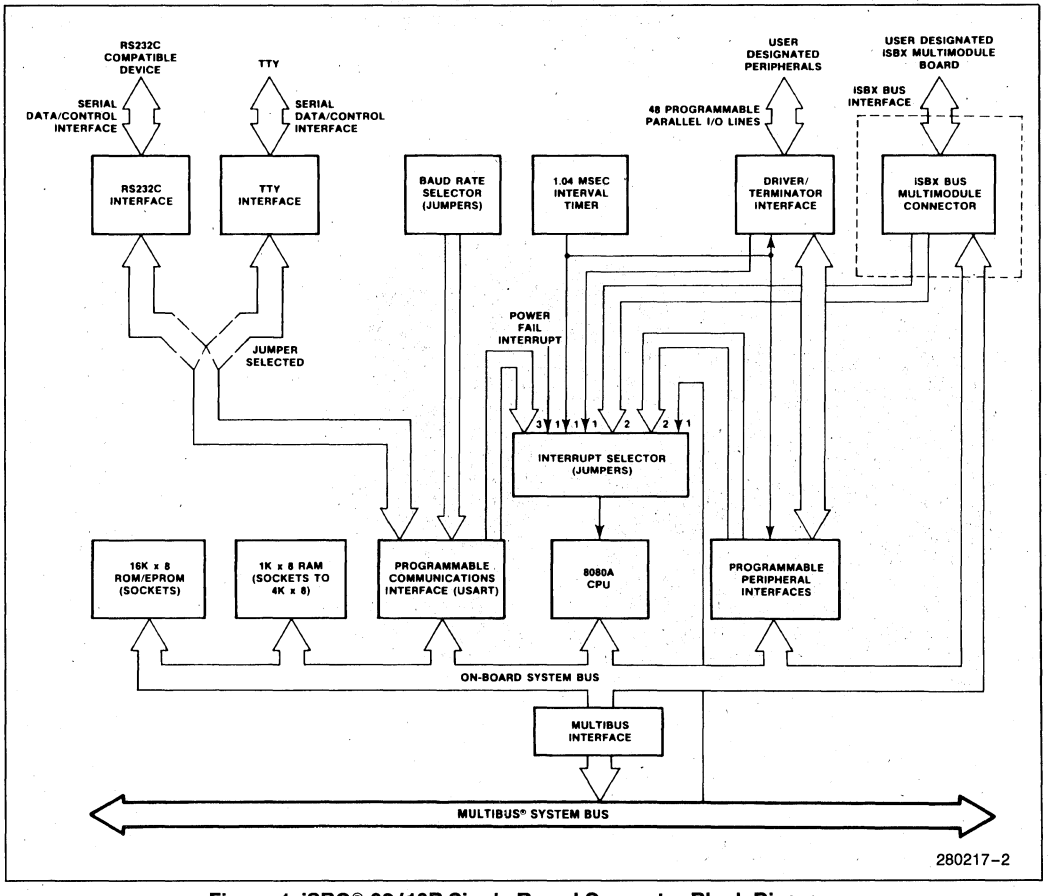


Figure 1. iSBC® 80/10B Single Board Computer Block Diagram

Memory Addressing

The 8080A has a 16-bit program counter which allows direct addressing of up to 64K bytes of memory. An external stack, located within any portion of read/write memory, may be used as a last-in/first-out storage area for the contents of the program counter, flags, accumulator, and all of the six general purpose registers. A 16-bit stack pointer controls the addressing of this external stack. This stack provides subroutine nesting bounded only by memory size.

Memory Capacity

The iSBC 80/10B board contains 1K bytes of read/write static memory. In addition, sockets for up to 4K bytes of RAM memory are provided on board. Read/write memory may be added in 1K byte increments using two 1K x 4 Intel 2114A-5 static RAMs. All on-board RAM read and write operations are performed at maximum processor speed. Sockets for up to 16K bytes of nonvolatile read-only-memory are provided on the board. Read-only-memory may be added in 1K byte increments up to 4K bytes (using Intel 2708 or 2758); in 2K byte increments up to 8K bytes (using Intel 2716); or in 4K byte increments up to 16K bytes (using Intel 2732). All on-board ROM or EPROM read operations are performed at maximum processor speed.

Parallel I/O Interface

The iSBC 80/10B board contains 48 programmable parallel I/O lines implemented using two Intel 8255A programmable peripheral interfaces. The system software is used to configure the I/O lines in any combination of unidirectional input/output, and bidirectional ports indicated in Table 1. Therefore, the I/O interface may be customized to meet specific peripheral requirements. In order to take full advantage of the large number of possible I/O configurations, sockets are provided for interchangeable I/O line drivers and terminators. Hence, the flexibility of the I/O interface is further enhanced by the capability of selecting the appropriate combination of optional line drivers and terminators to provide the required sink current, polarity, and drive/termination characteristics for each application. The 48 programmable I/O lines and signal ground lines are brought out to two 50-pin edge connectors that mate with flat cable or round cable.

Serial I/O Interface

A programmable communications interface using the Intel 8251A Universal Synchronous/Asynchronous Receiver/Transmitter (USART) is contained on the board. A jumper selectable baud rate generator provides the USART with all common communications frequencies. The USART can be programmed

Table 1. Input/Output Port Modes of Operation

Port	Lines (Qty)	Mode of Operation					
		Unidirectional				Bidirectional	Control
		Input		Output			
		Unlatched	Latched & Strobed	Latched	Latched & Strobed		
1	8	X	X	X	X	X	
2	8	X	X	X	X		
3	8	X		X			X(1)
4	8	X		X			
5	8	X		X			
6	4	X		X			
	4	X		X			

NOTE:
1. Port 3 must be used as a control port when either port 1 or port 2 are used as a latched and strobed input or a latched and strobed output port or port 1 is used as a bidirectional port.

by the system software to select the desired synchronous or asynchronous serial data transmission technique (including IBM Bi-Sync). The mode of operation (i.e., synchronous or asynchronous), data format, control character format and parity are all under program control. The 8251A provides full duplex, double-buffered transmit and receive capability. Parity, overrun, and framing error detection are all incorporated in the USART. The inclusion of jumper selectable TTY or RS232C compatible interfaces on the board, in conjunction with the USART, provides a direct interface to teletypes, CRTs, RS232C compatible cassettes, and asynchronous and synchronous modems. The RS232C or TTY command lines, serial data lines, and signal ground lines are brought out to a 26-pin edge connector that mates with RS232C compatible flat or round cable.

Interrupt Capability

Interrupt requests may originate from 11 sources. Two jumper selectable interrupt requests can be automatically generated by the programmable peripheral interface when a byte of information is ready to be transferred to the CPU (i.e., input buffer is full) or a byte of information has been transferred to a peripheral device (i.e., output buffer is empty). Three jumper selectable interrupt requests can be automatically generated by the USART when a character is ready to be transferred to the CPU (i.e., receive channel buffer is full), a character is ready to be transmitted (i.e., the USART is ready to accept a character from the CPU), or when the transmitter is empty (i.e., the USART has no character to transmit). These five interrupt request lines are all maskable under program control. Two interrupt request lines may be interfaced directly to user designated peripheral devices; one via the MULTIBUS system bus and the other via the I/O edge connector. One jumper selectable interrupt request may be interfaced to the power-fail interrupt control logic. One jumper selectable interrupt request may originate from the interval timer. Two general purpose interrupt requests are jumper selectable from the iSBX interface. These two signals permit a user installed MULTIMODULE board to interrupt to 8080A CPU. The eleven interrupt request lines share a single CPU interrupt level. When an interrupt request is recognized, a restart instruction (RESTART 7) is generated. The processor responds by suspending program execution and executing a user defined interrupt service routine originating at location 38_{16}.

Power-Fail Control

A power-fail interrupt may be detected through the AC-low signal generated by the power supply. This signal may be configured to interrupt the 8080A CPU to initiate an orderly power down instruction sequence.

Interval Timer

A 1.04 millisecond timer is available for interval interrupts or as a clock output to the parallel I/O connector. The timer output is jumper selectable to the programmable parallel interface, the parallel I/O connector (J1), or directly to the 8080A CPU.

MULTIBUS® System Expansion Capabilities

Memory and I/O capacity may be expanded and additional functions added using Intel MULTIBUS™ system compatible expansion boards. Memory may be expanded to 65,536 bytes by adding user specified combinations of RAM boards, EPROM boards, or combination boards. Input/output capacity may be increased by adding digital I/O and analog I/O expansion boards. In addition, the iSBC 80/10B board performs as a limited bus master in that it must occupy the lowest priority when used with other MULTIBUS masters. The bus master may take control of the MULTIBUS system bus by halting the iSBC 80/10B board program execution. Mass storage capability may be achieved by adding single density diskette, double density diskette, or hard disk controllers. Modular expandable backplanes and cardcages are available to support multiboard systems.

SPECIFICATIONS

Word Size

Instruction: 8, 16, or 24 bits
Data: 8 bits

Cycle Time

Basic Instruction Cycle: 1.95 μs

NOTE:
Basic instruction cycle is defined as the fastest instruction (i.e., four clock cycles).

Memory Addressing

On-Board ROM/EPROM
0–0FFF using 2708, 2758
0–1FFF using 2716
0–3FFF using 2732

On-Board RAM
3C00–3FFF with no RAM expansion
3000–3FFF with 2114A-5 expansion

NOTE:
All RAM configurations are automatically moved up to a base address of 4XXX when configuring EPROM for 2732.

Memory Capacity

On-Board ROM/EPROM
16K bytes (sockets only)

On-Board RAM
1K byte with user expansion in 1K increments to 4K byte using Intel 2114A-5 RAMs.

Off-Board Expansion
Up to 64K bytes using user specified combinations of RAM, ROM, and EPROM.

I/O Addressing

On-Board Programmable I/O

Device	I/O Address
8255 No. 1	
Port A	E4
Port B	E5
Port C	E6
Control	E7
8255 No. 2	
Port A	E8
Port B	E9
Port C	EA
Control	EB
8251A	
Data	EC
Control	ED
iSBX Multimodule	
MCS0	F0–F7
MCS1	F8–FF

Serial Baud Rates

Frequency (kHz) (Jumper Selectable)	Baud Rate (Hz)		
	Synchronous	Asynchronous (Program Selectable)	
		÷16	÷64
307.2	—	19200	4800
153.6	—	9600	2400
76.8	—	4800	1200
38.4	38400	2400	600
19.2	19200	1200	300
9.6	9600	600	150
6.98	6980	—	110
4.8	4800	300	75

Connectors

Interface	Double-Sided Pins (Qty)	Centers (in.)	Mating Connectors
MULTIBUS System	86	0.156	Viking 2KH43/9AMK12 Wire-wrap
iSBX Bus	36	0.1	iSBX 960-5
Parallel I/O (2)	50	0.1	3M 3415-000 Flat
Serial I/O	26	0.1	AMP 87194-6 Flat

I/O Capacity

Parallel: 48 programmable lines

Serial: 1 transmit, 1 receive

MULTIMODULE: 1 iSBX Bus MULTIMODULE Board

Serial Communications Characteristics

Synchronous: 5–8 bit characters; internal or external character synchronization; automatic sync insertion

Asynchronous: 5–8 bit characters; break character generation; 1, 1½, or 2 stop bits; false start bit detectors

Interrupts

Single-level with on-board logic that automatically vectors the processor to location 38H using a restart instruction (RESTART 7). Interrupt requests may originate from user specified I/O (2); the programmable peripheral interface (2); the iSBX MULTIMODULE board (2); the programmable communications interface (3); the power fail interrupt (1); or the interval timer (1).

Interfaces

MULTIBUS: All signals TTL compatible

iSBX Bus: All signals TTL compatible

Parallel I/O: All signals TTL compatible

Serial I/O: RS232C or a 20 mil current loop TTY interface (jumper selectable)

Interrupt Requests: All TTL compatible (active-low)

Clocks

System Clock: 2.048 MHz ±0.1%

Interval Timer: 1.042 ms ±0.1% (959.5 Hz)

Physical Characteristics

Width: 12.00 in (30.48 cm)

Height: 6.75 in. (17.15 cm)

Depth: 0.05 in. (1.27 cm)

Weight: 14 oz. (397.3 gm)

Electrical Characteristics

DC Power Requirements

Voltage	Without EPROM(1)	With 2708 EPROM(2)	With 2758, 2716, or 2732 EPROM(3)	Power Down Requirements (RAM and Support Circuit)
V_{CC} = +5V ±5%	I_{CC} = 2.0A(4)	3.1A	3.46A	84 mA + 140 mA/K (2114A-5)
V_{DD} = +12V ±5%	I_{DD} = 150 mA	400 mA	150 mA	Not Required
V_{BB} = −5V ±5%	I_{BB} = 2 mA	200 mA	2 mA	Not Required
V_{AA} = −12V ±5%	I_{AA} = 175 mA	175 mA	175 mA	Not Required

NOTES:
1. Does not include power required for optional ROM/EPROM, I/O drivers, or I/O terminators.
2. With four Intel 2708 EPROMS and 220Ω/330Ω for terminators, installed for 48 input lines. All terminator inputs low.
3. Same as #2 except with four 2758s, 2716s, or 2732s installed.
4. I_{CC} shown without RAM supply current. For 2114-5 add 140 mA per K byte to a maximum of 560 mA.

Line Drivers and Terminators

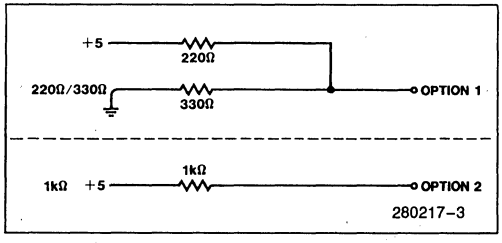
I/O Drivers: The following line drivers and terminators are all compatible with the I/O driver sockets on the iSBC 80/10B Board:

Driver	Characteristic	Sink Current (mA)
7438	I, OC	48
7437	I	48
7432	NI	16
7426	I, OC	16
7409	NI, OC	16
7408	NI	16
7403	I, OC	16
7400	I	16

NOTE:
I—inverting, NI—non-inverting, OC—open collector.

Port 1 has 25 nA totem pole drivers and 1 kΩ terminators.

I/O Terminators: 220Ω/330Ω divider or 1 kΩ pull up.



MULTIBUS® Drivers

Function	Characteristic	Sink Current (mA)
Data	Tri-State	25
Address	Tri-State	25
Commands	Tri-State	25

Environmental Characteristics

Operating Temperature: 0°C to 55°C

Equipment Supplied

iSBC 80/10B Single Board Computer
iSBC 80/10B Schematics

Reference Manual

9803119-01— iSBC 80/10B Single Board Computer Hardware Reference Manual (NOT SUPPLIED).

Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

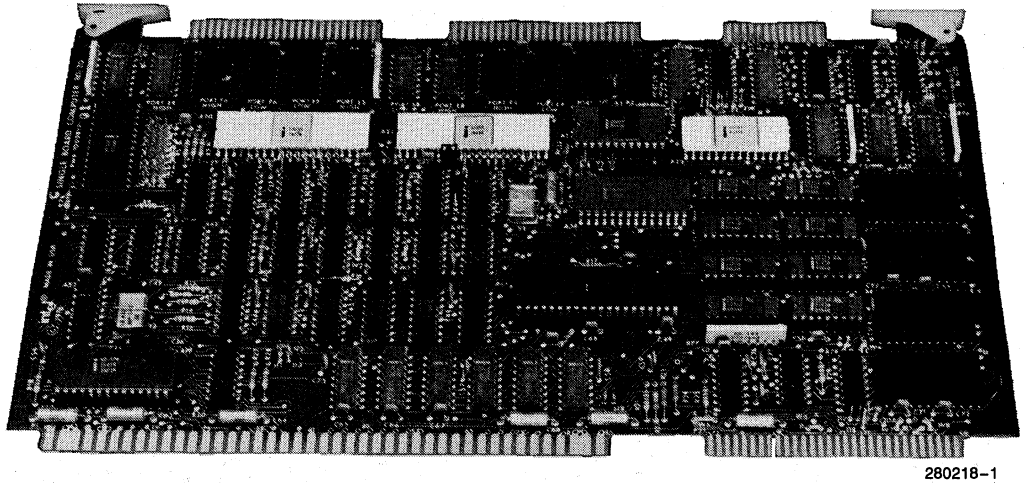
ORDERING INFORMATION

Part Number	Description
iSBC80/10B	Single Board Computer

iSBC® 80/20-4
SINGLE BOARD COMPUTER

- **8080A CPU Used as Central Processor**
- **4K Bytes of Static Read/Write Memory**
- **Sockets for up to 8K Bytes of Erasable Reprogrammable or Masked Read Only Memory**
- **48 Programmable Parallel I/O Lines with Sockets for Interchangeable Line Drivers and Terminators**
- **Programmable Synchronous/ Asynchronous RS232C Compatible Serial Interface with Fully Software Selectable Baud Rate Generation**
- **Full MULTIBUS® Control Logic Allowing up to 16 Masters to Share System Bus**
- **Two Programmable 16-bit BCD and Binary Timers**
- **Eight-Level Programmable Interrupt Control**
- **Compatible with Optional Memory and I/O Expansion Boards**
- **Auxiliary Power Bus, Memory Protect, and Power-Fail Interrupt Control Logic Provided for Battery Backup RAM Requirements**

The iSBC 80/20-4 Single Board Computer is a member of Intel's complete line of OEM computer systems which take full advantage of Intel's LSI technology to provide economical, self-contained computer-based solutions for OEM applications. Each iSBC 80/20-4 is a complete computer system on a single 6.75 × 12.00-inch printed circuit card. The CPU, system clock, read/write memory, nonvolatile read only memory, I/O ports and drivers, serial communications interface, priority interrupt logic, two programmable timers, MULTIBUS control logic, and bus expansion drivers all reside on each board.



280218-1

September 1987
Order Number: 280218-002

FUNCTIONAL DESCRIPTION

Intel's powerful 8-bit n-channel MOS 8080A CPU, fabricated on a single LSI chip, is the central processor for the iSBC 80/20-4. The 8080A contains six 8-bit general purpose registers and an accumulator. The six general purpose registers may be addressed individually or in pairs, providing both single and double precision operators. Minimum instruction execution time is 1.86 microseconds. A block diagram of iSBC 80/20-4 functional components is shown in Figure 1.

Memory Addressing

The 8080A has a 16-bit program counter which allows direct addressing of up to 65,536 bytes of memory. An external stack, located within any portion of read/write memory, may be used as a last-in/first-out storage area for the contents of the program counter, flags, accumulator, and all of the six general purpose registers. A 16-bit stack pointer controls the addressing of this external stack. This stack provides subroutine nesting bounded only by memory size.

Memory Capacity

The iSBC 80/20-4 contains 4K bytes of static read/write memory using Intel low power static RAMs. All on-board RAM read and write operations are performed at maximum processor speed. Power for on-board RAM memory is provided on an auxiliary power bus, and memory protect logic is included for battery backup RAM requirements. Sockets for up to 8K bytes of nonvolatile read only memory are provided on the board. Read only memory may be added in 1K byte increments using Intel 2708 erasable and electrically reprogrammable ROMs (EPROMs), or read only memory may be added in 2K byte increments using Intel 2716 EPROMs. All on-board ROM read operations are performed at maximum processor speed.

Parallel I/O Interface

The iSBC 80/20-4 contains 48 programmable parallel I/O lines implemented using two Intel 8255 programmable peripheral interfaces. The system software is used to configure the I/O lines in any combination of the unidirectional input/output, and bidirectional ports indicated in Table 1. Therefore, the I/O interface may be customized to meet specified peripheral requirements. In order to take full advantage of the large number of possible I/O configurations, sockets are provided for interchangeable I/O line drivers and terminators. Hence, the flexibility of the I/O interface is further enhanced by the capability of selecting the appropriate combination of optional line drivers and terminators to provide the required sink current, polarity, and drive/termination characteristics for each application. The 48 programmable I/O lines and signal ground lines are brought out to two 50-pin edge connectors that mate with flat, woven, or round cable.

Serial I/O Interface

A programmable communications interface using Intel's 8251 Universal Synchronous/Asynchronous Receiver/Transmitter (USART) is contained on the iSBC 80/20-4 board. A software selectable baud

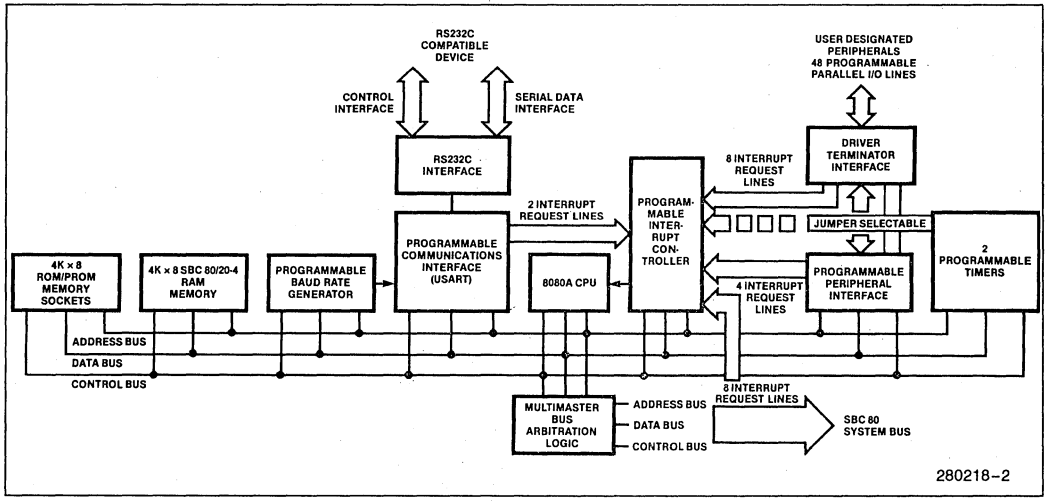


Figure 1. iSBC® 80/20 and iSBC® 80/20-4 Block Diagram Showing Functional Components

rate generator provides the USART with all common communications frequencies. The USART can be programmed by the system software to select the desired asynchronous or synchronous serial data transmission technique (including IBM Bi-Sync). The mode of operation (i.e., synchronous or asynchronous), data format, control character parity, and baud rate are all under program control. The 8251 provides full duplex, double-buffered transmit and recieve capability. Parity, overrun, and framing error detection are all incorporated in the USART. The RS232C compatible interface on each board, in conjunction with the USART, provides a direct interface to RS232C compatible terminals, cassettes, and asynchronous and synchronous modems. The RS232C command lines, serial data lines, and signal ground line are brought out to a 26-pin edge connector that mates with RS232C compatible flat or round cable.

Multimaster Capability

The iSBC 80/20-4 is a full computer on a single board with resources capable of supporting the majority of OEM system requirements. For those applications requiring additional processing capacity and the benefits of multiprocessing (i.e., several CPUs and/or controllers logically share system tasks with communication over the system bus), the iSBC 80/20-4 provides full MULTIBUS arbitration control logic. This control logic allows up to three iSBC 80/20-4 or high speed controllers to share the system bus in serial (daisy chain) priority fashion, and up to 16 masters may share the system bus with the addition of an external priority network. Once bus control is attained, a bus bandwidth of up to 5M bytes/sec may be achieved.

The bus controller provides its own clock which is derived independently from the processor clock. This allows different speed controllers to share resources on the same bus, and transfers via the bus proceed asynchronously. Thus, transfer speed is dependent on transmitting and receiving devices only. This design prevents slow master modules from being handicapped in their attempts to gain control of the bus, but does not restrict the speed at which faster modules can transfer data via the same bus. Once a bus request is granted, single or multiple read/write transfers can proceed at a maximum rate of 5 million data words per second. The most obvious applications for the master-slave capabilities of the bus are multiprocessor configurations, high speed direct-memory-access (DMA) operations and high speed peripheral control, but are by no means limited to these three.

Programmable Timers

The iSBC 80/20-4 board provides three fully programmable and independent BCD and binary 16-bit interval timers/event counters utilizing an Intel 8253 Programmable Interval Timer. Two of these timers/counters are available to the systems designer to generate accurate time intervals under software control. Routing of these counters is jumper selectable. Each may be independently routed to the programmable interrupt controller, the I/O line drivers

Table 1. Input/Output Port Modes of Operation

Port	Lines (qty)	Mode of Operation					
		Unidirectional				Bidirectional	Control
		Input		Output			
		Unlatched	Latched & Strobed	Latched	Latched & Strobed		
1	8	X	X	X	X	X	
2	8	X	X	X	X		
3	4	X		X			X(1)
	4	X		X			X(1)
4	8	X	X	X	X	X	
5	8	X	X	X	X		
6	4	X		X			X(2)
	4	X		X			X(2)

NOTES:
1. Part of port 3 must be used as a control port when either port 1 or port 2 are used as a latched and strobed input or a latched and strobed output port or port 1 is used as a bidirectional port.
2. Part of port 6 must be used as a control port when either port 4 or port 5 are used as a latched and strobed input or a latched and strobed output port or port 4 is used as a bidirectional port.

and terminators, or outputs from the 8255 programmable peripheral interfaces. The third interval timer in the 8253 provides the programmable baud rate generator for the iSBC 80/20-4 RS232C USART serial port. In utilizing the iSBC 80/20-4, the systems designer simply configures, via software, each timer independently to meet system requirements. Whenever a given time delay or count is needed, software commands to the programmable timers/event counters select the desired function. Seven functions are available, as shown in Table 2. The contents of each counter may be read at any time during system operation with simple read operations for event counting applications, and special commands are included so that the contents of each counter can be used "on the fly."

Table 2. Programmable Timer Functions

Function	Operation
Interrupt on terminal count	When terminal count is reached, an interrupt request is generated. This function is extremely useful for generation of real-time clocks.
Programmable one-shot	Output goes low upon receipt of an external trigger edge or software command and returns high when terminal count is reached. This function is retriggerable.
Rate generator	Divide by N counter. The output will go low for one input clock cycle, and the period from one low-going pulse to the next is N times the input clock period.
Square-wave rate generator	Output will remain high until one-half the count has been completed, and go low for the other half of the count.
Software triggered strobe	Output remains high until software loads count (N). N counts after count is loaded, output goes low for one input clock period.
Hardware triggered strobe	Output goes low for one clock period N counts after rising edge on counter trigger input. The counter is retriggerable.
Event counter	On a jumper selectable basis, the clock input becomes an input from the external system. CPU may read the number of events occurring after the counting "window" has been enabled or an interrupt may be generated after N events occur in the system.

Interrupt Capability

Operation and Priority Assignments—An Intel 8259 Programmable Interrupt Controller (PIC) provides vectoring for eight interrupt levels. As shown in Table 3, a selection of four priority processing modes is available to the systems designer so that the manner in which requests are processed may be configured to match system requirements. Operating mode and priority assignments may be reconfigured dynamically via software at any time during system operation. The PIC accepts interrupt requests from the programmable parallel and serial I/O interfaces, the programmable timers, the system bus, or directly from peripheral equipment. The PIC then determines which of the incoming requests is of the highest priority, determines whether this request is of higher priority than the level currently being serviced, and if appropriate, issues an interrupt to the CPU. Any combination of interrupt levels may be masked through storage via software, of a single byte to the interrupt register of the PIC.

Table 3. Programmable Interrupt Modes

Mode	Operation
Fully nested	Interrupt request line priorities fixed at 0 as highest, 7 as lowest.
Auto-rotating	Equal priority. Each level, after receiving service, becomes the lowest priority level until the next interrupt occurs.
Specific priority	System software assigns lowest priority level. Priority of all other levels based in sequence numerically on this assignment.
Polled	System software examines priority-encoded system interrupt status via interrupt status register.

Interrupt Addressing—The PIC generates a unique memory address for each interrupt level. These addresses are equally spaced at intervals of 4 or 8 (software selectable) bytes. This 32- or 64-byte block may be located to begin at any 32- or 64-byte boundary in the 65,536-byte memory space. A single 8080 jump instruction at each of these addressed then provides linkage to locate each interrupt service routine independently anywhere in memory.

Interrupt Request Generation—Interrupt requests may originate from 26 sources. Four jumper selectable interrupt requests can be automatically generated by the programmable peripheral interface when a byte of information is ready to be transferred to the CPU (i.e., input buffer is full) or a byte of information has been transferred to a peripheral device (i.e., output buffer is empty). Two jumper selectable interrupt

requests can be automatically generated by the USART when a character is ready to be transferred to the CPU (i.e., receive channel buffer is full), or a character is ready to be transmitted (i.e., transmit channel data buffer is empty). A jumper selectable request can be generated by each of the programmable timers. Nine additional interrupt request lines are available to the user for direct interface to user designated peripheral devices via the system bus, and eight interrupt request lines may be jumper routed directly from peripherals via the parallel I/O driver/terminator section.

Power-Fail Control—Control logic is also included for generation of a power-fail interrupt which works in conjunction with the AC-low signal from iSBC 635 Power Supply or equivalent.

Expansion Capabilities

Memory and I/O capacity may be expanded and additional functions added using Intel MULTIBUS compatible expansion boards. High speed integer and floating-point arithmetic capabilities may be added by using the iSBC 310A High Speed Mathematics Unit. Memory may be expanded to 65,536 bytes by adding user specified combinations of RAM boards, EPROM boards, or combination boards. Input/output capacity may be increased by adding digital I/O and analog I/O expansion boards. Mass storage capability may be achieved by adding single or double density diskette controllers as subsystems. Modular expandable backplanes and cardcages are available to support multiboard systems.

SPECIFICATIONS

Word Size

Instruction: 8, 16, or 24 bits
Data: 8 bits

Cycle Time

Basic Instruction Cycle: 1.86 μs

NOTE:
Basic instruction cycle is defined as the fastest instruction (i.e., four clock cycles).

Memory Addressing

On-Board ROM/EPROM—0-0FFF (2708) or 0-1FFF (2716)

On-Board RAM—4K bytes ending on a 16K boundary (e.g., $3FFF_H$, $7FFF_H$, $BFFF_H$, ... $FFFF_H$)

Memory Capacity

On-Board ROM/EPROM—8K bytes (sockets only)

On-Board RAM—4K bytes

Off-Board Expansion—Up to 65,536 bytes in user specified RAM, ROM, and EPROM

NOTE:
ROM/EPROM may be added in 1K or 2K-byte increments.

I/O Addressing

On-Board Programmable I/O (see Table 1)

Port	8255 No. 1			8255 No. 2			8255 No. 1 Control	8255 No. 2 Control	USART Data	USART Control
	1	2	3	4	5	6				
Address	E4	E5	E6	E8	E9	EA	E7	EB	EC	ED

I/O Capacity

Parallel—48 programmable lines (see Table 1)

NOTE:
Expansion to 504 input and 504 output lines can be accomplished using optional I/O boards.

Serial Communications Characteristics

Synchronous—5-8 bit characters; internal or external character synchronization; automatic sync insertion.

Asynchronous—5-8 bit characters; break character generation; 1, 1½, or 2 stop bits; false start bit detection.

Baud Rates

Frequency (kHz) (Software Selectable)	Baud Rate (Hz)		
	Synchronous	Asynchronous	
		+ 16	+ 64
153.6	—	9600	2400
76.8	—	4800	1200
38.4	38400	2400	600
19.2	19200	1200	300
9.6	9600	600	150
4.8	4800	300	75
2.4	2400	150	—
1.76	1760	110	—

NOTE:
Frequency selected by I/O write of appropriate 16-bit frequency factor to baud rate register.

Register Address (hex notation, I/O address space)

DE Baud rate register

NOTE:
Baud rate factor (16 bits) is loaded as two sequential output operations to same address (DE_H).

Interrupts

Register Addresses (hex notation, I/O address space)

DA Interrupt request register
DA In-service register
DB Mask register
DA Command register
DB Block address register
DA Status (polling register)

NOTE:
Several registers have the same physical address; sequence of access and one data bit of control word determine which register will respond.

Timers

Register Addresses (hex notation, I/O address space)

DF Control register
DC Timer 1
DD Timer 2

NOTE:
Timer counts loaded as two sequential output operations to same address, as given.

Input Frequencies

Reference	Event Rate
1.0752 MHz ±10% (0.930 μs period, nominal)	1.1 MHz max

NOTE:
Maximum rate for external events in event counter function.

Interfaces

Bus: All signals TTL compatible
Parallel I/O: All signals TTL compatible
Interrupt Requests: All TTL compatible
Timer: All signals compatible
Serial I/O: RS232C compatible, data set configuration

System Clock (8080A CPU)

2.1504 MHz ±0.1%

Auxiliary Power

An auxiliary power bus is provided to allow separate power to RAM for systems requiring battery backup of read/write memory. Selections of this auxiliary RAM power bus is made via jumpers on the board.

Memory Protect

An active-low TTL compatible memory protect signal is brought out on the auxiliary connector which, when asserted, disables read/write access to RAM memory on the board. This input is provided for the protection of RAM contents during system power-down sequences.

Connectors

Interface	Double-Sided Pins (qty)	Centers (in.)	Mating Connectors*
MULTIBUS System Bus	86	0.156	ELFAB BS1562043PBB Viking 2KH43/9AMK12 Soldered PCB Mount EDAC 337086540201 ELFAB BW1562D43PBB EDAC 337086540202 ELFAB BW1562A43PBB Wire Wrap
Auxiliary Bus	60	0.100	EDAC 345060524802 ELFAB BS1020A30PBB EDAC 345060540201 ELFAB BW1020D30PBB Wire Wrap
Parallel I/O (2)	50	0.100	3M 3415-001 Flat Crimp GTE Sylvania 6AD01251A1DD Soldered
Serial I/O	26	0.100	AMP 15837151 EDAC 345026520202 PCB Soldered 3M 3462-0001 AMP 88373-5 Flat Crimp

NOTE:
*Connectors compatible with those listed may also be used.

Line Drivers and Terminators

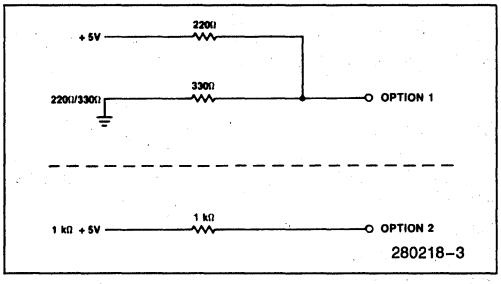
I/O Drivers—The following line drivers are all compatible with the I/O driver sockets on the ISBC 80/20-4.

Driver	Characteristic	Sink Current (mA)
7438	I, OC	48
7437	I	48
7432	NI	16
7426	I, OC	16
7409	NI, OC	16
7408	NI	16
7403	I, OC	16
7400	I	16

NOTE:
I = inverting; NI = non-inverting; OC = open collector.

Ports 1 and 4 have 20 mA totem-pole bidirectional drivers and 1 kΩ terminators.

I/O Terminators—220Ω/330Ω divider or 1 kΩ pull-up



280218-3

Bus Drivers

Driver	Characteristic	Sink Current (mA)
Data	Tri-State	50
Address	Tri-State	50
Commands	Tri-State	32

Output Frequencies/Timing Intervals

Function	Single Timer/Counter		Dual Timer/Counter (Two Timers Cascaded)	
	Min	Max	Min	Max
Real-Time Interrupt	1.86 μs	60.948 ms	3.72 μs	1.109 hr
Programmable One-Shot	1.86 μs	60.948 ms	3.72 μs	1.109 hr
Rate Generator	16.407 Hz	537.61 kHz	0.00025 Hz	268.81 kHz
Square-Wave Rate Generator	16.407 Hz	537.61 kHz	0.00025 Hz	268.31 kHz
Software Triggered Strobe	1.86 μs	60.948 ms	3.72 μs	1.109 hr
Hardware Triggered Strobe	1.86 μs	60.948 ms	3.72 μs	1.109 hr

Physical Characteristics

Width: 12.00 in. (30.48 cm)

Height: 6.75 in. (17.15 cm)

Depth: 0.50 in. (1.26 cm)

Weight: 14 oz. (397.6 gm)

Environmental Characteristics

Operating Temperature: 0°C to 55°C

Reference Manual

9800317D—iSBC 80/20-5 Hardware Reference Manual (NOT SUPPLIED)

Reference manuals are shipped with each product only if designated SUPPLIED (see above). Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

ORDERING INFORMATION

Part Number	Description
SBC 80/20-4	Single Board Computer with 4K bytes RAM

Electrical Characteristics

DC POWER REQUIREMENTS

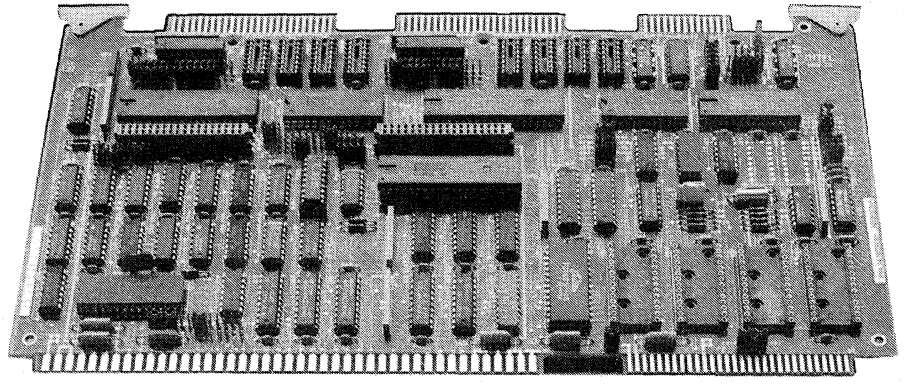
Voltage (±5%)	Without PROM(1) (max)	With 4K PROM(2) (max)	With iSBC 530(3) (max)	RAM Only(4) (max)	With 8K PROM(5) (max)
V_{CC} = +5V	I_{CC} = 4.0A	4.9A	4.9A	1.1A	5.2A
V_{DD} = +12V	I_{DD} = 90 mA	350 mA	450 mA	—	90 mA
V_{BB} = −5V	I_{BB} = 2 mA	180 mA	180 mA	—	2 mA
V_{AA} = −12V	I_{AA} = 20 mA	20 mA	120 mA	—	20 mA

NOTES:
1. Does not include power required for optional PROM, I/O drivers, and I/O terminators.
2. With four 2708 EPROMs and 220Ω/330Ω input terminators installed for 32 I/O lines, all terminator inputs low.
3. With four 2708 EPROMs, 220Ω/330Ω input terminators installed for 32 I/O lines, all terminator inputs low, and iSBC 530 Teletypewriter Adapter drawing power from serial port connector.
4. RAM chips powered via auxiliary power bus.
5. With four 8716 EPROMs and eight 220Ω/330Ω input terminators installed, all terminator inputs low.

iSBC® 80/24A
SINGLE BOARD COMPUTER

- **Upward Compatible with iSBC 80/20-4 Single Board Computer**
- **8085A-2 CPU Operating at 4.8 or 2.4 MHz**
- **Two iSBX™ Bus Connectors for iSBX MULTIMODULE™ Board Expansion**
- **8K Bytes of Static Read/Write Memory**
- **Sockets for Up to 32K Bytes of Read Only Memory**
- **48 Programmable Parallel I/O Lines with Sockets for Interchangeable Line Drivers and Terminators**
- **Programmable Synchronous/ Asynchronous RS232C Compatible Serial Interface with Software Selectable Baud Rates**
- **Full MULTIBUS® Control Logic for Multimaster Configurations and System Expansion**
- **Two Programmable 16-Bit BCD or Binary Timers/Event Counters**
- **12 Levels of Programmable Interrupt Control**
- **Auxiliary Power Bus, Memory Protect, and Power-Fail Interrupt Control Logic Provided for Battery Backup RAM Requirements**

The Intel 80/24A Single Board Computer is a member of Intel's complete line of OEM microcomputer systems which take full advantage of Intel's LSI technology to provide economical, self-contained computer-based solutions for OEM applications. The iSBC 80/24A board is a complete computer system on a single 6.7 × 12.00-inch printed circuit card. The CPU, system clock, iSBX bus interface, read/write memory, read only memory sockets, I/O ports and drivers, serial communications interface, priority interrupt logic, and programmable timers all reside on the board. Full MULTIBUS interface logic is included to offer compatibility with the Intel OEM Microcomputer Systems family of Single Board Computers, expansion memory options, digital and analog I/O expansion boards, and peripheral and communications controllers.



142927-1

September 1987
Order Number: 142927-004

FUNCTIONAL DESCRIPTION

Central Processing Unit

Intel's powerful 8-bit N-channel 8085A-2 CPU fabricated on a single LSI chip, is the central processor for the iSBC 80/24A board operating at either 4.8 or 2.4 MHz (jumper selectable). The 8085A-2 CPU is directly software compatible with the Intel 8080A CPU. The 8085A-2 contains six 8-bit general purpose registers and an accumulator. The six general purpose registers may be addressed individually or in pairs, providing single and double precision operators. Minimum instruction execution time is 826 nanoseconds. A block diagram of the iSBC 80/24A functional components is shown in Figure 1.

MULTIMODULE™ Board Expansion

The iSBX bus interface brings designers incremental on-board expansion at minimal cost. Two iSBX bus MULTIMODULE connectors are provided for plug-in expansion of any iSBX MULTIMODULE board. The iSBX MULTIMODULE concept provides the ability to adapt quickly to new technology, the economy of buying only what is needed, and the ready availability of a spectrum of functions for greater application potential. iSBX boards are available to provide expansion equivalent to the I/O available on the iSBC 80/24A board or the user may configure entirely new functionality, such as math, directly on board.

The iSBX 350 Parallel I/O MULTIMODULE board provides 24 I/O lines using an 8255A Programmable Peripheral Interface. Therefore two iSBX 350 modules together with the iSBC 80/24A board may offer 96 lines of programmable I/O. Alternately, a serial port may be added using the iSBX 351 Serial I/O MULTIMODULE board and math may be configured on-board with the iSBX 331 Fixed/Floating Point Math MULTIMODULE board. Future iSBX products are also planned. The iSBX MULTIMODULE board is a logical extension of the on-board programmable I/O and is accessed by the iSBC 80/24A single board computer as common I/O port locations. The iSBX board is coupled directly to the 8085A-2 CPU and therefore becomes an integral element of the iSBC 80/24A single board computer providing optimum performance. All MULTIMODULE boards offer incremental expansion, optimum performance, and minimal cost.

Memory Addressing

The 8085A-2 has a 16-bit program counter which allows direct addressing of up to 64K bytes of memory. An external stack, located within any portion of read/write memory, may be used as a last-in/first-out storage area for the contents of the program counter, flags, accumulator, and all of the six general purpose registers. A 16-bit stack pointer controls the addressing of this external stack. This stack provides subroutine nesting bounded only by memory size.

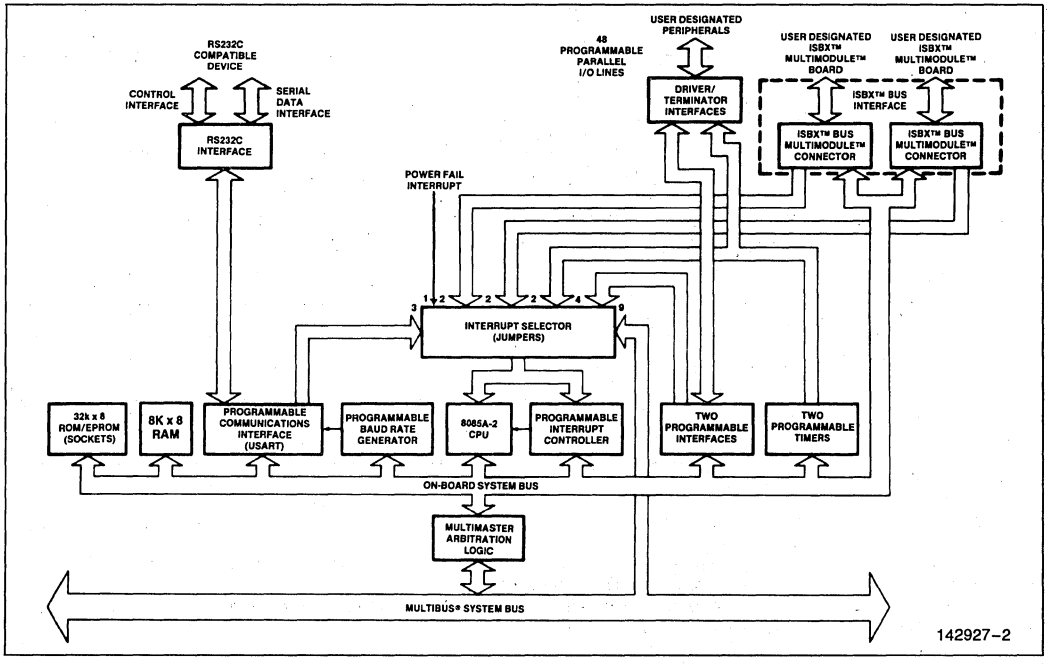


Figure 1. iSBC® 80/24A Single Board Computer Block Diagram

Memory Capacity

The iSBC 80/24A board contains 8K bytes of static read/write memory using an 8K × 8 SRAMs. All RAM read and write operations are performed at maximum processor speed. Power for the on-board RAM may be provided on an auxiliary power bus, and memory protect logic is included for RAM battery backup requirements.

Four sockets are provided for up to 32K bytes of nonvolatile read only memory on the iSBC 80/24A board. EPROM may be added as shown with whiteout and 2732A.

Parallel I/O Interface

The iSBC 80/24A board contains 48 programmable parallel I/O lines implemented using two Intel 8255A Programmable Peripheral Interfaces. The system software is used to configure the I/O lines in any combination of unidirectional input/output and bidirectional ports as indicated in Table 1. Therefore, the I/O interface may be customized to meet specific peripheral requirements. In order to take full advantage of the large number of possible I/O configurations, sockets are provided for interchangeable I/O line drivers and terminators. Hence, the flexibility of the I/O interface is further enhanced by the capability of selecting the appropriate combination of optional line drivers and terminators to provide the required sink current, polarity, and drive/termination characteristics for each application. The 48 programmable I/O lines and signal ground lines are brought out to two 50-pin edge connectors that mate with flat, woven, or round cables.

Serial I/O Interface

A programmable communications interface using the Intel 8251A Universal Synchronous/Asynchronous Receiver/Transmitter (USART) is contained on the iSBC 80/24A board. A software selectable baud rate generator provides the USART with all common communication frequencies. The USART can be programmed by the system software to select the desired asynchronous or synchronous serial data transmission technique (including IBM Bi-Sync). The mode of operation (i.e. synchronous or asynchronous), data format, control character format, parity, and baud rate are all under program control. The 8251A provides full duplex, double buffered transmit and receive capability. Parity, overrun, and framing error detection are all incorporated in the USART. The RS232C compatible interface, in conjunction with the USART, provides a direct interface to RS232C compatible terminals, cassettes, and asynchronous and synchronous modems. The RS232C command lines serial data lines, and signal ground line are brought out to a 26-pin edge connector that mates with RS232C compatible flat or round cable.

Multimaster Capability

The iSBC 80/24A board is a full computer on a single board with resources capable of supporting a large variety of OEM system requirements. For

Table 1. Input/Output Port Modes of Operation

Port	Lines (qty)	Mode of Operation					Control
		Unidirectional				Bidirectional	
		Input		Output			
		Unlatched	Latched & Strobed	Latched	Latched & Strobed		
1	8	X	X	X	X	X	
2	8	X	X	X	X		
3	4	X		X			X[1]
	4	X		X			X[1]
4	8	X	X	X	X	X	
5	8	X	X	X	X		
6	4	X		X			X[2]
	4	X		X			X[2]

NOTES:
1. Part of port 3 must be used as a control port when either port 1 or port 2 are used as a latched and strobed input or a latched and strobed output port or port 1 is used as a bidirectional port.
2. Part of port 6 must be used as a control port when either port 4 or port 5 are used as a latched and strobed input or a latched and strobed output port or port 4 is used as a bidirectional port.

those applications requiring additional processing capacity and the benefits of multiprocessing (i.e. several CPUs and/or controllers logically sharing system tasks through communication over the system bus), the iSBC 80/24A board provides full MULTIBUS arbitration control logic. This control logic allows up to three iSBC 80/24A boards or other bus masters to share the system bus in serial (daisy chain) priority fashion, and up to 16 masters to share the MULTIBUS system bus with the addition of an external priority network. The MULTIBUS arbitration logic operates synchronously with a MULTIBUS clock (provided by the iSBC 80/24A board or optionally connected directly to the MULTIBUS clock) while data is transferred via a handshake between the master and slave modules. This allows different speed controllers to share resources on the same bus since transfers via the bus proceed asynchronously. Thus, transfer speed is dependent on transmitting and receiving devices only. This design provides slow master modules from being handicapped in their attempts to gain control of the bus, but does not restrict the speed at which faster modules can transfer data via the same bus. The most obvious applications for the master-slave capabilities of the bus are multiprocessor configurations, high speed direct memory access (DMA) operations, and high speed peripheral control, but are by no means limited to these three.

Programmable Timers

The iSBC 80/24A board provides three independent, fully programmable 16-bit interval timers/event counters utilizing the Intel 8254 Programmable Interval Timer. Each counter is capable of operating in either BCD or binary modes. Two of these timers/counters are available to the systems designer to generate accurate time intervals under software control. Routing for the outputs and gate/trigger inputs of two of these counters is jumper selectable. The outputs may be independently routed to the 8259A Programmable Interrupt Controller, to the I/O line drivers associated with the 8255A Programmable Peripheral Interface, or may be routed as inputs to the 8255A chip. The gate/trigger inputs may be routed to I/O terminators associated with the 8255A or as output connections from the 8255A. The third interval timer in the 8254 provides the programmable baud rate generator for the RS232C USART serial port. In utilizing the iSBC 80/24A board, the systems designer simply configures, via software, each timer independently to meet system requirements. Whenever a given time delay or count is needed, software commands to the programmable timers/event counters select the desired function. Seven functions are available, as shown in Table 2. The contents of each counter may be read at any time during system operation with simple read operations for event counting applications, and special commands are included so that the contents of each counter can be read "on the fly".

Table 2. Programmable Timer Functions

Function	Operation
Interrupt on terminal count	When terminal count is reached, an interrupt request is generated. This function is extremely useful for generation of real-time clocks.
Programmable one-shot	Output goes low upon receipt of an external trigger edge or software command and returns high when terminal count is reached. This function is retriggerable.
Rate generator	Divide by N counter. The output will go low for one input clock cycle, and the period from one low-going pulse to the next is N times the input clock period.
Square-wave rate generator	Output will remain high until one-half the count has been completed, and go low for the other half of the count.
Software triggered strobe	Output remains high until software loads count (N). N counts after count is loaded, output goes low for one input clock period.
Hardware triggered strobe	Output goes low for one clock period N counts after rising edge on counter trigger input. The counter is retriggerable.
Event counter	On a jumper selectable basis, the clock input becomes an input from the external system. CPU may read the number of events occuring after the counting "window' has been enabled or an interrupt may be generated after N events occur in the system.

Interrupt Capability

The iSBC 80/24A board provides vectoring for 12 interrupt levels. Four of these levels are handled directly by the interrupt processing capability of the 8085A-2 CPU and represent the four highest priority interrupts of the iSBC 80/24A board. Requests are routed to the 8085A-2 interrupt inputs—TRAP, RST 7.5, RST 6.5, and RST 5.5 (in decreasing order of priority), each of which generates a call instruction to

a unique address (TRAP: 24H; RST 7.5: 3CH; RST 6.5: 34H; and RST 5.5: 2CH). An 8085A-2 JMP instruction at each of these addresses then provides linkage to interrupt service routines located independently anywhere in memory. All interrupt inputs with the exception of the trap interrupt may be masked via software. The trap interrupt should be used for conditions such as power-down sequences which require immediate attention by the 8085A-2 CPU. The Intel 8259A Programmable Interrupt Controller (PIC) provides vectoring for the next eight interrupt levels. As shown in Table 3, a selection of four priority processing modes is available to the systems designer for use in designing request processing configurations to match system requirements. Operating mode and priority assignments may be reconfigured dynamically via software at any time during system operation. The PIC accepts interrupt requests from the programmable parallel and serial I/O interfaces, the programmable timers, the system bus, iSBX bus, or directly from peripheral equipment. The PIC then determines which of the incoming requests is of the highest priority, determines whether this request is of higher priority than the level currently being serviced, and, if appropriate, issues an interrupt to the CPU. Any combination of interrupt levels may be masked, via software, by storing a single byte in the interrupt mask register of the PIC. The PIC generates a unique memory address for each interrupt level. These addresses are equally spaced at intervals of 4 or 8 (software selectable) bytes. This 32 or 64-byte block may be located to begin at any 32 or 64-byte boundary in the 65,536-byte memory space. A single 8085A-2 JMP instruction at each of these addresses then provides linkage to locate each interrupt service routine independently anywhere in memory.

Table 3. Programmable Interrupt Modes

Mode	Operation
Fully nested	Interrupt request line priorities fixed at 0 as highest, 7 as lowest.
Autorotating	Equal priority. Each level, after receiving service, becomes the lowest priority level until next interrupt occurs.
Specific priority	System software assigns lowest priority level. Priority of all other levels based in sequence numerically on this assignment.
Polled	System software examines priority-encoded system interrupt status via interrupt status register.

Interrupt Request Generation

Interrupt requests may originiate from 23 sources. Two jumper selectable interrupt requests can be generated by each iSBX MULTIMODULE board. Two jumper selectable interrupt requests can be automatically generated by each programmable peripheral interface when a byte of information is ready to be transferred to the CPU (i.e., input buffer is full) or a byte of information has been transferred to a peripheral device (i.e., output buffer is empty). Three jumper selectable interrupt requests can be automatically generated by the USART when a character is ready to be transferred to the CPU (i.e., receiver channel buffer is full), a character is ready to be transmitted (i.e., the USART is ready to accept a character from the CPU), or when the transmitter is empty (i.e., the USART has no character to transmit). A jumper selectable request can be generated by each of the programmable timers. Nine interrupt request lines are available to the user for direct interface to user designated peripheral devices via the MULTIBUS system bus. A power-fail signal can also be selected as an interrupt source.

Power-Fail Control

A power-fail interrupt may be detected through the AC-low signal generated by the power supply. This signal may be configured to interrupt the 8085A-2 CPU to initiate an orderly power down instruction sequence.

MULTIBUS® System Expansion Capabilities

Memory and I/O capacity may be expanded and additional functions added using Intel MULTIBUS system compatible expansion boards. Memory may be expanded to 65,536 bytes by adding user specified combinations of RAM boards, EPROM boards, or combination boards. Input/output capacity may be increased by adding digital I/O and analog I/O expansion boards. Mass storage capability may be achieved by adding single or double density diskette or hard disk controllers as subsystems. Expanded communication needs can be handled by communication controllers. Modular expandable backplanes and card cages are available to support multiboard systems.

SPECIFICATIONS

Word Size

Instruction— 8, 16 or 24 bits
Data — 8 bits

Cycle Time

BASIC INSTRUCTION CYCLE

826 ns (4.84 MHz operating frequency)
1.65 μs (2.42 MHz operating frequency)

NOTE:
Basic instruction cycle is defined as the fastest instruction (i.e., four clock cycles).

Memory Addressing

ON-BOARD EPROM

0-0FFF using 2708, 2758 (1 wait state)
0-1FFF using 2716 (1 wait state)
0-3FFF using 2732 (1 wait state)
using 2732A (no wait states)
0-7FFF using 2764A (no wait states)

ON-BOARD RAM

E000-FFFF

NOTE:
Default configuration—may be reconfigured to top end of any 16K boundary.

Memory Capacity

ON-BOARD EPROM

32K bytes (sockets only)

May be added in 1K (using 2708 or 2758), 2K (using 2716), 4K (using Intel 2732A), or 8K (using Intel 2764A) byte increments.

ON-BOARD RAM

8K bytes

OFF-BOARD EXPANSION

Up to 64K bytes using user specified combinations of RAM, ROM, and EPROM.

Up to 128K bytes using bank select control via I/O port and 2 jumper options.

May be disabled using PROM ENABLE via I/O port and jumper option, resulting in off-board RAM overlay capability.

I/O Addressing

ON-BOARD PROGRAMMABLE I/O

Device	I/O Address
8255A No. 1	
Port A	E4
Port B	E5
Port C	E6
Control	E7
8255A No. 2	
Port A	E8
Port B	E9
Port C	EA
Control	EB
8251A	
Data	EC, EE
Control	ED, EF
iSBX MULTIMODULE J5	
MCS0	C0–C7
MCS1	C8–CF
iSBX MULTIMODULE J6	
MCS0	F0–F7
MCS1	F8–FF

I/O Capacity

Parallel — 48 programmable lines
Serial — 1 transmit, 1 receive, 1 SID, 1 SOD
iSBX MULTIMODULE— 2 iSBX MULTIMODULE Boards

Serial Communications Characteristics

Synchronous — 5–8 bit characters; internal or external character synchronization; automatic sync insertion

Asynchronous— 5–8 bit characters; break character generation; 1, 1½, or 2 stop bits; false start bit detectors

Baud Rates

Output Frequency in kHz	Baud Rate (Hz)		
	Synchronous	Asynchronous	
		÷16	÷64
153.6	—	9600	2400
76.8	—	4800	1200
38.4	38400	2400	600
19.2	19200	1200	300
9.6	9600	600	150
4.8	4800	300	75
2.4	2400	150	—
1.76	1760	110	—

NOTE:
Frequency selected by I/O write of appropriate 16-bit frequency factor to baud rate register.

Register Address (hex notation, I/O address space)

DE Baud rate register

NOTE:
Baud rate factor (16 bits) is loaded as two sequential output operations to same address (DE_H).

Interrupts

Addresses for 8259A Registers (hex notation, I/O address space)

DA or D8 Interrupt request register
DA or D8 In-service register
DB or D9 Mask register
DA or D8 Command register
DB or D9 Block address register
DA or D8 Status (polling register)

NOTE:
Several registers have the same physical address; sequence of access and one data bit of control word determine which register will respond.

Interrupt levels routed to 8085A-2 CPU automatically vector the processor to unique memory locations:

Interrupt Input	Memory Address	Priority	Type
TRAP	24	Highest	Non-maskable
RST 7.5	3C		Maskable
RST 6.5	34	↓	Maskable
RST 5.5	2c	Lowest	Maskable

Timers

Register Addresses (hex notation, I/O address space)

DF Control register
DC Timer 0
DD Timer 1
DE Timer 2

NOTE:
Timer counts loaded as two sequential output operations to same address as given.

Output Frequencies/Timing Intervals

Function	Single Timer/Counter		Dual Timer/Counter (Two Timers Cascaded)	
	Min	Max	Min	Max
Real-Time Interrupt	1.86 μs	60.948 ms	3.72 μs	1.109 hrs
Programmable One-Shot	1.86 μs	60.948 ms	3.72 μs	1.109 hrs
Rate Generator	16.407 Hz	537.61 kHz	0.00025 Hz	268.81 kHz
Square-Wave Rate Generator	16.407 Hz	537.61 kHz	0.00025 Hz	268.81 kHz
Software Triggered Strobe	1.86 μs	60.948 ms	3.72 μs	1.109 hrs
Hardware Triggered Strobe	1.86 μs	60.948 ms	3.72 μs	1.109 hrs

NOTE:
Input frequency to timers is 1.0752 MHz (default configuration).

Input Frequencies

Reference: 1.0752 MHz ±0.1% (0.930 μs period, nominal)

Event Rate: 1.1 MHz max

Interfaces

MULTIBUS — All signals TTL compatible
iSBX Bus — All signals TTL compatible
Parallel I/O — All signals TTL compatible
Serial I/O — RS232C compatible, configurable as a data set or data terminal
Timer — All signals TTL compatible
Interrupt Requests— All TTL compatible

System Clock (8085A-2 CPU)

4.84 or 2.42 MHz ±0.1% (jumper selectable)

Auxiliary Power

An auxiliary power bus is provided to allow separate power to RAM for systems requiring battery backup of read/write memory. Selection of this auxiliary RAM power bus is made via jumpers on the board.

Memory Protect

An active-low TTL compatible memory protect signal is brought out on the auxiliary connector which, when asserted, disables read/write access to RAM memory on the board. This input is provided for the protection of RAM contents during system power-down sequences.

Line Drivers and Terminators

I/O Driver— The following line drivers and terminators are all compatible with the I/O driver sockets on the iSBC 80/24A Board:

Driver	Characteristic	Sink Current (mA)
7438	I, OC	48
7437	I	48
7432	NI	16
7426	I, OC	16
7409	NI, OC	16
7408	NI	16
7403	I, OC	16
7400	I	16

NOTE:
I = inverting; NI = non-inverting; OC = open collector.

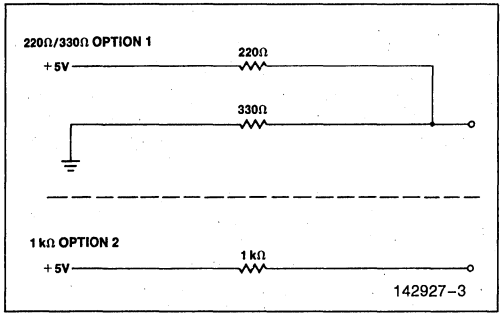
Ports E4 and E8 have 32 mA totem-pole drivers and 1K terminators.

I/O Terminators— 220Ω/330Ω divider of 1 kΩ pull-up.

Connectors

Interface	Double-Sided Pins (qty)	Centers (In.)	Mating Connectors*
MULTIBUS System Bus	86	0.156	ELFAB BS1562043PBB Viking 2KH43/9AMK12 Soldered PCB Mount EDAC 337086540201 ELFAB BW1562D43PBB EDAC 337086540202 ELFAB BW1562A43PBB Wire Wrap
Auxiliary Bus	60	0.100	EDAC 345060524802 ELFAB BS1020A30PBB EDAC 345060540201 ELFAB BW1020D30PBB Wire Wrap
iSBX Bus (2)	36	0.100	iSBX 960-5
Parallel I/O (2)	50	0.100	3M 3415-001 Flat Crimp GTE Sylvania 6AD01251A1DD Soldered
Serial I/O	26	0.100	AMP 15837151 EDAC 345026520202 PCB Soldered 3M 3462-0001 AMP 88373-5 Flat Crimp

***NOTE:**
Connectors compatible with those listed may also be used.



Bus Drivers

Function	Characteristic	Sink Current (mA)
Data	Tri-State	32
Address	Tri-State	32
Commands	Tri-State	32

Physical Characteristics

Width: 12.00 in. (30.48 cm)
Height: 6.75 in. (17.15 cm)
Depth: 0.50 in. (1.27 cm)
Weight: 12.64 oz. (354 gm)

Electrical Characteristics

DC POWER REQUIREMENTS

Configuration	Current Requirements			
	$V_{CC} = +5V$ ±5% (max)	$V_{DD} = +12V$ ±5% (max)	$V_{BB} = -5V$ ±5% (max)	$V_{AA} = -12V$ ±5% (max)
Without EPROM(1)	2.66A	40 mA	—	20 mA
RAM Only(2)	0.01A	—	—	—
With iSBC 530(3)	2.66A	140 mA	—	120 mA
With 4K EPROM(4) (using 2708)	3.28A	300 mA	180 mA	20 mA
With 4K EPROM(4) (using 2758)	3.44A	40 mA	—	20 mA
With 8K EPROM(4) (using 2716)	3.44A	40 mA	—	20 mA
With 16K EPROM(4) (using 2732A)	3.46A	40 mA	—	20 mA
With 32K EPROM(4) (using 2764A)	3.42A	40 mA	—	20 mA

NOTES:
1. Does not include power for optional EPROM, I/O drivers, and I/O terminators.
2. RAM chips powered via auxiliary power bus.
3. Does not include power for optional EPROM, I/O drivers, I/O terminators. Power for iSBC 530 Adapter is supplied via serial port connector.
4. Includes power required for four EPROM chips, and I/O terminators installed for 16 I/O lines; all terminators inputs low.

Environmental Characteristics

Operating Temperature: 0°C to 55°C

Reference Manual

148437-001— iSBC 80/24A Single Board Computer Hardware Reference Manual (NOT SUPPLIED)

Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

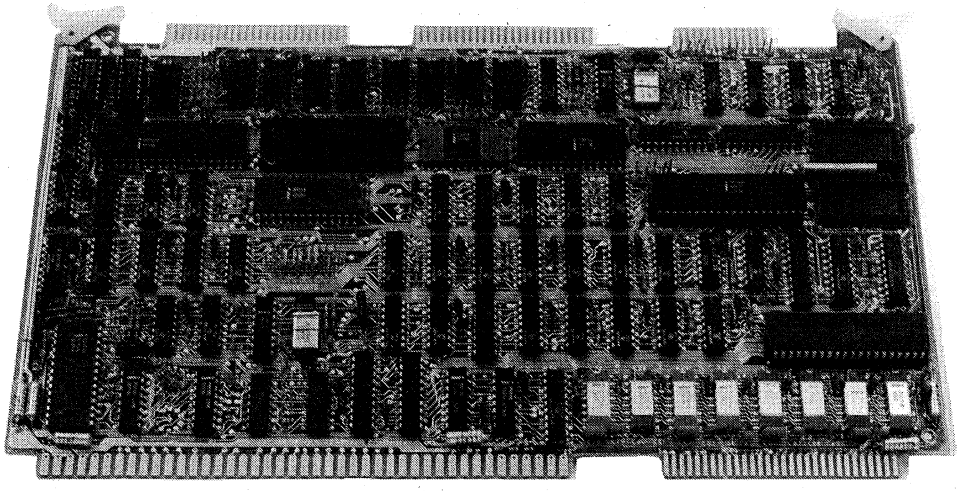
ORDERING INFORMATION

Part Number	Description
SBC 80/24A	Single Board Computer

iSBC® 80/30
SINGLE BOARD COMPUTER

- 8085A CPU Used as Central Processing Unit
- 16K Bytes of Dual Port Dynamic Read/Write Memory with On-Board Refresh
- Sockets for up to 8K Bytes of Read Only Memory
- Sockets for 8041A/8741A Universal Peripheral Interface and Interchangeable Line Drivers and Line Terminators
- 24 Programmable Parallel I/O Lines with Sockets for Interchangeable Line Drivers and Terminators
- Full MULTIBUS® Control Logic Allowing up to 16 Masters to Share the System
- Programmable Synchronous/Asynchronous RS232C Compatible Serial Interface with Fully Software Selectable Baud Rate Generation
- 12 Levels of Programmable Interrupt Control
- Two Programmable 16-Bit BCD or Binary Counters
- Auxiliary Power Bus, Memory Protect, and Power-Fail Interrupt Control Logic for RAM Battery Backup
- Compatible with Optional iSBC® 80 CPU, Memory, and I/O Expansion Boards

The iSBC 80/30 Single Board Computer is a member of Intel's complete line of OEM computer systems which take full advantage of Intel's LSI technology to provide economical self-contained computer-based solutions for OEM applications. The iSBC 80/30 is a complete computer system on a single 6.75 x 12.00-inch printed circuit card. The CPU, system clock, read/write memory, nonvolatile read only memory, universal peripheral interface capability, I/O ports and drivers, serial communications interface, priority interrupt logic, programmable timers, MULTIBUS control logic, and bus expansion drivers all reside on the board.



280219-1

September 1987
Order Number: 280219-002

FUNCTIONAL DESCRIPTION

Central Processing Unit

Intel's powerful 8-bit n-channel 8085A CPU, fabricated on a single LSI chip, is the central processor for the iSBC 80/30. The 8085A CPU is directly software compatible with the Intel 8080A CPU. The 8085A contains six 8-bit general purpose registers and an accumulator. The six general purpose registers may be addressed individually or in pairs, providing both single and double precision operators. The minimum instruction execution time is 1.45 microseconds. The 8085A CPU has a 16-bit program counter. An external stack, located within any portion of iSBC 80/30 read/write memory, may be used as a last-in/first-out storage area for the contents of the program counter, flags, accumulator, and all of the six general purpose registers. A 16-bit stack pointer controls the addressing of this eternal stack. This stack provides subroutine nesting bounded only by memory size.

Bus Structure

The iSBC 80/30 has an internal bus for all on-board memory and I/O operations and a system bus (i.e., the MULTIBUS) for all external memory and I/O operations. Hence, local (on-board) operations do not tie up the system bus, and allow true parallel processing when several bus masters (i.e., DMA devices, other single board computers) are used in a multimaster scheme. A block diagram of the iSBC 80/30 functional components is shown in Figure 1.

RAM Capacity

The iSBC 80/30 contains 16K bytes of dynamic read/write memory using Intel 2117 RAMs. All RAM read and write operations are performed at maximum processor speed. Power for the on-board RAM may be provided on an auxiliary power bus, and memory protect logic is included for RAM battery backup requirements. The iSBC 80/30 contains a dual port controller, which provides dual port capability for the on-board RAM memory. RAM accesses may occur from either the iSBC 80/30 or from any other bus master interfaced via the MULTIBUS. Since on-board RAM accesses do not require the MULTIBUS, the bus is available for any other concurrent operations (e.g., DMA data transfers) requiring the use of the MULTIBUS. Dynamic RAM refresh is accomplished automatically by the iSBC 80/30 for accesses originating from either the CPU or via the MULTIBUS. Memory space assignment can be selected independently for on-board and MULTIBUS RAM accesses. The on-board RAM, as seen by the 8085A CPU, may be placed anywhere within the 0- to 64K-address space. The iSBC 80/30 provides extended addressing jumpers to allow the on-board RAM to reside within a one megabyte address space when accessed via the MULTIBUS. In addition, jumper options are provided which allow the user to reserve 8K- and 16K-byte segments of on-board RAM for use by the 8085A CPU only. This reserved RAM space is not accessible via the MULTIBUS and does not occupy any system address space.

EPROM/ROM Capacity

Sockets for up to 8K bytes of nonvolatile read only memory and provided on the iSBC 80/30 board. Read only memory may be added in 1 K-byte increments up to a maximum of 2 K-bytes using Intel 2708 or 2758 erasable and electrically reprogrammable ROMs (EPROMs); in 2 K-byte increments up to a maximum of 4 K-bytes using Intel 2716 EPROMs; or in 4 K-byte increments up to 8K-bytes maximum using Intel 2732 EPROMs. All on-board EPROM/ROM operations are performed at maximum processor speed.

Parallel I/O Interface

The iSBC 80/30 contains 24 programmable parallel I/O lines implemented using the Intel 8255A Programmable Peripharal Interface. The system software is used to configure the I/O lines in any combination of unidirectional input/output and bidirectional ports indicated in Table 1. Therefore, the I/O interface may be customized to meet specific peripheral requirements. In order to take full advantage of the large number of possible I/O configurations, sockets are provided for interchangeable I/O line drivers and terminators. Hence, the flexibility of the I/O interface is further enhanced by the capability of selecting the appropriate combination of optional line drivers and terminators to provide the required sink current, polarity, and drive/termination characteristics for each application. The 24 programmable I/O lines and signal ground lines are brought out to a 50-pin edge connector that mates with flat, woven, or round cable.

Universal Peripheral Interface (UPI)

The iSBC 80/30 provides sockets for a user supplied Intel 8041A/8741A Universal Peripheral Interface (UPI) chip and the associated line drivers and terminators for the UPI's I/O ports. The 8041A/8741A is a single chip microcomputer containing a CPU, 1K bytes of ROM (8041A) or EPROM (8741A), 64 bytes of RAM, 18 programmable I/O lines, and an 8-bit timer. Special interface registers included in the chip allow the 8041A to function as a

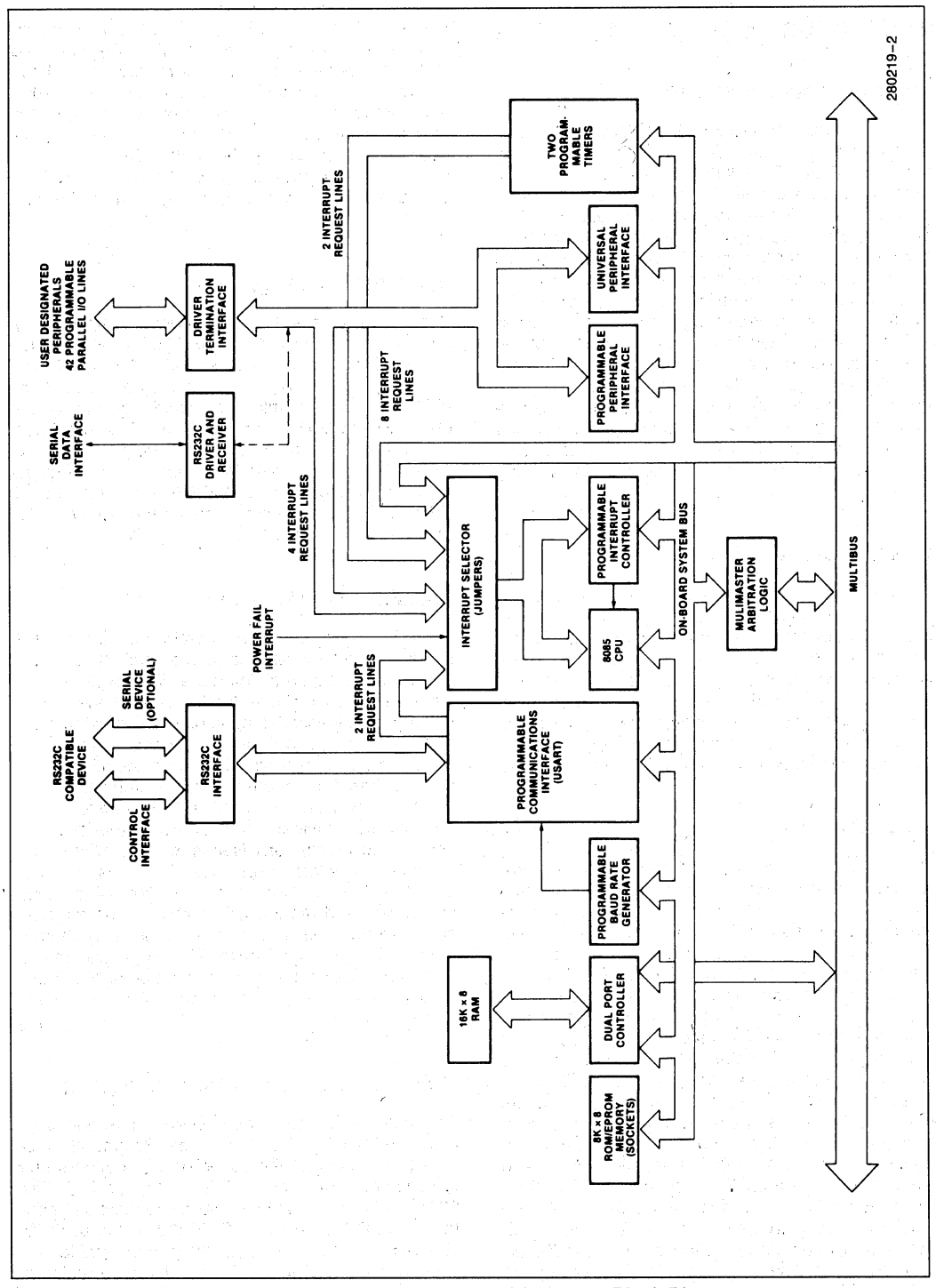


Figure 1. iSBC® 80/30 Single Board Computer Block Diagram

slave processor to the iSBC 80/30's 8085A CPU. The UPI allows the user to specifiy algorithms for controlling user peripherals directly in the chip, thereby relieving the 8085A for other system functions. The iSBC 80/30 provides an RS232C driver and an RS232C receiver for optional connection to the 8041A/8741A in applications where the UPI is programmed to handle simple serial interfaces. For additional information, including 8041A/8741A instructions, refer to the UPI-41A User's Manual and application note AP-41.

Serial I/O

A programmable communications interface using the Intel 8251A Universal Synchronous/Asynchronous Receiver/Transmitter (USART) is contained on the iSBC 80/30. A software selectable baud rate generator provides the USART with all common communication frequencies. The USART can be programmed by the system software to select the desired asynchronous or synchronous serial data transmission technique (including IBM By-Sync). The mode of operation (i.e., synchronous or asynchronous), data format, control character format, parity, and baud rate are all under program control. The 8251A provides full duplex, double buffered transmit and receive capability. Parity, overrun, and framing error detection are all incorporated in the USART. The RS232C compatible interface on each board, in conjunction with the USART, provides a direct interface to RS232C compatible terminals, cassettes, and asynchronous and synchronous modems. The RS232C command lines, serial data lines, and signal ground line are brought out to a 26-pin edge connector that mates with RS232C compatible flat or round cable.

Multimaster Capability

The iSBC 80/30 is a full computer on a single board with resources capable of supporting a great variety of OEM system requirements. For those applications requiring additional processing capacity and the benefits of multiprocessing (i.e., several CPUs and/or controllers logically sharing system tasks through communication over the system bus), the iSBC 80/30 provides full MULTIBUS arbitration control logic. This control logic allows up to three iSBC 80/30's or other bus masters to share the system bus in serial (daisy chain) priority fashion, and up to 16 masters to share the MULTIBUS with the addition of an external priority network. The MULTIBUS arbitration logic operates synchronously with a MULTIBUS clock (provided by the iSBC 80/30 or optionally connected directly to the MULTIBUS clock) while data is transferred via a handshake between the master and slave modules. This allows different speed controllers to share resources on the same bus, and transfer via the bus proceed asynchronously. Thus, transfer speed is dependent on transmitting and receiving devices only. This design prevents slow master modules from being handicapped in their attempts to gain control of the bus, but does not restrict the speed at which faster modules can transfer data via the same bus. The most obvious applications for the master-slave capabilities of the bus are multiprocessor configurations, high speed direct memory access (DMA) operations, and high speed peripheral control, but are by no means limited to these three.

Programmable Timers

The iSBC 80/30 provides three independent, fully programmable 16-bit interval timers/event counters utilizing the Intel 8253 Programmable Interval Timer. Each counter is capabile of operating in either BCD or binary modes. Two of these timers/counters are available to the systems designer to generate accurate time intervals under software control. Routing for the outputs and gate/trigger inputs of two of these counters is jumper selectable. The outputs may be independently routed to the 8259A Program-

Port	Lines (qty)	Mode of Operation					Control
		Unidirectional				Bidirectional	
		Input		Output			
		Unlatched	Latched & Strobed	Latched	Latched & Strobed		
1	8	X	X	X	X	X	
2	8	X	X	X	X		
3	4	X		X			X[1]
	4	X		X			X[1]

NOTE:
1. Part of port 3 must be used as a control port when either port 1 or port 2 are used as a latched and strobed input or a latched and strobed output port or port 1 is used as a bidirectional port.

mable Interrupt Controller, to the I/O line drivers associated with the 8255A Programmable Peripheral Interface, and to the 8041A/8741A Universal Programmable Interface, or may be routed as inputs to the 8255A and 8041A/8741A chips. The gate/trigger inputs may be routed to I/O terminators associated with the 8255A or as output connections from the 8255A. The third interval timer in the 8253 provides the programmable baud rate generator for the iSBC 80/30 RS232C USART serial port. In utilizing the iSBC 80/30, the systems designer simply configures, via software, each timer independently to meet system requirements.

Whenever a given time delay or count is needed, software commands to the programmable timers/event counters select the desired function. Seven functions are available, as shown in Table 2. The contents of each counter may be read at any time during system operation with simple read operations for event counting applications, and special commands are included so that the contents of each counter can be read "on the fly".

Table 2. Programmable Timer Functions

Function	Operation
Interrupt on Terminal Count	When terminal count is reached, an interrupt request is generated. This function is extremely useful for generation of real-time clocks.
Programmable One-Shot	Output goes low upon receipt of an external trigger edge or software command and returns high when terminal count is reached. This function is retriggerable.
Rate Generator	Divide by N counter. The output will go low for one input clock cycle, and the period from one low-going pulse to the next is N times the input clock period.
Square-Wave Rate Generator	Output will remain high until one-half the count has been completed, and go low for the other half of the count.
Software Triggered Strobe	Output remains high until software loads count (N). N counts after count is loaded, output goes low for one input clock period.
Hardware Triggered Strobe	Output goes low for one clock period N counts after rising edge on counter trigger input. The counter is retriggerable.
Event Counter	On a jumper selectable basis, the clock input becomes an input from the external system. CPU may read the number of events occurring after the counting "window" has been enabled or an interrupt may be generated after N events occur in the system.

Interrupt Capability

The iSBC 80/30 provides vectoring for 12 interrupt levels. Four of these levels are handled directly by the interrupt processing capability of the 8085A CPU and represent the four highest priority interrupts of the iSBC 80/30. Requests are routed to the 8085A interrupt inputs, TRAP, RST 7.5, RST 6.5, and RST 5.5 (in decreasing order of priority) and each input generates a unique memory address (TRAP: 24H; RST 7.5: 3CH; RST 6.5: 34H; and RST 5.5: 2CH). An 8085A jump instruction at each of these addresses then provides linkage to interrupt service routines located independently anywhere in memory. All interrupt inputs with the exception of the trap interrupt may be masked via software. The trap interrupt should be used for conditions such as power-down sequences which require immediate attention by the 8085A CPU. The Intel 8259A Programmable Interrupt Controller (PIC) provides vectoring for the next eight interrupt levels. As shown in Table 3, a selection of four priority processing modes is available to the systems designer for use in designing request processing configurations to match system requirements. Operating mode and priority assignments may be reconfigured dynamically via software at any time during system operation. The PIC accepts interrupt requests from the programmable parallel and serial I/O interfaces, the programmable timers, the system bus, or directly from peripheral equipment. The PIC then determines which of the incoming requests is of the highest priority, determines whether this request is of higher priority than the level currently being serviced, and, if appropriate, issues an interrupt to the CPU. Any combination of interrupt levels may be masked, via software, by storing a single byte in the interrupt mask register of the PIC. The PIC generates a unique memory address for each interrupt level. These addresses are equally spaced at intervals of 4 or 8 (software selectable) bytes. This 32- or 64-byte block may be located to begin at any 32- or 64-byte boundary in the 65,536-byte memory space. A single 8085A jump instruction at each of these addresses then provides linkage to locate each interrupt service routine independently anywhere in memory.

Interrupt Request Generation—Interrupt requests may originate from 18 sources. Two jumper selectable interrupt requests can be automatically generated by the programmable peripheral interface when

a byte of information is ready to be transferred to the CPU (i.e., input buffer is full) or a byte of information has been transferred to a peripheral device (i.e., output buffer is empty). Two jumper selectable interrupt requests can be automatically generated by the USART when a character is ready to be transferred to the CPU (i.e., receive channel buffer is full), or a character is ready to be transmitted (i.e., transmit channel data buffer is empty). A jumper selectable request can be generated by each of the programmable timers and by the universal peripheral interface, eight additional interrupt request lines are available to the user for direct interface to user designated peripheral devices via the system bus, and two interrupt request lines may be jumper routed directly from peripherals via the parallel I/O driver/terminator section.

Table 3. Programmable Interrupt Modes

Mode	Operation
Fully Nested	Interrupt request line priorities fixed at 0 as highest, 7 as lowest.
Auto-rotating	Equal priority. Each level, after receiving service, becomes the lowest priority level until next interrupt occurs.
Specific Priority	System software assigns lowest priority level. Priority of all other levels based in sequence numerically on this assignment.
Polled	System software examines priority-encoded system interrupt status via interrupt status register.

Power-Fail Control

Control logic is also included to accept a power-fail interrupt in conjunction with the AC-low signal from the iSBC 635 Power Supply or equivalent.

Expansion Capabilities

Memory and I/O capacity may be expanded and additional functions added by using Intel MULTIBUS compatible expansion boards. High speed integer and floating point arithmetic capabilities may be added by using the iSBC 310A High Speed Mathematics Unit. Memory may be expanded to 65,536 bytes by adding user specified combinations of RAM boards, EPROM boards, or combination boards. Input/output capacity may be increased by adding digital I/O and analog I/O expansion boards. Mass storage capability may be achieved by adding single or double density diskette controllers as sub-systems. Modular expandable backplanes and cardcages are available to support multi-board systems.

SPECIFICATIONS

Word Size

Instruction: 8, 16, or 24 bits
Data: 8 bits

Cycle Time

Basic Instruction Cycle: 1.45 μs

NOTE:
Basic instruction cycle is defined as the fastest instruction (i.e., four clock cycles).

Memory Addressing

On-Board ROM/EPROM: 0-07FF (using 2708 or 2758 EPROMs); 0-0FFF (using 2716 EPROMs); 0-1FFF (using 2716 EPROMs; 0-1FFF (using 2732 EPROMs).

On-Board RAM: 16K bytes of dual port RAM starting on a 16K boundary. One or two 8 K-byte segments may be reserved for CPU use only.

Memory Capacity

On-Board Read Only Memory: 8K bytes (sockets only)
On-Board RAM: 16K bytes
Off-Board Expansion: Up to 65,536 bytes in user specified combinations of RAM, ROM, and EPROM

NOTE:
Read only memory may be added in 1K, 2K, or 4K byte increments.

I/O Addressing

On-Board Programmable: I/O (see Table 1)

Port	8255A				8041A/8741A		USART	
	1	2	3	Control	Data	Control	Data	Control
Address	E8	E9	EA	EB	E4 or E6	E5 or E7	EC	ED

I/O Capacity

Parallel: 42 programmable lines using one 8255A (24 I/O lines) and an optional 8041A/8741A (18 I/O lines)

Serial: 2 programmable lines using one 8251A and an optional 8041A/8741A programmed for serial operation

NOTE:
For additional information on the 8041A/8741A refer to the UPI-41 User's Manual (Publication 9800504).

Serial Communications Characteristics

Synchronous: 5–8 bit characters; internal or external character synchronization; automatic sync insertion.

Asynchronous: 5–8 bit characters; break character generation; 1, 1½, or 2 stop bits; false start bit detection.

Baud Rates

Frequency (kHz) (Software Selectable)	Baud Rate (Hz)		
	Synchronous	Asynchronous	
		÷ 16	÷ 64
153.6	—	9600	2400
76.8	—	4800	1200
38.4	38400	2400	600
19.2	19200	1200	300
9.6	9600	600	150
4.8	4800	300	75
2.4	2400	150	—
1.76	1760	110	—

NOTE:
Frequency selected by I/O write of appropriate 16-bit frequency factor to baud rate register (8253 Timer 2) .

Interrupts

Addresses for 8259A Registers (Hex notation, I/O address space)

DA Interrupt request register

DA In-service register

DB Mask register

DA Command register

DB Block address register

DA Status (polling register)

NOTE:
Several registers have the same physical address; sequence of access and one data bit of control word determine which register will respond.

Interrupt Levels routed to 8085A CPU automatically vector the processor to unique memory locations:

Interrupt Input	Memory Address	Priority	Type
TRAP	24	Highest	Non-maskable
RST 7.5	3C	↑	Maskable
RST 6.5	34	↓	Maskable
RST 5.5	2C	Lowest	Maskable

Timers

Register Addresses (Hex notation, I/O address space)

DF Control register

DC Timer 0

DD Timer 1

DE Timer 2

NOTE:
Timer counts loaded as two sequential output operations to same address, as given.

Input Frequencies

Reference: 2.46 MHz ±0.1% (0.041 μs period, nominal); 1.23 MHz ±0.1% (0.81 μs period, nominal); or 153.60 kHz ±0.1% (6.51 μs period nominal).

NOTE:
Above frequencies are user selectable

Event Rate: 2.46 MHz max

NOTE:
Maximum rate for external events in event counter function.

Interfaces

MULTIBUS: All signals TTL compatible

Parallel I/O: All signals TTL compatible

Interrupt Requests: All TTL compatible

Timer: All signals TTL compatible

Serial I/O: RS232C compatible, data set configuration

System Clock (8085A CPU)

2.76 MHz ±0.1%

Auxiliary Power

An auxiliary power bus is provided to allow separate power to RAM for systems requiring battery backup of read/write memory. Selection of this auxiliary RAM power bus is made via jumpers on the board.

Connectors

Interface	Pins (qty)	Centers (in.)	Mating Connectors
Bus	86	0.156	Viking 2KH43/9AMK12
Parallel I/O	50	0.1	3M 3415-000
Serial I/O	26	0.1	3M 3462-000

Memory Protect

An active-low TTL compatible memory protect signal is brought out on the auxiliary connector which, when asserted, disables read/write access to RAM memory on the board. This input is provided for the protection of RAM contents during system power-down sequences.

Line Drivers and Terminators

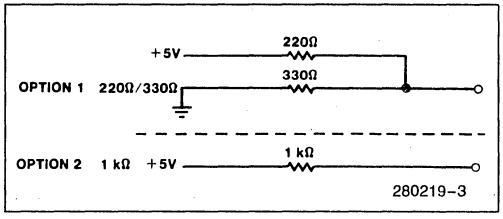
I/O Drivers: The following line drivers are all compatible with the I/O driver sockets on the iSBC 80/30.

Driver	Characteristics	Sink Current (mA)
7438	I, OC	48
7437	I	48
7432	NI	16
7426	I, OC	16
7409	NI, OC	16
7408	NI	16
7403	I, OC	16
7400	I	16

NOTE:
I = inverting; NI = non-inverting; OC = open collector

Port 1 of the 8255A has 20 mA totem-pole bidirectional drivers and 1 kΩ terminators.

I/O Terminators: 220Ω/330Ω divider or 1 kΩ pullup



Bus Drivers

Function	Characteristic	Sink Current (mA)
Data	Tri-State	50
Address	Tri-State	50
Commands	Tri-State	32

Physical Characteristics

Width: 12.00 in. (30.48 cm)
Height: 6.75 in. (17.15 cm)
Depth: 0.50 in. (1.27 cm)
Weight: 18 oz. (509.6 gm)

Output Frequencies/Timing Intervals

Function	Single Timer/ Counter		Dual Timer/Counter (Two Timers Cascaded)	
	Min	Max	Min	Max
Real-Time Interrupt	1.63 μs	427.1 ms	3.26 μs	466.50 min
Programmable One-Shot	1.63 μs	427.1 ms	3.26 μs	466.50 min
Rate Generator	2.342 Hz	613.5 kHz	0.000036 Hz	306.8 kHz
Square-Wave Rate Generator	2.342 Hz	613.5 kHz	0.000036 Hz	306.8 kHz
Software Triggered Strobe	1.63 μs	427.1 ms	3.26 μs	466.50 min
Hardware Triggered Strobe	1.63 μs	427.1 ms	3.26 μs	466.50 min

Electrical Characteristics

DC POWER REQUIREMENTS

Configuration	Current Requirements			
	V_{CC} = +5V ±5% (max)	V_{DD} = +12V ±5% (max)	V_{BB} = −5V ±5% (max)	V_{AA} = −12V ±5% (max)
Without EPROM(1)	I_{CC} = 3.5A	I_{DD} = 220 mA	I_{BB} = —	I_{AA} = 50 mA
With 8041/8741(2)	3.6A	220 mA	—	50 mA
RAM only(3)	350 mA	20 mA	2.5 mA	—
With iSBC 530(4)	3.5A	320 mA	—	150 mA
With 2K EPROM(5) (using 8708)	4.4A	350 mA	95 mA	40 mA
With 2K EPROM(5) (using 2758)	4.6A	220 mA	—	50 mA
With 4K EPROM(5) (using 2716)	4.6A	220 mA	—	50 mA
With 8K EPROM(5) (using 2332)	4.6A	220 mA	—	50 mA

NOTES:
1. Does not include power required for optional EPROM/ROM, 8041A/8741A I/O drivers, and I/O terminators.
2. Does not include power required for optional EPROM/ROM. I/O drivers and I/O terminators.
3. RAM chips powered via auxiliary power bus.
4. Does not include power required for optional EPROM/ROM, 8041A/8741A I/O drivers, and I/O terminators. Power for iSBC 530 is supplied through the serial port connector.
5. Includes power reqiured for two EPROM/ROM chips, 8041A/8741A and 220Ω/330Ω input terminators installed for 34 I/O lines; all terminator inputs low.

Environmental Characteristics

Operating Temperature: 0°C to 55°C

Reference Manual

9800611B— iSBC 80/30 Single Board Computer Hardware Reference Manual (NOT SUPPLIED)

Reference manuals are shipped with each product only if designated SUPPLIED. Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

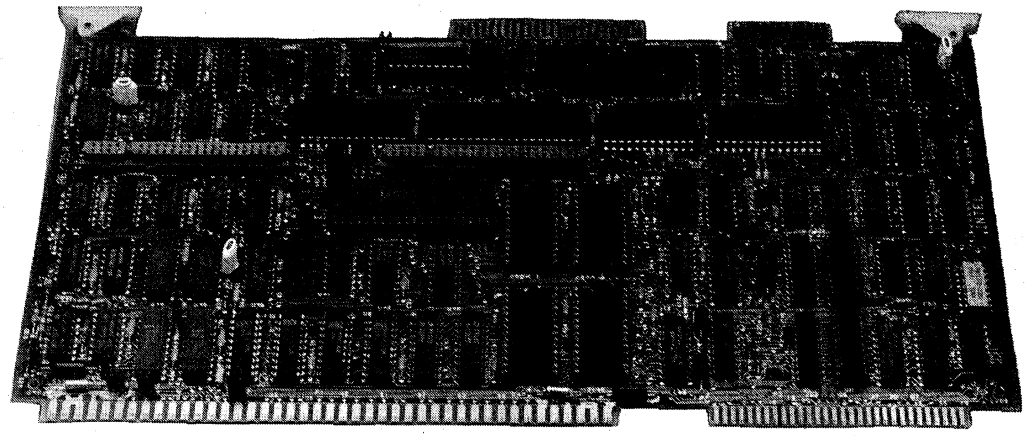
ORDERING INFORMATION

Part Number	Description
SBC 80/30	Single Board Computer with 16K bytes RAM

iSBC® 86/05A
SINGLE BOARD COMPUTER

- 8086/10 (8086-2) Microprocessor with 5 or 8 MHz CPU Clock
- Software Compatible with 8086, 8088, 80186, 80286 Based 16-bit Single Board Computers
- Optional 8086/20 Numeric Data Processor with iSBC® 337 A MULTIMODULE™ Processor
- 8K bytes of Static RAM; Expandable On-Board to 16K Bytes
- Sockets for up to 256K Bytes of JEDEC 24/28-Pin Standard Memory Devices; Expandable On-Board to 512K Bytes
- Two iSBX™ Bus Connectors
- Programmable Synchronous/ Asynchronous RS232C Compatible Serial Interface with Software Selectable Baud Rate
- 24 Programmable Parallel I/O Lines
- Two Programmable 16-Bit BCD or Binary Timers/Event Counters
- 9 Levels of Vectored Interrupt Control, Expandable to 65 Levels
- MULTIBUS® Bus Interface for Multimaster Configurations and System Expansion
- Supported by a Complete Family of Single Board Computers, Memory, Digital and Analog I/O, Peripheral Controllers, Packaging and Software

The iSBC 86/05A Single Board Computer is a member of Intel's complete line of OEM microcomputer systems which take full advantage of Intel's technology to provide economical, self-contained, computer-based solutions for OEM applications. The iSBC 86/05A board is a complete computer system on a single 6.75 x 12.00 in. printed circuit card. The CPU, system clock, read/write memory, nonvolatile read only memory, I/O ports and drivers, serial communications interface, priority interrupt logic and programmable timers, all reside on the board. The large control storage capacity makes the iSBC 86/05A board ideally suited for control-oriented applications such as process control, instrumentation, industrial automation, and many others.



143325-1

September 1987
Order Number: 143325-003

FUNCTIONAL DESCRIPTION

Central Processing Unit

The central processor for the iSBC 86/05A board is Intel's iAPX 86/10 (8086-2) CPU. a clock rate of 8 MHz is supported with a jumper selectable option of 5 MHz. The CPU architecture includes four 16-bit byte addressable data registers, two 16-bit memory base pointer registers and two 16-bit index registers. All are accessed by a total of 24 operand addressing modes for comprehensive memory addressing and for support of the data structures required for today's structured, high level languages as well as assembly language.

Instruction Set

The 8086 instruction repertoire includes variable length instruction format (including double operand instructions), 8- and 16-bit signed and unsigned arithmetic operators for binary, BCD and unpacked ASCII data, and iterative word and byte string manipulation functions.

For enhanced numerics processing capability, the iSBC 337A MULTIMODULE Numeric Data Processor extends the iAPX 86/10 architecture and data set. Over 60 numeric instructions offer arithmetic, trigonometric, transcendental, logarithmic and exponential instructions. Supported data types include 16-, 32-, and 64-bit integer, and 32- and 64-bit floating point, 18-digit packed BCD and 80-bit temporary.

Architectural Features

A 6-byte instruction queue provides pre-fetching of sequential instructions and can reduce the 740 ns minimum instruction cycle to 250 ns for queued instructions. The stack-oriented architecture readily supports modular programming by facilitating fast, simple, inter-module communication, and other programming constructs needed for asynchronous real-time systems. The memory expansion capabilities offer a 1 megabyte addressing range. The dynamic relocation scheme allows ease in segmentation of pure procedure and data for efficient memory utilization. Four segment registers (code, stack, data, extra) contain program loaded offset values which are used to map 16-bit addresses to 20-bit addresses. Each register maps 64K bytes at a time with activation of a specific register controlled explicity by program control and selected implicity by specific functions and instructions. All Intel languages support the extended memory capability, relieving the programmer of managing the megabyte memory space yet allowing explicit control when necessary.

Memory Configuration

The iSBC 86/05A microcomputer contains 8K bytes of high-speed 8K x 4 bit static RAM on-board. In addition, the above on-board RAM may be expanded to 16K bytes with the iSBC 302 MULTIMODULE RAM option which mounts on the iSBC 86/05A board. All on-board RAM is accessed by the 8086-2 CPU with no wait states, yielding a memory cycle time of 500 ns.

The iSBC 86/05A board also has four 28-pin, 8-bit wide (byte-wide) sockets, configured to accept JEDEC 24/28-pin standard memory devices. Up to 256K bytes of EPROM are supported in 64K byte increments with Intel 27512 EPROMs. The iSBC 86/05A board also supports 2K x 8, 4K x 8, 8K x 8, 16K x 8 and 32K x 8 EPROM memory devices. These sites also support 2K x 8 and 8K x 8 byte-wide static RAM (SRAM) devices and iRAM devices, yielding up to 32K bytes of SRAM in 8K byte increments on the baseboard.

When the addition of the iSBC 341 MULTIMODULE EPROM option, the on-board capacity for these devices is doubled, providing up to 512K bytes of EPROM and 64K bytes of byte-wide SRAM capacity on-board.

Parallel I/O Interface

The iSBC 86/05A Single Board Computer contains 24 programmable parallel I/O lines implemented using the Intel 8255A Programmable Peripheral Interface. The system software is used to configure the I/O lines in any combination of unidirectional input/output and bidirectional ports indicated in Table 1. In order to take advantage of the large number of possible I/O configurations, sockets are provided for interchangeable I/O line drivers and terminators, allowing the selection of the appropriate combination of optional line drivers and terminators with the required drive/termination characteristics. The 24 programmable I/O lines and signal ground lines are brought out to a 50-pin edge connector.

Serial I/O

A programmable communications interface using the Intel 8251A Universal Synchronous/Asynchronous Receiver/Transmitter (USART) is contained on the iSBC 86/05A board. A software selectable baud rate generator provides the USART with all common communication frequencies. The mode of operation (i.e., synchronous or asynchronous), data format, control character format, parity, and baud rate are all under program control. The 8251A provides full duplex, double buffered transmit and receive capability. Parity, overrun, and framing error detection are all

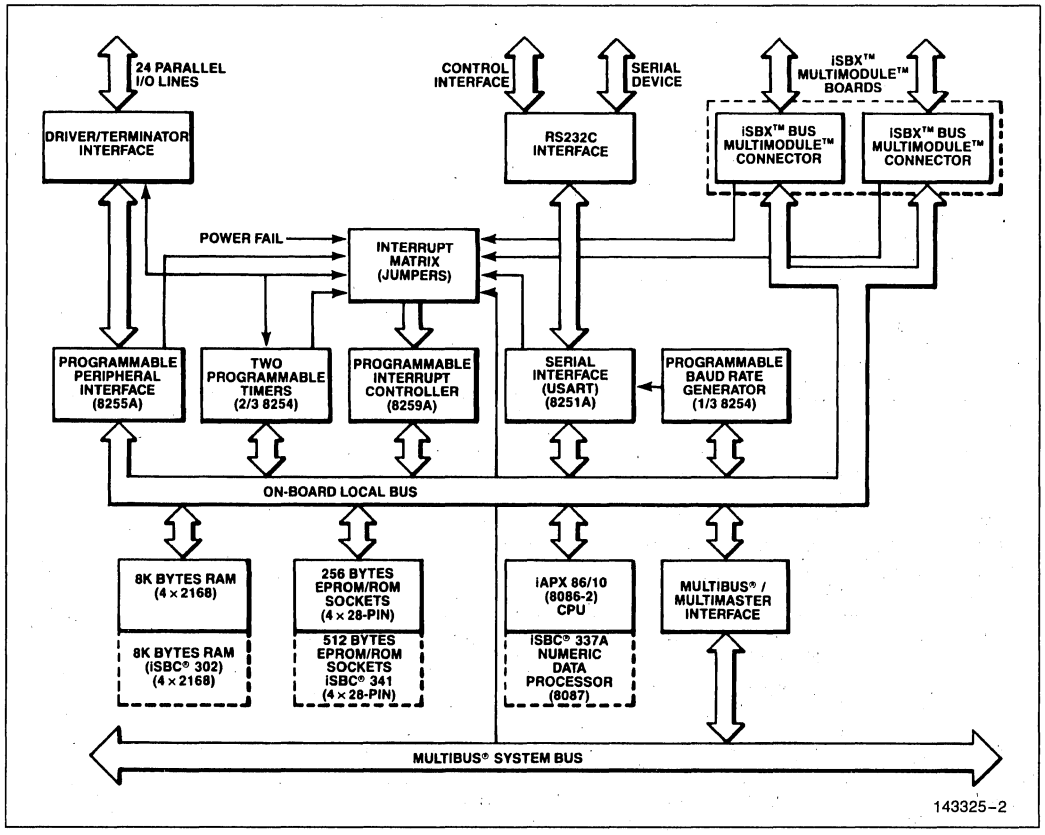


Figure 1. iSBC® 86/05A Block Diagram

incorporated in the USART. The RS232C compatible interface in conjunction with the USART, provides a direct interface to RS232C compatible terminals, cassettes, and asynchronous/synchronous modems. The RS232C command lines, serial data lines and signal ground line are brought out to a 26-pin edge connector.

Programmable Timers

The iSBC 86/05A board provides three independent, fully programmable 16-bit interval timers/event counters utilizing the Intel 8254 Programmable Interval Timer. Each counter is capable of operating in either BCD or binary modes. Two of these timers/counters are available to the systems designer to generate accurate time intervals under software control. Routing for the outputs and gate/trigger inputs of two of these counters is jumper selectable. The outputs may be independently routed to the 8259A Programmable Interrupt Controller and to the I/O terminators associated with the 8255A to allow external devices or an 8255A port to gate the timer or to count external events. The third interval timer in the 8254 provides the programmable baud rate generator for the iSBC 86/05A board RS232C USART serial port. The system software configures each timer independently to select the desired function. Seven functions are available as shown in Table 2. The contents of each counter may be read at any time during system operation.

iSBX™ MULTIMODULE™ On-Board Expansion

Two 8/16-bit iSBX MULTIMODULE connectors are provided on the iSBC 86/05A microcomputer. Through these connectors, additional on-board I/O and memory functions may be added. iSBX MULTIMODULE boards support functions such as additional parallel and serial I/O, analog I/O, mass storage device controllers (e.g., cassettes and floppy disks), BITBUS™ controllers, bubble memory, and other custom interfaces to meet specific needs. By mounting directly on the single board computer, less inter-

Table 1. Input/Output Port Modes of Operation

Port	Lines (qty)	Mode of Operation					Control
		Unidirectional				Bidirectional	
		Input		Output			
		Latched	Latched & Strobed	Latched	Latcched & Strobed		
1	8	X	X	X	X	X	
2	8	X	X	X	X		
3	4	X		X			X[1]
	4	X		X			X[1]

NOTE:
1. Part of port 3 must be used as a control port when either port 1 or port 2 are used as a latched and strobed input or a latched and strobed output port or port 1 is used as a bidirectional port.

Table 2. Programmable Timer Functions

Function	Operation
Interrupt on Terminal Count	When Terminal Count is Reached, an Interrupt Request is Generated. This Function is Extremely Useful for Generation of Real-Time Clocks.
Programmable One-Shot	Output Goes Low upon Receipt of an External Trigger Edge or Software Command and Returns High when Terminal Count is Reached. This Function is Retriggerable.
Rate Generator	Divide by N Counter. The Output will go Low for One Input Clock Cycle, and the Period from One Low Going Pulse to the Next is N Times the Input Clock Period.
Square-Wave Rate Generator	Output will Remain High Until One-Half the Count has been Completed, and go Low for the Other Half of the Count.
Software Triggered Strobe	Output Remains High Until Software Loads Count (N). N Counts After Count is Loaded, Output goes Low for One Input Clock Period.
Hardware Triggered Strobe	Output Goes Low for One Clock Period N Counts After Rising Edge Counter Trigger Input. The Counter is Retriggerable.
Event Counter	On a Jumper Selectable Basis, the Clock Input Becomes an Input from the External System. CPU may Read the Number of Events Occurring After the Counter "Window" has been Enabled or an Interrupt may be Generated After N Events Occur in the System.

face logic, less power, simpler packaging, higher performance, and lower cost result when compared to other alternatives such as MULTIBUS form factor compatible boards. The iSBX connectors on the iSBC 86/05A board provide all signals necessary to interface to the local on-board bus, including 16 data lines for maximum data transfer rates. iSBX MULTIMODULE boards designed with 8-bit data paths and using the 8-bit iSBX connector are also supported on the iSBC 86/05A microcomputer. A broad range of iSBX MULTIMODULE options are available in this family from Intel. Custom iSBX modules may also be designed for use on the iSBC 86/05A board. An iSBX bus interface specification is available from Intel.

MULTIBUS SYSTEM BUS AND MULTIMASTER CAPABILITIES

Overview

The MULTIBUS system bus (IEEE 796) is Intel's industry standard microcomputer bus structure. Both 8- and 16-bit single board computers are supported on the MULTIBUS structure with 24 address and 16 data lines. In its simplest application, the MULTIBUS system bus allows expansion of functions already contained on a single board computer (e.g., memory and digital I/O). However, the MULTIBUS structure also allows very powerful distributed processing configurations with multiple processors and intelligent slave I/O, and peripheral boards capable of solving the most demanding microcomputer applications. The MULTIBUS system bus is supported with a broad array of board level products, LSI interface components, detailed published specifications and application notes.

Expansion Capabilities

Memory and I/O capacity may be expanded and additional functions added using Intel MULTIBUS compatible expansion boards. Memory may be expanded by adding user specified combinations of RAM boards, EPROM boards, or combination boards. Input/output capacity may be added with digital I/O and analog I/O expansion boards. Mass storage capability may be achieved by adding single or double density diskette controllers, or hard disk controllers.

Multimaster Capabilities

For those applications requiring additional processing capacity and the benefits of multiprocessing (i.e., several CPUs and/or controllers logically sharing system tasks through communication of the system bus), the iSBC 86/05A board provides full MULTIBUS arbitration control logic. This control logic allows up to three iSBC 86/05A boards or other bus masters to share the system bus using a serial (daisy chain) priority scheme and allows up to 16 masters to share the MULTIBUS system bus with an external parallel priority decoder. In addition to the multiprocessing configurations made possible with multimaster capability, it also provides a very efficient mechanism for all forms of DMA (Direct Memory Access) transfers.

Interrupt Capability

The iSBC 86/05A board provides 9 vectored interrupt levels. The highest level is the NMI (Non-Maskable Interrupt) line which is directly tied to the 8086 CPU. This interrupt is typically used for signaling catastrophic events (e.g., power failure). The Intel 8259A Programmable Interrupt Controller (PIC) provides control and vectoring for the next eight interrupt levels. As shown in Table 3, a selection of four priority processing modes is available for use in designing request processing configurations to match system requirements for efficient interrupt servicing with minimal latencies. Operating mode and priority assignments may be reconfigured dynamically via software at any time during system operation. The PIC accepts interrupt requests from all on-board I/O resources and from the MULTIBUS system bus. The PIC then resolves requests according to the selected mode and, if appropriate, issues an interrupt to the CPU. Any combination of interrupt levels may be masked via software, by storing a single byte in the interrupt mask register of the PIC. In systems requiring additional interrupt levels, slave 8259A PICs may be interfaced via the MULTIBUS system bus, to generate additional vector addresses, yielding a total of 65 unique interrupt levels.

Interrupt Request Generation

Interrupt requests to be serviced by the iSBC 86/05A board may originate from 24 sources. Table 4 includes a list of devices and functions supported by interrupts. All interrupt signals are brought to the interrupt jumper matrix where any combination of interrupt sources may be strapped to the desired interrupt request level on the 8259A PIC or the NMI input to the CPU directly.

Power-Fail Control and Auxiliary Power

Control logic is also included, to accept a power-fail interrupt in conjunction with a power-supply having AC-low signal generation capabilities, to initiate an orderly shut down of the system in the event of a power failure. Additionally, an active-low TTL compatible memory protect signal is brought out on the auxiliary connector which, when asserted, disables read/write access to RAM for systems requiring battery backup of read/write memory. Selection of this auxiliary RAM power bus is made via jumpers on the board.

Table 3. Programmable Interrupt Modes

Mode	Operation
Fully Nested	Interrupt Request Line Priorities Fixed at 0 as Highest, 7 as Lowest.
Auto-Rotating	Equal Priority. Each Level, After Receiving Service, Becomes the Lowest Priority Level until next Interrupt Occurs.
Specific Priority	System Software Assigns Lowest Priority Level. Priority of all Other Levels Based in Sequence Numerically on this Assignment.
Polled	System Software Examines Priority-Encoded System Interrupt Status via Interrupt Status Register.

Table 4. Interrupt Request Sources

Device	Function	Number of Interrupts
MULTIBUS Bus Interface	Requests from MULTIBUS Resident Peripherals or Other CPU Boards	8; may be Expanded to 64 with Slave 8259A PICs on MULTIBUS Boards
8255A Programmable Peripheral Interface	Signals Input Buffer Full or Output Buffer Empty; also BUS INTR OUT General Purpose Interrupt from Driver/Terminator Sockets	3
8251A USART	Transmit Buffer Empty and Receive Buffer Full	2
8254 Timers	Timer 0, 1 Outputs; Function Determined by Timer Mode	2
iSBX Connectors	Function Determined by iSBX MULTIMODULE Board	4 (2 per iSBX Connector)
Bus Fail Safe Timer	Indicates Addressed MULTIBUS Resident Device has not Responded to Command within 6–10 ms	1
Power Fail Interrupt	Indicates AC Power is not within Tolerance	1
Power Line Clock	Source of 120 Hz Signal from Power Supply	1
External Interrupt	General Purpose Interrupt from Auxiliary (P2) Connector on Backplane	1
iSBC 337A MULTIMODULE Numeric Data Processor	Indicates Error or Exception Condition	1

System Development Environment

Development support for the iSBC 86/05A Board is offered on the System 310 and Series IV Microcomputer Development System from Intel as well as the IBM Personal Computer.

In the Series IV, System 310 and IBM PC development environments, languages offered are Assembler, PLM-86, C, Fortran and Pascal. A powerful software debugger, PSCOPE, is also offered on all development systems. PSCOPE provides Software Trace Execution, defineable breakpoints and user defined/executable debugging procedures.

In-Circuit Emulator

The I²ICE™ In-Circuit Emulator provides the necessary link between the software development environment and the "target" iSBC 86/05A board, the I²ICE In-Circuit Emulator provides a sophisticated command set to assist in debugging software and final integration of the user hardware and software.

iSDM™ System Debug Monitor

The Intel iSDM System Debug Monitor package contains the necessary hardware, software, cables, EPROMs and documentation required to interface, through a serial or parallel connection, an iSBC 86/05A target system to System 310 or Series IV Intellec® Microcomputer Development System for execution and interactive debugging of applications software on the target system. The Monitor can: load programs into the target system; execute the programs instruction by instruction or at full speed; set breakpoints; and examine/modify CPU registers, memory content, and other crucial environmental details. Additional custom commands can be built using the Command Extension Interface (CEI).

Software Support

The iRMX 86 operating system is offered for development with a System 310 and provides users with a powerful set of system building blocks for developing many different real-time applications. Key iRMX 86 operating system features include multitasking, multiprogramming, interrupt management, device independence, file protection and control, interactive debugging, plus interfaces to many Intel and non-Intel developed hardware and software products.

The iRMX 86 operating system is highly modular and configurable, and includes a sophisticated file management, I/O system, and powerful human interface. The iRMX 86 operating system is also easily customized and extended by the user to match unique requirements.

SPECIFICATIONS

Word Size

Instruction: 8, 16, 24, or 32 bits
Data: 8, 16 bits

System Clock

5.00 MHz or 8.00 MHz ± 0.1% (jumper selectable)

Basic Instruction Cycle

At 8 MHz: 750 ns
250 ns (assumes instruction in the queue)
At 5 MHz: 1.2 sec.
400 ns (assumes instruction in the queue)

NOTE:
Basic instruction cycle is defined as the fastest instruction time (i.e., two clock cycles).

Memory Cycle Time

500 ns cycle time (no wait states requires a memory component access time of 250 ns or less)
RAM: 500 ns
EPROM: Jumper selectable from 500 ns to 875 ns

Memory Capacity/Addressing

JEDEC 24/28 Pin Sites		
Device	**Total Capacity**	**Address Range**
2K × 8	8K bytes	FE000-FFFFF$_H$
4K × 8	16K bytes	FC000-FFFFF$_H$
8K × 8	32K bytes	F8000-FFFFF$_H$
16K × 8	64K bytes	F0000-FFFFF$_H$
32K × 8	128K bytes	E0000-FFFFF$_H$
64K × 8	256K bytes	C0000-FFFFF$_H$
With iSBC® 341 MULTIMODULE™ EPROM/SRAM		
Device	**Total Capacity**	**Address Range**
2K × 8	16K bytes	FC000-FFFFF$_H$
4K × 8	32K bytes	F8000-FFFFF$_H$
8K × 8	64K bytes	F0000-FFFFF$_H$
16K × 8	128K bytes	E0000-FFFFF$_H$
32K × 8	256K bytes	C0000-FFFFF$_H$
64K × 8	512K bytes	80000-FFFFF$_H$

NOTE:
iSBC 86/05A EPROM sockets support JEDEC 24/28-pin standard EPROMs and RAMS.

ON-BOARD STATIC RAM

8K bytes — 0–1FFF$_H$

16K bytes— 0–3FFF$_H$ (with iSBC 302 MULTIMODULE Board)

I/O CAPACITY

PARALLEL — 24 programmable lines using one 8255A.

SERIAL — 1 programmable line using one 8251A.

iSBX MULTIMODULE— 2 iSBX single wide MULTIMODULE board or 1 iSBX double-width MULTIMODULE board.

SERIAL COMMUNICATIONS CHARACTERISTICS

SYNCHRONOUS — 5–8 bit characters; internal or external character synchronization; automatic sync insertion.

ASYNCHRONOUS— 5–8 bit characters; break character generation; 1, 1½, or 2 stop bits; false start bit direction.

Baud Rates

Frequency (KHz) (Software Selectable)	Baud Rate (Hz)		
	Synchronous	Asynchronous	
		÷16	÷64
153.6	—	9600	2400
76.8	—	4800	1200
38.4	38400	2400	600
19.2	19200	1200	300
9.6	9600	600	150
4.8	4800	300	75
2.4	2400	150	—
1.76	1760	110	—

NOTE:
1. Frequency selected by I/O write of appropriate 16-bit frequency factor to baud rate register (8254 Timer 2).

TIMERS

Input Frequencies

Reference: 2.46 MHz ±0.1% (0.041 sec. period, nominal); or 153.60 KHz ±0.1% (6.51 sec. period, nominal)

NOTE:
Above frequencies are user selectable

Event Rate: 2.46 MHz max

Output Frequencies/Timing Intervals

Function	Single Timer/Counter		Dual Timer/Counter (Two Timers Cascaded)	
	Min	Max	Min	Max
Real-Time Interrupt	1.63 μs	427.1 ms	3.26s	466.50 min
Programmable One-Shot	1.63 μs	427.1 ms	3.26s	466.50 min
Rate Generator	2.342 Hz	613.5 kHz	0.000036 Hz	306.8 kHz
Square-Wave Rate Generator	2.342 Hz	613.5 kHz	0.000036 Hz	306.8 kHz
Software Triggered Strobe	1.63 μs	427.1 ms	3.26s	466.50 min
Hardware Triggered Strobe	1.63 μs	427.1 ms	3.26s	466.50 min
Event Counter	—	2.46 MHz	—	—

INTERFACES

MULTIBUS Bus:	All signals TTL compatible
iSBX BUS Bus:	All signals TTL compatible
PARALLEL I/O:	All signals TTL compatible
SERIAL I/O:	RS232C compatible, configurable as a data set or data terminal
TIMER:	All signals TTL compatible
INTERRUPT REQUESTS:	All TTL compatible

Connectors

Interface	Double-Sided Pins (qty)	Centers (in.)	Mating Connectors
MULTIBUS System	86	0.156	Viking Wire Wrap
iSBX Bus			
8-Bit Data	36	0.1	iSBX 960-5
16-Bit Data	44	0.1	iSBX 961-5
Parallel I/O (2)	50	0.1	3M Flat or T1 PINS
Serial I/O	26	0.1	3M Flat or AMP Flat

LINE DRIVERS AND TERMINATORS

I/O Drivers

The following line drivers are all compatible with the I/O driver sockets on the iSBC 86/05A board.

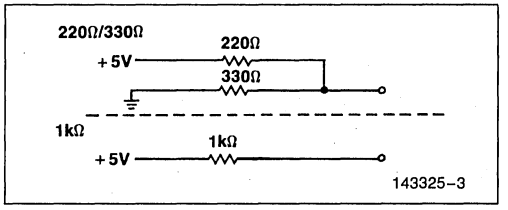
Driver	Characteristic	Sink Current (mA)
7438	I,OC	48
7437	I	48
7432	NI	16
7426	I,OC	16
7409	NI,OC	16
7408	NI	16
7403	I,OC	16
7400	I	16

NOTES:
I = inverting; NI = non-inverting; OC = open collector.

Port 1 of the 8255A has 20 mA totem-pole bidirectional drivers and 1K terminators

I/O Terminators

220/330 divider or 1K pullup



MULTIBUS® DRIVERS

Function	Characteristic	Sink Current (mA)
Data	Tri-State	50
Address	Tri-State	50
Commands	Tri-State	32
Bus Control	Open Collector	20

Physical Characteristics

Width: 12.00 in. (30.48 cm)
Height: 6.75 in. (17.15 cm)
Depth: 0.70 in. (1.78 cm)
Weight: 14 oz (388 gm)

ELECTRICAL CHARACTERISTICS

DC Power Requirements

Configuration	Current Requirements (All Voltages ±5%)		
	+5V	+12V	−12V
Without EPROM(1) RAM only(2)	4.7A 120 mA	25 mA	23 mA
With 8K EPROM(3) (using 2716)	5.0A	25 mA	23 mA
With 16K EPROM(3) (using 2732)	4.9A	25 mA	23 mA
With 32K EPROM(3) (using 2764)	4.9A	25 mA	23 mA

NOTES:
1. Does not include power for optional ROM/EPROM, I/O drivers, and I/O terminators.
2. RAM chips powered via auxiliary power bus in power-down mode.
3. Includes power required for 4 ROM/EPROM chips, and I/O terminators installed for 16 I/O lines; all terminator inputs low.

ENVIRONMENTAL CHARACTERISTICS

Operating Temperature: 0°C to 55°C

Relative Humidity: to 90% (without condensation)

REFERENCE MANUAL

Order no. 147162-002—*iSBC 86/05A Hardware Reference Manual* (NOT SUPPLIED)

Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

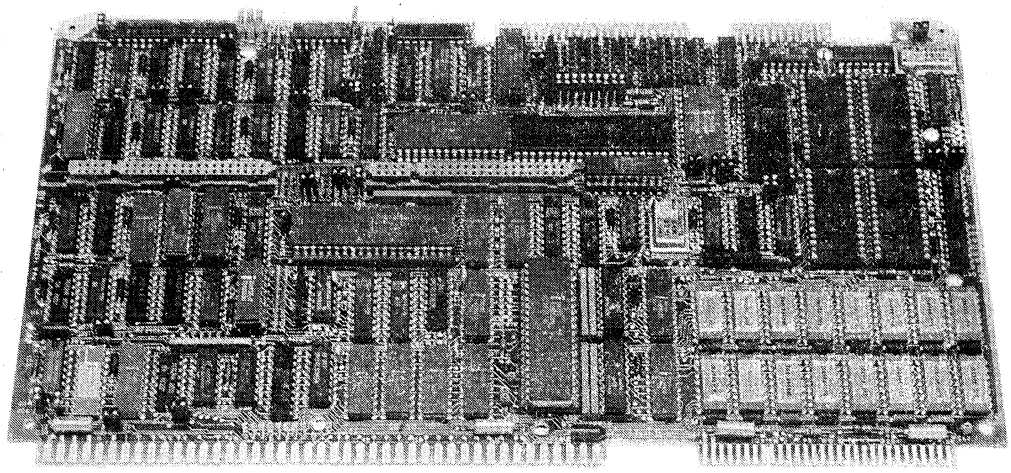
ORDER INFORMATION

Part Number	Description
SBC 86/05A	16-bit Single Board Computer with 8K bytes RAM

iSBC® 86/14 AND iSBC® 86/30 SINGLE BOARD COMPUTERS

- 8086 Microprocessor with 5 or 8 MHz CPU Clock
- Fully Software Compatible with iSBC® 86/12A Single Board Computer
- Optional 8086 Numeric Data Processor with iSBC® 337A MULTIMODULE™ Processor
- 32K/128K bytes of Dual-Port Read/Write Memory Expandable On-Board to 256K bytes with On-Board Refresh
- Sockets for up to 64K bytes of JEDEC 24/28-pin Standard Memory Devices
- Two iSBX™ Bus Connectors
- 24 Programmable Parallel I/O Lines
- Programmable Synchronous/Asynchronous RS232C Compatible Serial Interface with Software Selectable Baud Rates
- Two Programmable 16-Bit BCD or Binary Timers/Event Counters
- 9 Levels of Vectored Interrupt Control, Expandable to 65 Levels
- MULTIBUS® Interface for Multimaster Configurations and System Expansion
- Supported by a Complete Family of Single Board Computers, Memory, Digital and Analog I/O, Peripheral Controllers, Packaging and Software

The iSBC 86/14 and iSBC 86/30 Single Board Computers are members of Intel's complete line of OEM microcomputer systems which take full advantage of Intel's technology to provide economical, self-contained, computer-based solutions for OEM applications. Each board is a complete computer system on a single 6.75 x 12.00-in. printed circuit card distinguished by RAM memory content with 32K bytes and 128K bytes provided on the iSBC 86/14 and iSBC 86/30 board, respectively. The CPU, system clock, read/write memory, nonvolatile read only memory, I/O ports and drivers, serial communications interface, priority interrupt logic and programmable timers, all reside on the boards.



280007-1

September 1987
Order Number: 280007-004

FUNCTIONAL DESCRIPTION

Central Processing Unit

The central processor for the iSBC 86/XX* boards is Intel's iAPX 86/10 (8086-2) CPU. A clock rate of 8 MHz is supported with a jumper selectable option of 5 MHz. The CPU architecture includes four 16-bit byte addressable data registers, two 16-bit memory base pointer registers and two 16-bit index registers, all accessed by a total of 24 operand addressing modes for comprehensive memory addressing and for support of the data structures required for today's structured, high level languages as well as assembly language.

NOTE:
iSBC 86/XX designates both the iSBC 86/14 and iSBC 86/30 CPU boards.

Instruction Set

The 8086 instruction repertoire includes variable length instruction format (including double operand instructions), 8-bit and 16-bit signed and unsigned arithmetic operators for binary, BCD and unpacked ASCII data, and iterative word and byte string manipulation functions.

For enhanced numerics processing capability, the iSBC 337A MULTIMODULE Numeric Data Processor extends the 8086/10 architecture and data set. Over 60 numeric instructions offer arithmetic, trigonometric, transcendental, logarithmic and exponential instructions. Supported data types include 16-, 32, and 64-bit integer, and 32- and 64-bit floating point, 18-digit packed BCD and 80-bit temporary.

Architectural Features

A 6-byte instruction queue provides pre-fetching of sequential instructions and can reduce the 750 nsec minimum instruction cycle to 250 nsec for queued instructions. The stack-oriented architecture readily supports modular programming by facilitating fast, simple, inter-module communication, and other programming constructs needed for asynchronous real-time systems. The memory expansion capabilities offer a 1 megabyte addressing range. The dynamic relocation scheme allows ease in segmentation of pure procedure and data for efficient memory utilization. Four segment registers (code, stack, data, extra) contain program loaded offset values which are used to map 16-bit addresses to 20-bit addresses. Each register maps 64K bytes at a time and activation of a specific register is controlled explicitly by program control and is also selected implicitly by specific functions and instructions.

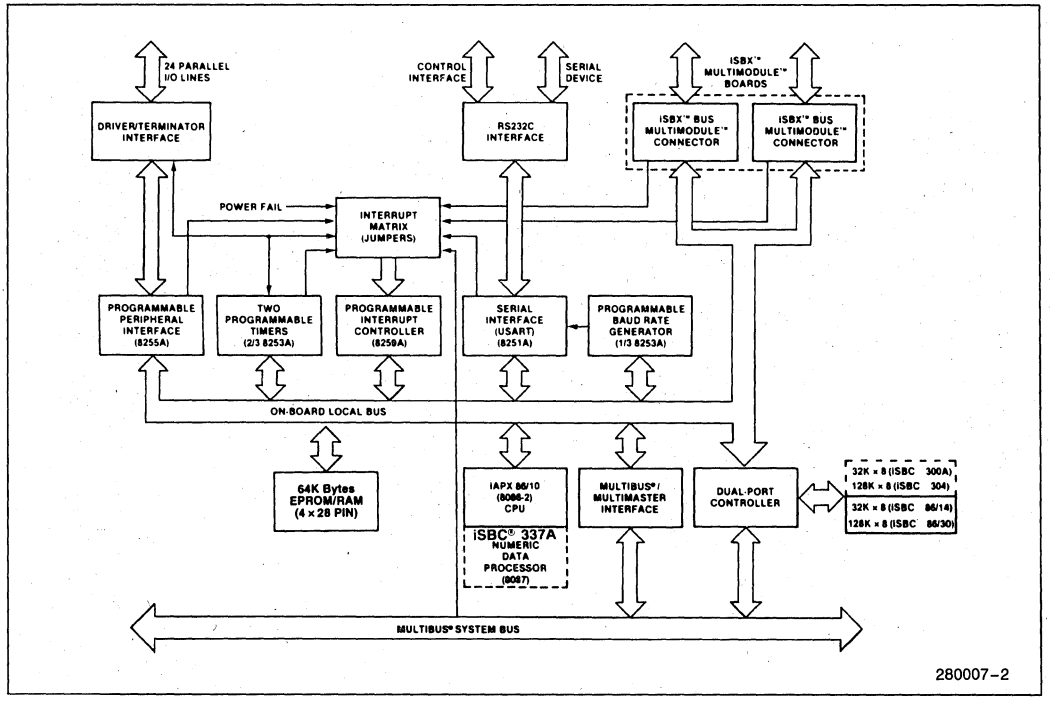


Figure 1. iSBC® 86/XX Block Diagram

RAM Capabilities

The iSBC 86/14 and iSBC 86/30 microcomputers contain 32K bytes and 128K bytes of dual-port dynamic RAM, respectively. In addition, on-board RAM may be doubled on each microcomputer by optionally adding RAM MULTIMODULE boards. The on-board RAM may be expanded to 256K bytes with the iSBC 304 MULTIMODULE Board mounted onto the iSBC 86/30 board. Likewise, the iSBC 86/14 microcomputer may be expanded to 64K bytes with the iSBC 300A MULTIMODULE option. The dual-port controller allows access to the on-board RAM (including RAM MULTIMODULE options) from the iSBC 86/XX boards and from any other MULTIBUS master via the system bus. Segments of on-board RAM may be configured as a private resource, protected from MULTIBUS system access. The amount of memory allocated as a private resource may be configured in increments of 25% of the total on-board memory ranging from 0% to 100% (optional RAM MULTIMODULE boards double the increment size). These features allow the multiprocessor systems to establish local memory for each processor and shared system memory configurations where the total system memory size (including local on-board memory) can exceed one megabyte without addressing conflicts.

EPROM Capabilities

Four 28-pin sockets are provided for the use of Intel 2716s, 2732As, 2764s, 27128s, and their respective ROMs. When using 27128s, the on-board EPROM capacity is 64K bytes. Other JEDEC standard pinout devices are also supported, including byte-wide static RAMs.

Parallel I/O Interface

The iSBC 86/XX Single Board Computers contain 24 programmable parallel I/O lines implemented using the Intel 8255A Programmable Peripheral Interface. The system software is used to configure the I/O lines in any combination of unidirectional input/output and bidirectional ports indicated in Table 1. In order to take advantage of the large number of possible I/O configurations, sockets are provided for interchangeable I/O line drivers and terminators, allowing the selection of the appropriate combination of optional line drivers and terminators with the required drive/termination characteristics. The 24 programmable I/O lines and signal ground lines are brought out to a 50-pin edge connector.

Serial I/O

A programmable communications interface using the Intel 8251A Universal Synchronous/Asynchronous Receiver/Transmitter (USART) is contained on the iSBC 86/XX boards. A software selectable baud rate generator provides the USART with all common communication frequencies. The mode of operation (i.e., synchronous or asynchronous), data format, control character format, parity, and baud rate are all under program control. The 8251A provides full duplex, double buffered transmit and receive capability. Parity, overrun, and framing error detection are all incorporated in the USART. The RS232C command lines, serial data lines and signal ground line are brought out to a 26-pin edge connector.

Programmable Timers

The iSBC 86/XX boards provide three independent, fully programmable 16-bit interval timers/event counters utilizing the Intel 8253 Programmable In-

Table 1. Input/Output Port Modes of Operation

Port	Lines (Qty)	Mode of Operation					
		Unidirectional				Bidirectional	Control
		Input		Output			
		Latched	Latched & Strobed	Latched	Latched & Strobed		
1	8	X	X	X	X	X	
2	8	X	X	X	X		
3	4	X		X			X(1)
	4	X		X			X(1)

NOTE:
1. Part of port 3 must be used as a control port when either port 1 or port 2 are used as a latched and strobed input or a latched and strobed output port or port 1 is used as a bidirectional port.

terval Timer. Each counter is capable of operating in either BCD or binary modes. Two of these timers/counters are available to the systems designer to generate accurate time intervals under software control. Routing for the outputs and gate/trigger inputs of two of these counters is jumper selectable. The outputs may be independently routed to the 8259A Programmable Interrupt Controller and to the I/O terminators associated with the 8255A to allow external devices or an 8255A port to gate the timer or to count external events. The third interval timer in the 8253 provides the programmable baud rate generator for the iSBC 86/XX boards' RS232C USART serial port. The system software configures each timer independently to select the desired function. Seven functions are available as shown in Table 2. The contents of each counter may be read at any time during system operation.

Table 2. Programmable Timer Functions

Function	Operation
Interrupt on Terminal Count	When terminal count is reached, an interrupt request is generated. This function is extremely useful for generation or real-time clocks.
Programmable One-Shot	Output goes low upon receipt of an internal trigger edge or software command and returns high when terminal count is reached. This function is retriggerable.
Rate Generator	Divide by N counter. The output will go low for one input clock cycle, and the period from one low going pulse to the next is N times the input clock period.
Square-Wave Rate Generator	Output will remain high until one-half the count has been completed, and go low for the other half of the count.
Software Triggered Strobe	Output remains high until software loads count (N). N counts after count is loaded, output goes low for one input clock period.
Hardware Triggered Strobe	Output goes low for one clock period N counts after rising edge counter trigger input. The counter is retriggerable.
Event Counter	On a jumper selectable basis, the clock input becomes an input from the external system. CPU may read the number of events occurring after the counter "window" has been enabled or an interrupt may be generated after N events occur in the system.

iSBX™ MULTIMODULE™ On-Board Expansion

Two 8/16-bit iSBX MULTIMODULE connectors are provided on the iSBC 86/XX microcomputers. Through these connectors, additional on-board I/O functions may be added. iSBX MULTIMODULE boards optimally support functions provided by VLSI peripheral components such as additional parallel and serial I/O, analog I/O, small mass storage device controllers (e.g., cassettes and floppy disks), and other custom interfaces to meet specific needs. By mounting directly on the single board computer, less interface logic, less power, simpler packaging, higher performance, and lower cost result when compared to other alternatives such as MULTIBUS form factor compatible boards. The iSBX connectors on the iSBC 86/XX boards provide all signals necessary to interface to the local on-board bus, including 16 data lines for maximum data transfer rates. iSBX MULTIMODULE boards designed with 8-bit data paths and using the 8-bit iSBX connector are also supported on the iSBC 86/XX microcomputers. A broad range of iSBX MULTIMODULE options are available in this family from Intel. Custom iSBX modules may also be designed for use on the iSBC 86/XX boards. An iSBX bus interface specification and iSBX connectors are available from Intel.

MULTIBUS® SYSTEM BUS AND MULTIMASTER CAPABILITIES

Overview

The MULTIBUS system bus is Intel's industry standard microcomputer bus structure. Both 8 and 16-bit single board computers are supported on the MULTIBUS structure with 24 address and 16 data lines. In its simplest application, the MULTIBUS system bus allows expansion of functions already contained on a single board computer (e.g., memory and digital I/O). However, the MULTIBUS structure also allows very powerful distributed processing configurations with multiple processors and intelligent slave I/O, and peripheral boards capable of solving the most demanding microcomputer applications. The MULTIBUS system bus is supported with a broad array of board level products, LSI interface components, detailed published specifications and application notes.

Expansion Capabilities

Memory and I/O capacity may be expanded and additional functions added using Intel MULTIBUS compatible expansion boards. Memory may be expanded by adding user specified combinations of RAM boards, EPROM boards, or combination boards. On-

board EPROM capacity may be expanded to 128K by user reprogramming of a PAL device to support 27256 EPROM devices. Input/output capacity may be added with digital I/O and analog I/O expansion boards. Mass storage capability may be achieved by adding single or double density diskette controllers, or hard disk controllers. Modular expandable backplanes and cardcages are available to support multiboard systems.

Multimaster Capabilities

For those applications requiring additional processing capacity and the benefits of multiprocessing (i.e., several CPUs and/or controllers logically sharing system tasks through communication of the system bus), the iSBC 86/XX boards provide full MULTIBUS arbitration control logic. This control logic allows up to three iSBC 86/XX boards or other bus masters, including iSBC 80 family MULTIBUS compatible 8-bit single board computers to share the system bus using a serial (daisy chain) priority scheme and allows up to 16 masters to share the MULTIBUS system bus with an external parallel priority decoder. In addition to the multiprocessing configurations made possible with multimaster capability, it also provides a very efficient mechanism for all forms of DMA (Direct Memory Access) transfers.

Interrupt Capability

The iSBC 86/XX boards provide 9 vectored interrupt levels. The highest level is the NMI (Non-Maskable Interrupt) line which is directly tied to the 8086 CPU. This interrupt is typically used for signaling catastrophic events (e.g., power failure). The Intel 8259A Programmable Interrupt Controller (PIC) provides control and vectoring for the next eight interrupt levels. As shown in Table 3, a selection of four priority processing modes is available for use in designing

Table 3. Programmable Interrupt Modes

Mode	Operation
Fully Nested	Interrupt request line priorities fixed at 0 as highest, 7 as lowest.
Auto-Rotating	Equal priority. Each level, after receiving service, becomes the lowest priority level until next interrupt occurs.
Specific Priority	System software assigns lowest priority level. Priority of all other levels based in sequence numerically on this assignment.
Polled	System software examines priority-encoded system interrupt status via interrupt status register.

request processing configurations to match system requirements for efficient interrupt servicing with minimal latencies. Operating mode and priority assignments may be reconfigured dynamically via software at any time during system operation. The PIC accepts interrupt requests from all on-board I/O resources and from the MULTIBUS system bus. The PIC then resolves requests according to the selected mode and, if appropriate, issues an interrupt to the CPU. Any combination of interrupt levels may be masked via software, by storing a single byte in the interrupt mask register of the PIC. In systems requiring additional interrupt levels, slave 8259A PICs may be interfaced via the MULTIBUS system bus, to generate additional vector addresses, yielding a total of 65 unique interrupt levels.

Interrupt Request Generation

Interrupt requests to be serviced by the iSBC 86/XX boards may originate from 28 sources. Table 4 includes a list of devices and functions supported by interrupts. All interrupt signals are brought to the interrupt jumper matrix where any combination of interrupt sources may be strapped to the desired interrupt request level on the 8259A PIC or the NMI input to the CPU directly.

Power-Fail Control and Auxiliary Power

Control logic is also included to accept a power-fail interrupt in conjunction with the AC-low signal from the iSBC 635 and iSBC 640 Power Supply or equivalent, to initiate an orderly shut down of the system in the event of a power failure. Additionally, an active-low TTL compatible memory protect signal is brought out on the auxiliary connector which, when asserted, disables read/write access to RAM memory on the board. This input is provided for the protection of RAM contents during system power-down sequences. An auxiliary power bus is also provided to allow separate power to RAM for systems requiring battery back-up of read/write memory. Selection of this auxiliary RAM power bus is made via jumpers on the board.

System Development Capabilities

The development cycle of iSBC 86/XX products can be significantly reduced and simplified by using either the System 86/310 or the Intellec Series IV Microcomputer Development System or the IBM PC.

IN-CIRCUIT EMULATOR

The I²ICE In-Circuit Emulator provides the necessary link between the software development environment and the "target" iSBC 86/XX execution system. In addition to providing the mechanism for loading executable code and data into the iSBC 86/XX boards, the I²ICE In-Circuit Emulator provides a sophisticated command set to assist in debugging software and final integration of the user hardware and software.

PL/M-86

Intel's system's implementation language, PL/M-86, is standard in the System 86/310 and is also available for the Series IV and the IBM PC. PL/M-86 provides the capability to program in algorithmic language and eliminates the need to manage register usage or allocate memory while still allowing explicit control of the system's resources when needed. FORTRAN 86, PASCAL 86 and C86 are also available the Intellec Series IV, 86/310 systems and the IBM PC.

SPECIFICATIONS

Word Size

Instruction: 8, 16, 24, or 32 bits

Data: 8, 16 bits

System Clock

5.00 MHz or 8.00 MHz ±0.1% (jumper selectable)

Cycle Time

BASIC INSTRUCTION CYCLE

8 MHz: 750 ns
250 ns (assumes instruction in the queue)

5 MHz: 1.2 μs
400 ns (assumes instruction in the queue)

NOTE:
Basic instruction cycle is defined as the fastest instruction time (i.e., two clock cycles).

Table 4. Interrupt Request Sources

Device	Function	Number of Interrupts
MULTIBUS Interface	Requests from MULTIBUS resident peripherals or other CPU boards.	8; may be Expanded to 64 with Slave 8259A PICs on MULTIBUS Boards
8255A Programmable Peripheral Interface	Signals input buffer full or output buffer empty; also BUS INTR OUT general purpose interrupt from driver/terminator sockets.	3
8251A USART	Transmit buffer empty and receive buffer full.	2
8253 Timers	Timer 0, 1 outputs; function determined by timer mode.	2
iSBX Connectors	Function determined by iSBX MULTIMODULE board.	4 (2 per iSBX Connector)
Bus Fail Safe Timer	Indicates addressed MULTIBUS resident device has not responded to command within 6 ms.	1
Power Fail Interrupt	Indicates AC power is not within tolerance.	1
Power Line Clock	Source of 120 Hz signal from power supply.	1
External Interrupt	General purpose interrupt from auxiliary (P2) connector on backplane.	1
iSBC 337A MULTIMODULE Numeric Data Processor	Indicates error or exception condition.	1
Parity Error	Indicates on-board RAM parity error from iSBC 303 parity MULTIMODULE board (iSBC 86/14 option).	1
Edge-Level Conversion	Converts edge triggered interrupt request to level interrupt.	1
OR-Gate Matrix	Outputs of OR-gates on-board for multiple interrupts.	2

Memory Cycle Time

RAM: 750 ns

EPROM: Jumper selectable from 500 ns to 875 ns

Memory Capacity/Addressing

ON-BOARD EPROM

Device	Total Capacity	Address Range
2716	8K bytes	FE000–FFFFF$_H$
2732A	16K bytes	FC000–FFFFF$_H$
2764	32K bytes	F8000–FFFFF$_H$
27128	64K bytes	F0000–FFFFF$_H$

NOTE:
iSBC 86/XX EPROM sockets support JEDEC 24/28-pin standard EPROMs and RAMs. Total EPROM capacity may be increased to 128 bytes by the user reprogramming an on-board PAL.

ON-BOARD RAM

Board	Total Capacity	Address Range
iSBC 86/14	32K bytes	0–07FFF$_H$
iSBC 86/30	128K bytes	0–1FFFF$_H$

WITH MULTIMODULE™ RAM

Board	Total Capacity	Address Range
iSBC 300A (with iSBC 86/14)	64K bytes	0–0FFFF$_H$
iSBC 304 (with iSBC 86/30)	256K bytes	0–3FFFF$_H$

I/O Capacity

Parallel: 24 programmable lines using one 8255A

Serial: 1 programmable line using one 8251A

iSBX MULTIMODULE: 2 iSBX boards

Serial Communications Characteristics

Synchronous: 5–8 bits characters; internal or external character synchronization; automatic sync insertion

Asynchronous: 5–8 bit characters; break character generation; 1, 1½, or 2 stop bits; false start bit direction

BAUD RATES

Frequency (kHz) (Software Selectable	Baud Rate (Hz)		
	Synchronous	Asynchronous	
		÷16	÷64
153.6	—	9600	2400
76.8	—	4800	1200
38.4	38400	2400	600
19.2	19200	1200	300
9.6	9600	600	150
4.8	4800	300	75
2.4	2400	150	—
1.76	1760	110	—

NOTE:
Frequency selected by I/O write of appropriate 16-bit frequency factor to baud rate register (8253 Timer 2).

Timers

INPUT FREQUENCIES

Reference: 2.46 MHz ±0.1% (0.041 μsec period, nominal); or 153.60 kHz ±0.1% (6.51 μsec period, nominal)

NOTE:
Above frequencies are user selectable.

Event Rate: 2.46 MHz max

OUTPUT FREQUENCIES/TIMING INTERVALS

Function	Single Timer/Counter		Dual Timer/counter (Cascaded)	
	Min	Max	Min	Max
Real-Time Interrupt	1.63μs	427.1 ms	3.26s	466.50 min
Programmable One-Shot	1.63 μs	427.1 ms	3.26s	466.50 min
Rate Generator	2.342 Hz	613.5 kHz	0.000036 Hz	306.8 kHz
Square-Wave Rate Generator	2.342 Hz	613.5 kHz	0.000036 Hz	306.8 kHz
Software Triggered Strobe	1.63μs	427.1 ms	3.26s	466.50 min
Hardware Triggered Strobe	1.63 μs	427.1 ms	3.26s	466.50 min
Event Counter	—	2.46 MHz	—	—

Interfaces

MULTIBUS: All signals TTL compatible

iSBX Bus: All signals TTL compatible

Parallel I/O: All signals TTL compatible

Serial I/O: RS232C compatible, configurable as a data set or data terminal

Timer: All signals TTL compatible

Interrupt Requests: All TTL compatible

Connectors

Interface	Double-Sided Pins	Centers (in.)	Mating Connectors
MUILTIBUS System	86	0.156	Viking 3KH43/9AMK12 Wire Wrap
iSBX Bus 8-Bit Data	36	0.1	iSBX 960-5
Parallel I/O (2)	50	0.1	3M 3415-000 Flat or TI H312125 Pins
Serial I/O	26	0.1	3M 3462-0001 Flat or AMP 88106-1 Flat

Line Drivers and Terminators

I/O DRIVERS

The following line drivers are all compatible with the I/O driver sockets on the iSBC 86/05 board.

Driver	Characteristics	Sink Current (mA)
7438	I,OC	48
7437	I	48
7432	NI	16
7426	I,OC	16
7409	NI,OC	16
7408	NI	16
7403	I,OC	16
7400	I	16

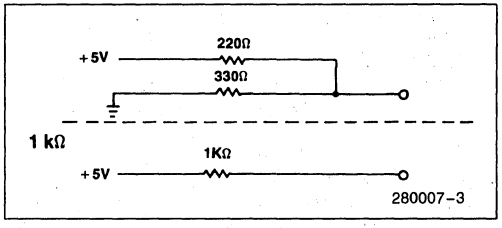
NOTE:
I = inverting; NI = non-inverting; OC = open collector.

Port 1 of the 8255A has 20 mA totem-pole bidirectional drivers and 1 KΩ terminators

I/O TERMINATORS

220Ω/330Ω divider or 1 kΩ pullup

220Ω/330Ω



MULTIBUS® Drivers

Function	Characteristic	Sink Current (mA)
Data	Tri-State	32
Address	Tri-State	32
Commands	Tri-State	32
Bus Control	Open Collector	20

Physical Characteristics

Width: 12.00 in. (30.48 cm)
Height: 6.75 in. (17.15 cm)
Depth: 0.70 in. (1.78 cm)
Weight: 14 oz (388 gm)

Environmental Characteristics

Operating Temperature: 0°C to 55°C
Relative Humidity: to 90% (without condensation)

Electrical Characteristics

DC POWER REQUIREMENTS

Configuration	Current Requirements (All Voltages ±5%)		
	+5V	+12V	−12V
Without EPROM[1]	5.1A	25 mA	23 mA
RAM only[2]	600 mA	—	—
With 8K EPROM[3] (using 2716)	5.4A	25 mA	23 mA
With 16K EPROM[3] (using 2732A)	5.5A	25 mA	23 mA
With 32K EPROM[3] (using 2764)	5.6A	25 mA	23 mA

NOTES:
1. Does not include power for optional ROM/EPROM, I/O drivers, and I/O terminators.
2. RAM chips powered via auxiliary power bus in power-down mode.
3. Includes power required for 4 ROM/EPROM chips, and I/O terminators installed for 16 I/O lines; all terminator inputs low.

Environmental Characteristics

Operating Temperature: 0°C to 55°C
Relative Humidity: to 90% (without condensation)

Reference Manual

144044-002: iSBC 86/14 and iSBC 86/30 Hardware Reference Manual (NOT SUPPLIED)

Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

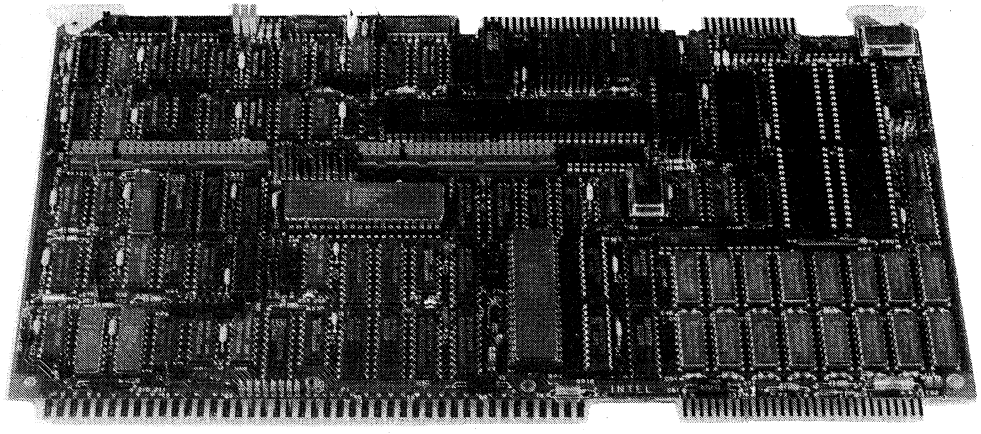
ORDERING INFORMATION

Part Number	Description
SBC 86/14	Single Board Computer
SBC 86/30	Single Board Computer

iSBC® 86/35
SINGLE BOARD COMPUTER

- 8086 (8086-2) Microprocessor with 5 or 8 MHz CPU Clock
- Optional 8086 Numeric Data Processor with iSBC® 337A MULTIMODULE™ Processor
- Upward Compatible with iSBC 86/30 Single Board Computer
- 512K Bytes of Dual-Port Read/Write Memory Expandable On-Board to 640K or 1M Bytes
- Sockets for up to 128K Bytes of JEDEC 24/28-Pin Standard Memory Devices
- Two iSBX™ Bus Connectors
- 24 Programmable Parallel I/O Lines
- Programmable Synchronous/ Asynchronous RS232C Compatible Serial Interface with Software Selectable Baud Rates
- Three Programmable 16-Bit BCD or Binary Timers/Event Counters
- 9 Levels of Vectored Interrupt Control, Expandable Off Board to 65 Levels
- MULTIBUS® Interface for Multimaster Configurations and System Expansion
- Supported by a Complete Family of Single Board Computers, Memory, Digital and Analog I/O, Peripheral Controllers, Packaging and Software

The iSBC 86/35 Single Board Computer is a member of Intel's complete line of OEM microcomputer systems that take full advantage of Intel's technology to provide economical, self-contained, computer-based solutions for OEM applications. The board is a complete computer system containing the CPU, system clock, dual port read/write memory, nonvolatile read only memory, I/O ports and drivers, serial communications interface, priority interrupt logic and programmable timers, all on a single 6.75 x 12.00 in. printed circuit card. The iSBC 86/35 board is distinguished by its large RAM content of 512K bytes which is expandable on-board to 1 megabyte; the direct addressing capability of the 8086-2 CPU. The large, on-board memory resource combined with the 8086 microprocessor provides high-level system performance ideal for applications, such as robotics, process control, medical instrumentation, office systems, and business data processing.



210219-1

September 1987
Order Number: 210219-004

FUNCTIONAL DESCRIPTION

Overview

The iSBC 86/35 board combines the power of the industry standard 8086 CPU with up to a megabyte page of board resident, dual ported system memory to improve the system's overall performance. By placing the direct memory addressing capability of the iAPX 86/10 CPU on board, MULTIBUS® access to system memory can be eliminated, significantly improving system throughput. Intel's incorporation of 256K bit DRAM technology, parallel and serial I/O, iSBX™ connectors, and interrupt control capabilities make this high performance single board computer system a reality.

Central Processing Unit

The central processor for the iSBC 86/35 board is Intel's iAPX 86/10 (8086-2) CPU. A clock rate of 8 MHz is supported with a jumper selectable option for 5 MHz. The CPU architecture includes four 16-bit byte addressable data registers, two 16-bit index registers, all accessed by a total of 24 operand addressing modes for comprehensive memory addressing and for support of the data structures required for today's structured, high level languages as well as assembly language.

Instruction Set

The 8086 instruction repertoire includes variable length instruction format (including double operand instructions), 8-bit and 16-bit signed and unsigned arithmetic operators for binary, BCD and unpacked ASCII data, and iterative word and byte string manipulation functions.

For enhanced 5 or 8 MHz numerics processing capability, the iSBC 337A MULTIMODULE Numeric Data Processor extends the iAPX 86/10 architecture and data set. Over 60 numeric instructions offer arithmetic, trigonometric, transcendental, logarithmic and exponential instructions. Supported data types include 16-, 32-, and 64-bit integer, and 32- and 64-bit floating point, 18-digit packed BCD and 80-bit temporary.

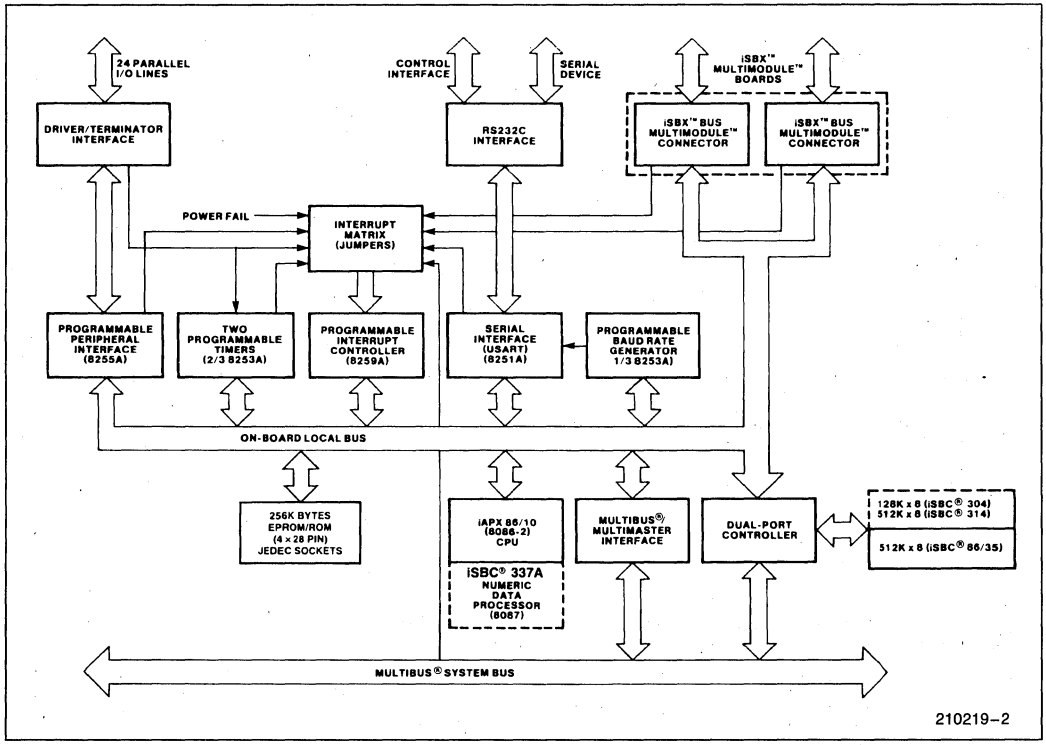


Figure 1. iSBC® 86/35 Block Diagram

Architectural Features

A 6-byte instruction queue provides pre-fetching of sequential instructions and can reduce the 750 ns minimum instruction cycle to 250 ns for queued instructions. The stack-oriented architecture readily supports modular programming by facilitating fast, simple, inter-modular communication, and other programming constructs needed for asynchronous real-time systems. The memory expansion capabilities offer a 1 megabyte addressing range. The dynamic relocation scheme allows ease in segmentation of pure procedure and data for efficient memory utilization. Four segment registers (code, stack, data, extra) contain program loaded offset values which are used to map 16-bit addresses to 20-bit addresses. Each register maps 64K bytes at a time and activation of a specific register is controlled explicitly by program control and is also selected implicitly by specific functions and instructions.

RAM Capabilities

The iSBC 86/35 microcomputer contains 512K bytes of dual-port dynamic RAM which may be expanded on-board by adding a RAM Multimodule board as an option. The on-board RAM may be expanded to 640K bytes with the iSBC 304 MULTIMODULE board mounted onto the iSBC 85/35 board. Likewise, the iSBC 86/35 microcomputer may be expanded to 1 Megabyte with the iSBC 314 MULTIMODULE board option.

The dual-port controller allows access to the on-board RAM (including RAM MULTIMODULE board options) from the iSBC 86/35 board and from any other MULTIBUS master via the system bus. Segments of on-board RAM may be configured as a private resource, protected from MULTIBUS system access.

EPROM Capabilities

Four 28-pin JEDEC sockets are provided for the use of Intel 2764, 27128, 27256, 27512, EPROMs and their respective ROMs. When using 27512, the on-board EPROM capacity is 256K bytes. Other JEDEC standard pinout devices are also supported, including byte-wide static RAMs.

Parallel I/O Interface

The iSBC 86/35 Single Board Computer contains 24 programmable parallel I/O lines implemented using the Intel 8255A Programmable Peripheral Interface. The system software is used to configure the I/O lines in any combination of unidirectional input/output and bidirectional ports indicated in Table 1. In order to take advantage of the large number of possible I/O configurations, sockets are provided for interchangeable I/O line drivers and terminators, allowing the selection of the appropriate combination of optional line drivers and terminators with the required drive/termination characteristics. The 24 programmable I/O lines and signal ground lines are brought out to a 50-pin edge connector.

Table 1. Input/Output Port Modes of Operation

Port	Lines (qty)	Mode of Operation					Control
		Unidirectional				Bidirectional	
		Input		Output			
		Latched	Latched & Strobed	Latched	Latched & Strobed		
1	8	X	X	X	X	X	
2	8	X	X	X	X		
3	4	X		X			X[1]
	4	X		X			X[1]

NOTE:
1. Part of port 3 must be used as a control port when either port 1 or port 2 are used as a latched and strobed input or a latched and strobed output port or port 1 is used as a bidirectional port.

Serial I/O

A programmable communications interface using the Intel 8251A Universal Synchronous/Asynchronous Receiver/Transmitter (USART) is contained on the iSBC 86/35 board. A software selectable baud rate generator provides the USART with all common communication frequencies. The mode of operation (i.e., synchronous or asynchronous), data format, control character format, parity, and baud rate are all under program control. The 8251A provides full duplex, double buffered transmit and receive capability. Parity, overrun, and framing error detection are all incorporated in the USART. The RS232C command lines, serial data lines and signal ground line are brought out to a 26-pin edge connector.

Programmable Timers

The iSBC 86/35 board provides three independent, fully programmable 16-bit interval timers/event counters utilizing the Intel 8253 Programmable Interval Timer. Each counter is capable of operating in either BCD or binary modes. Two of these timers/counters are available to the systems designer to generate accurate timer intervals under software control. Routing for the outputs and gate/trigger inputs of two of these counters is jumper selectable. The outputs may be independently routed to the 8259A Programmable Interrupt Controller and to the I/O terminators associated with the 8255A to allow external devices or an 8255A port to gate the timer or to count external events. The third interval timer in the 8253 provides the programmable baud rate generator for the iSBC 86/35 board's RS232C USART serial port. The system software configures each timer independently to select the desired function. Seven functions are available as shown in Table 2. The contents of each counter may be read at any time during system operation.

Table 2. Programmable Timer Functions

Function	Operation
Interrupt on terminal count	When terminal count is reached, an interrupt request is generated. This function is extremely useful for generation of real-time clocks.
Programmable one-shot	Output goes low upon receipt of an external trigger edge or software command and returns high when terminal count is reached. This function is retriggerable.
Rate generator	Divide by N counter. The output will go low for one input clock cycle, and the period from one low going pulse to the next is N times the input clock period.
Square-wave rate generator	Output will remain high until one-half the count has been completed, and go low for the other half of the count.
Software triggered strobe	Output remains high until software loads count (N). N counts after count is loaded, output goes low for one input clock period.
Hardware triggered strobe	Output goes low for one clock period N counts after rising edge counter trigger input. The counter is retriggerable.
Event counter	On a jumper selectable basis, the clock input becomes an input from the external system. CPU may read the number of events occurring after the counter "window" has been enabled or an interrupt may be generated after N events occur in the system.

iSBX™ MULTIMODULE™ On-Board Expansion

Two 8/16-bit iSBX MULTIMODULE connectors are provided on the iSBC 86/35 microcomputer. Through these connectors, additional on-board I/O functions may be added. iSBX MULTIMODULE boards optimally support functions provided by VLSI peripheral components such as additional parallel and serial I/O, analog I/O, small mass storage device controllers (e.g., cassettes and floppy disks),

and other custom interfaces to meet specific needs. By mounting directly on the single board computer, less interface logic, less power, simpler packaging, higher performance, and lower cost result when compared to other alternatives such as MULTIBUS form factor compatible boards. The iSBX connectors on the iSBC 86/35 board provides all signals necessary to interface to the local on-board bus, including 16 data lines for maximum data transfer rates. iSBX MULTIMODULE boards designed with 8-bit data paths and using the 8-bit iSBX connector are also supported on the iSBC 86/35 microcomputer. A broad range of iSBX MULTIMODULE options are available in this family from Intel. Custom iSBX modules may also be designed for use on the iSBC 86/35 board. An iSBX bus interface specification and iSBX connectors are available from Intel.

MULTIBUS® SYSTEM BUS CAPABILITIES

Overview

The MULTIBUS system bus is Intel's industry standard (IEEE 796) microcomputer bus structure. Both 8- and 16-bit single board computers are supported on the MULTIBUS structure with 24 address and 16 data lines. In its simplest application, the MULTIBUS system bus allows expansion of functions already contained on a single board computer (e.g., memory and digital I/O). However, the MULTIBUS structure also allows very powerful distributed processing configurations with multiple processors and intelligent slave I/O, and peripheral boards capable of solving the most demanding microcomputer applications. The MULTIBUS system bus is supported with a broad array of board level products, LSI interface components, detailed published specifications and application notes. Please refer to the MULTIBUS Handbook (order number 210883) for more detailed information.

Multimaster Capabilities

For those applications requiring additional processing capacity and the benefits of multiprocessing (i.e. several CPUs and/or controllers logically sharing system tasks through communication on the system bus), the iSBC 86/35 board provides full MULTIBUS arbitration control logic. This control logic allows both serial (daisy chain) and parallel priority schemes. The serial scheme allows up to three iSBC 86/35 boards/bus masters to share the MULTIBUS system bus; while up to 16 masters may be connected using the parallel scheme and external decode logic.

Interrupt Capability

The iSBC 86/35 board provides 9 vectored interrupt levels. The highest level is the NMI (Non-Maskable Interrupt) line which is directly tied to the 8086-2 CPU. This interrupt is typically used for signaling catastrophic events (e.g., power failure). The Intel 8259A Programmable Interrupt Controller (PIC) provides control and vectoring for the next eight interrupt levels. As shown in Table 3, a selection of four priority processing modes is available for use in designing request processing configurations to match system requirements for efficient interrupt servicing with minimal latencies. Operating mode and priority assignments may be reconfigured dynamically via software at any time during system operation. The PIC accepts interrupt requests from all on-board I/O resources and from the MULTIBUS system bus. The PIC then resolves requests according to the selected mode and, if appropriate, issues an interrupt to the CPU. Any combination of interrupt levels may be masked via software, by storing a single byte in the interrupt mask register of the PIC. In systems requiring additional interrupt levels, slave 8259A PICs may be interfaced via the MULTIBUS system bus, to generate additional vector addresses, yielding a total of 65 unique interrupt levels.

Table 3. Programmable Interrupt Masks

Mode	Operation
Fully nested	Interrupt request line priorities fixed at 0 as highest, 7 as lowest.
Auto-rotating	Equal priority. Each level, after receiving service, becomes the lowest priority level until next interrupt occurs.
Specific priority	System software assigns lowest priority level. Priority of all other levels based in sequence numerically on this assignment.
Polled	System software examines priority-encoded system interrupt status via interrupt status register.

Interrupt Request Generation

Interrupt requests to be serviced by the iSBC 86/35 board may originate from 28 sources. Table 4 includes a list of devices and functions supported by interrupts. All interrupt signals are brought to the interrupt jumper matrix where any combination of interrupt sources may be strapped to the desired interrupt request level on the 8259A PIC or the NMI input to the CPU directly.

Power-Fail Control and Auxiliary Power

Control logic is included to accept a power-fail interrupt in conjunction with the AC-low signal from the Power Supply to initiate an orderly shut down of the system in the event of a power failure. Additionally, an active-low TTL compatible memory protect signal is brought out on the auxiliary connector which, when asserted, disables read/write access to RAM memory on the board. This input is provided for the protection of RAM contents during system power-

Table 4. Interrupt Request Sources

Device	Function	Number of Interrupts
MULTIBUS® interface	Requests from MULTIBUS® resident peripherals or other CPU boards	8; may be expanded to 64 with slave 8259A PICs on MULTIBUS® boards
8255A Programmable Peripheral Interface	Signals input buffer full or output buffer empty; also BUS INTR OUT general purpose interrupt from driver/terminator sockets	3
8251A USART	Transmit buffer empty and receive buffer full	2
8253 Timers	Timer 0, 1 outputs; function determined by timer mode	2
iSBX™ connectors	Function determined by iSBX™ MULTIMODULE™ board	4 (2 per iSBX™ connector)
Bus fail safe timer	Indicates addressed MULTIBUS® resident device has not responded to command within 6 ms	1
Power fail interrupt	Indicates AC power is not within tolerance	1
Power line clock	Source of 120 Hz signal from power supply	1
External interrupt	General purpose interrupt from auxiliary (P2) connector on backplane	1
iSBC 337A MULTIMODULE Numeric Data Processor	Indicates error or exception condition	1
Edge-level conversion	Converts edge triggered interrupt request to level interrupt	1
OR-gate matrix	Outputs of OR-gates on-board for multiple interrupts	2

down sequences. An auxiliary power bus is also provided to allow separate power to RAM for systems requiring battery backup of read/write memory. Selection of this auxiliary RAM power bus is made via jumpers on the board.

System Development Capabilities

The development cycle of iSBC 86/35 products can be significantly reduced and simplified by using either the System 86/330 or the Intellec® Series IV Microcomputer Development System.

IN-CIRCUIT EMULATOR

The I^2ICE In-Circuit Emulator provides the necessary link between the software development environment and the "target" iSBC 86/35 execution system. In addition to providing the mechanism for loading executable code and data into the iSBC 86/35 board, the I^2ICE In-Circuit Emulator provides a sophisticated command set to assist in debugging software and final integration of the user hardware and software.

Software Support

Real time support for the iSBC 86/35 board is provided by the iRMX 86 operating system. The iRMX 86 Operating System is a highly functional operating system with a rich set of features and options based on an object-oriented architecture. In addition to being modular and configurable, functions beyond the nucleus include a sophisticated file management and I/O system, and powerful human interface. Both packages are easily customized and extended by the user to match unique requirements.

Interactive multi-user support is provided by the Xenix* operating system. Xenix is a compatible derivative of UNIX**, System III.

Language support for the iSBC 86/35 board includes Intel's ASM 86, PL/M 86, and PASCAL, and FORTRAN, as well as many third party 8086 languages. The iSDM monitor provides on-target, interactive system debug capability including breakpoint and memory examination features. The monitor supports iSBC/iAPX 86, 88, 186, and 188 based applications.

*Xenix is a trademark of Microsoft Corp.
**UNIX is a trademark of Bell Labs.

SPECIFICATIONS

Word Size

INSTRUCTION — 8, 16, 24, or 32 bits

DATA — 8, 16 bits

System Clock

5 MHz or 8 MHz ±0.1% (jumper selectable)

Cycle Time

BASIC INSTRUCTION CYCLE

8 MHz — 250 ns (assumes instruction in the queue)

5 MHz — 400 ns (assumes instruction in the queue)

NOTE:
Basic instruction cycle is defined as the fastest instruction time (i.e., two clock cycles). Jumper selectable for 1 wait-state on-board memory access.

Memory Capacity/Addressing

ON-BOARD EPROM

Device	Total Capacity	Address Range
2764	32K bytes	F8000–FFFFF$_H$
27128	64K bytes	F0000–FFFFF$_H$
27256	128K bytes	E0000–FFFFF$_H$
27512	256K bytes	D0000–FFFFF$_H$

ON-BOARD RAM

Board	Total Capacity	Address Range
iSBC 86/35	512K bytes	0–7FFFF$_H$

WITH MULTIMODULE™ RAM

Board	Total Capacity	Address Range
iSBC 304	640K bytes	8–9 FFFF$_H$
iSBC 314	1M bytes	8–FFFFF$_H$

I/O Capacity

PARALLEL—24 programmable lines using one 8255A.

SERIAL—1 programmable line using one 8251A.

iSBX™ MULTIMODULE™—2 iSBX boards

Serial Communications Characteristics

SYNCHRONOUS—5–8 bit characters; internal or external character synchronization; automatic sync insertion

ASYNCHRONOUS—5–8 bit characters; break character generation; 1, 1½, or 2 stop bits; false start bit detection

BAUD RATES

Frequency (kHz) (Software Selectable)	Baud Rate (Hz)	
	Synchronous	Asynchronous
		÷16 ÷64
153.6	—	9600 2400
76.8	—	4800 1200
38.4	38400	2400 600
19.2	19200	1200 300
9.6	9600	600 150
4.8	4800	300 75
2.4	2400	150 —
1.76	1760	110 —

NOTE:
Frequency selected by I/O write of appropriate 16-bit frequency factor to baud rate register (8253 Timer 2).

Timers

INPUT FREQUENCIES

Reference: 2.46 MHz ±0.1% (0.041 μs period, nominal); or 153.60 kHz ±0.1% (6.51 μs period, nominal)

NOTE:
Above frequencies are user selectable.

Event Rate: 2.46 MHz max

OUTPUT FREQUENCIES/TIMING INTERVALS

Function	Single Timer/Counter		Dual Timer/Counter (Cascaded)	
	Min	Max	Min	Max
Real-time Interrupt	1.63 μs	427.1 ms	3.26s	466.50 min
Programmable one-shot	1.63 μs	427.1 ms	3.26s	466.50 min
Rate generator	2.342 Hz	613.5 kHz	0.000036 Hz	306.8 kHz
Square-wave rate generator	2.342 Hz	613.5 kHz	0.000036 Hz	306.8 kHz
Software triggered strobe	1.63 μs	427.1 ms	3.26s	466.50 min
Hardware triggered strobe	1.63 μs	427.1 ms	3.26s	466.50 min
Event counter	—	2.46 MHz	—	—

Interfaces

MULTIBUS®—All signals TTL compatible

iSBX™ BUS—All signals TTL compatible

PARALLEL I/O—All signals TTL compatible

SERIAL I/O—RS232C compatible, configurable as a data set or data terminal

TIMER—All signals TTL compatible

INTERRUPT REQUESTS—All TTL compatible

Connectors

Interface	Double-Sided Pins	(in.)	Connectors
MULTIBUS® System	86	0.156	Viking 3KH43/9AMK12 Wire Wrap
iSBX™ Bus 8-Bit Data 16-Bit Data	 36 44	 0.1 0.1	Viking 000292-0001 000293-0001
Parallel I/O (2)	50	0.1	3M 3415-000 Flat or TI H312125 Pins
Serial I/O	26	0.1	3M 3462-0001 Flat or AMP 88106-1 Flat

Line Drivers and Terminators

I/O DRIVERS—The following line drivers are all compatible with the I/O driver sockets on the iSBC 86/05 board

Driver	Characteristic	Sink Current (mA)
7438	I,OC	48
7437	I	48
7432	NI	16
7426	I,OC	16
7409	NI,OC	16
7408	NI	16
7403	I,OC	16
7400	I	16

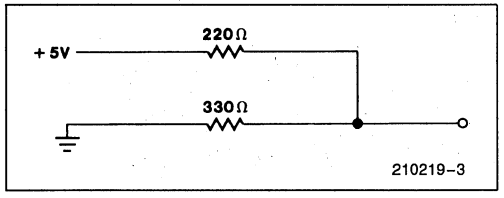
NOTE:
I = inverting; NI = non-inverting; OC = open collector.

Port 1 of the 8255A has 20 mA totem-pole bi-directional drives and 1 kΩ temrinators

I/O TERMINATORS—220Ω/330Ω divider or 1 kΩ pullup

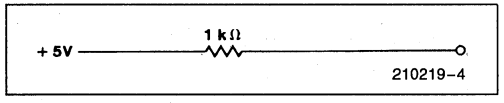
(OPTION 1)

220Ω/330Ω



(OPTION 2)

1 kΩ



MULTIBUS® Drivers

Function	Characteristic	Sink Current (mA)
Data	Tri-State	32
Address	Tri-State	32
Commands	Tri-State	32
Bus Control	Open Collector	20

Physical Characteristics

Width: 12.00 in. (30.48 cm)
Height: 6.75 in. (17.15 cm)
Depth: 0.70 in. (1.78 cm)
Weight: 14 oz. (388 gm)

Electrical Characteristics

DC POWER REQUIREMENTS

Configuration	Current Requirements (All Voltages ±5%)		
	+5V	+12V	−12V
Without EPROM(1)	5.1A	25 mA	23 mA
RAM only(2)	660 mA	—	—
With 32K EPROM(3) (using 2764)	5.6A	25 mA	23 mA
With 64K EPROM (using 27128)	5.7A	25 mA	23 mA
With 128K EPROM (using 27256)	5.8A	25 mA	23 mA

NOTES:
1. Does not include power for optional ROM/EPROM, I/O drivers, and I/O terminators.
2. RAM chips powered via auxiliary power bus in power-down mode.
3. Includes power required for 4 ROM/EPROM chips, and I/O terminators installed for 16 I/O lines; all terminator inputs low.

Environmental Characteristics

OPERATING TEMPERATURE — 0°C to 55°C @ 200 linear feet per minute (LFM) air velocity

RELATIVE HUMIDITY — to 90% (without condensation)

Reference Manual

146245-002 — iSBC 86/35 Hardware Reference Manual (NOT SUPPLIED)

Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

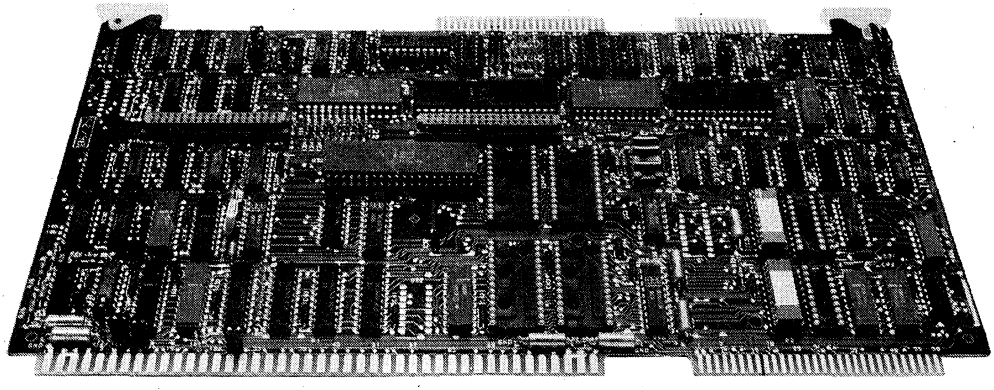
ORDERING INFORMATION

Part Number	Description
SBC 86/35	Single Board Computer

iSBC® 88/25
SINGLE BOARD COMPUTER

- 8-Bit 8088 Microprocessor Operating at 5 MHz
- One Megabyte Addressing Range
- Two iSBX™ Bus Connectors
- Optional Numeric Data Processor with iSBC® 337 MULTIMODULE™ Processor
- 4K Bytes of Static RAM; Expandable On-Board to 16K Bytes
- Sockets for up to 64K Bytes of JEDEC 24/28-Pin Standard Memory Devices; Expandable On-Board to 128K Bytes
- Programmable Synchronous/ Asynchronous RS232C Compatible Serial Interface with Software Selectable Baud Rates
- 24 Programmable Parallel I/O Lines
- Two Programmable 16-Bit BCD or Binary Timers/Event Counters
- 9 Levels of Vectored Interrupt Control, Expandable to 65 Levels
- MULTIBUS® Interface for Multimaster Configurations and System Expansion
- Development Support with Intel's iPDS, Low Cost Personal Development System, and EMV-88 Emulator

The iSBC 88/25 Single Board Computer is a member of Intel's complete line of OEM microcomputer systems which take full advantage of Intel's technology to provide economical, self-contained, computer-based solutions for OEM applications. The iSBC 88/25 board is complete computer system on a single 6.75 × 12.00-in. printed circuit card. The CPU, system clock, read/write memory, nonvolatile read only memory, I/O ports and drivers, serial communications interface, priority interrupt logic and programmable timers, all reside on the board. The large control storage capacity makes the iSBC 88/25 board ideally suited for control-oriented applications such as process control, instrumentation, industrial automation and many others.



143847-1

September 1987
Order Number: 143847-003

FUNCTIONAL DESCRIPTION

Central Processing Unit

The central processor for the iSBC 88/25 board is Intel's 8088 CPU operating at 5 MHz. The CPU architecture includes four 16-bit byte addressable data registers, two 16-bit memory base pointer registers and two 16-bit index registers, all accessed by a total of 24 operand addressing modes for comprehensive memory addressing and for support of the data structures required for today's structured, high level languages, as well as assembly language.

Instruction Set

The 8088 instruction repertoire includes variable length instruction format (including double operand instructions), 8-bit and 16-bit signed and unsigned arithmetic operators for binary, BCD and unpacked ASCII data, and iterative word and byte string manipulation functions.

For enhanced numerics processing capability, the iSBC 337 MULTIMODULE Numeric Data Processor extends the architecture and data set. Over 60 numeric instructions offer arithmetic, trigonometric, transcendental, logarithmic and exponential instructions. Supported data types include 16, 32, and 64-bit integer, and 32 and 64-bit floating point, 18-digit packed BCD and 80-bit temporary.

Architectural Features

A 4-byte instruction queue provides pre-fetching of sequential instructions and can reduce the 750 ns minimum instruction cycle to 250 ns for queued instructions. The stack-oriented architecture readily supports modular programming by facilitating fast, simple, inter-module communication, and other programming constructs needed for asynchronous real-time systems. The memory expansion capabilities

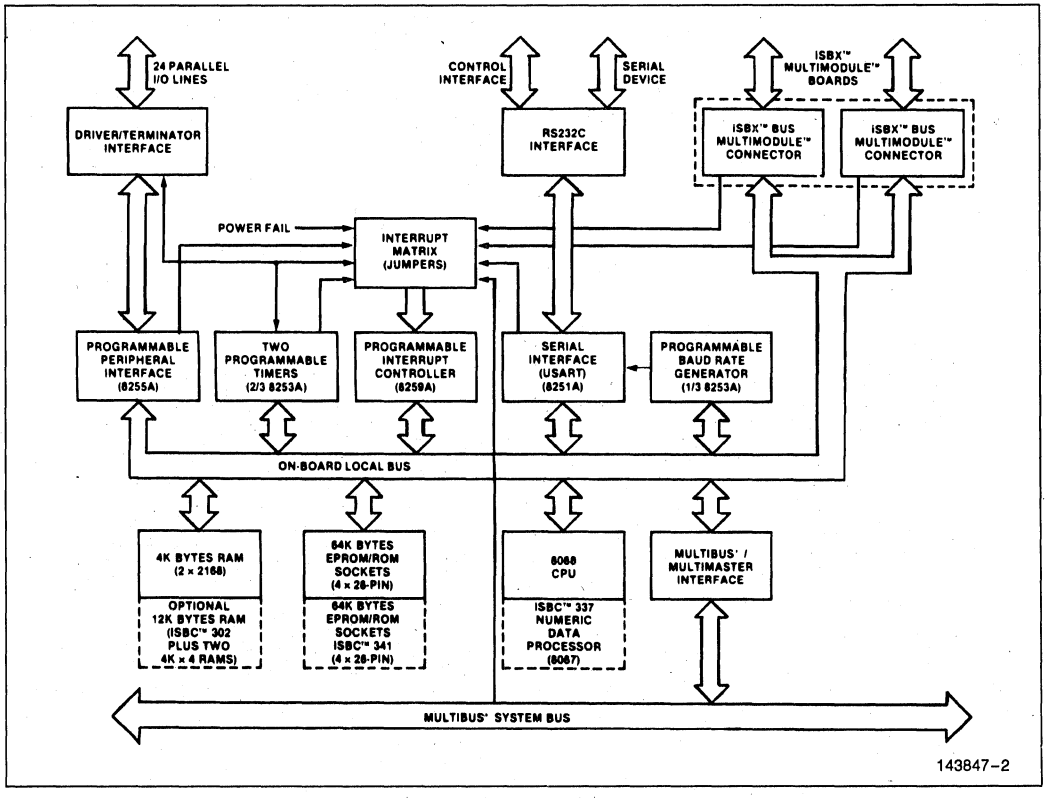


Figure 1. iSBC® 88/25 Block Diagram

offer a 1 megabyte addressing range. The dynamic relocation scheme allows ease in segmentation of pure procedure and data for efficient memory utilization. Four segment registers (code, stack, data, extra) contain program loaded offset values which are used to map 16-bit addresses to 20-bit addresses. Each register maps 64 Kbytes at a time and activation of a specific register is controlled explicitly by program control and is also selected implicitly by specific functions and instructions. All Intel languages support the extended memory capability, relieving the programmer of managing the megabyte memory space, yet allowing explicit control when necessary.

Memory Configuration

The iSBC 88/25 microcomputer contains 4 Kbytes of high-speed static RAM on-board. In addition, the on-board RAM may be expanded to 12 Kbytes via the iSBC 302 8 Kbyte RAM module which mounts on the iSBC 88/25 board and then to 16 Kbytes by adding two 4K × 4 RAM devices in sockets on the iSBC 302 module. All on-board RAM is accessed by the 8088 CPU with no wait states, yielding a memory cycle time of 800 ns.

In addition to the on-board RAM, the iSBC 88/25 board has four 28-pin sockets, configured to accept JEDEC 24/28-pin standard memory devices. Up to 64 Kbytes of EPROM are supported in 16 Kbyte increments with Intel 27128 EPROMs. The iSBC 88/25 board is also compatible with the 2716, 2732 and 2764 EPROMs allowing a capacity of 8K, 16K and 32 Kbytes, respectively. Other JEDEC standard pinout devices are also supported, including byte-wide static and integrated RAMs.

With the addition of the iSBC 341 MULTIMODULE EPROM option, the on-board capacity for these devices is doubled, providing up to 128 Kbytes of EPROM capacity on-board.

Parallel I/O Interface

The iSBC 88/25 Single Board Computer contains 24 programmable parallel I/O lines implemented using the Intel 8255A Programmable Peripheral interface. The system software is used to configure the I/O lines in any combination of unidirectional input/output and bidirectional ports indicated in Table 1. In order to take advantage of the large number of possible I/O configurations, sockets are provided for interchangeable I/O line drivers and terminators, allowing the selection of the appropriate combination of optional line drivers and terminators with the required drive/termination characteristics.

The 24 programmable I/O lines and signal ground lines are brought out to a 50-pin edge connector.

Serial I/O

A programmable communications interface using the Intel 8251A Universal Synchronous/Asynchronous Receiver/Transmitter (USART) is contained on the iSBC 88/25 board. A software selectable baud rate generator provides the USART with all common communication frequencies. The mode of operation (i.e., synchronous or asynchronous), data format, control character format, parity and baud rate are all under program control. The 8251A provides full duplex, double buffered transmit and receive capability. Parity, overrun and framing error detection are all incorporated in the USART. The RS232C compatible interface on each board, in conjunction with the USART, provides a direct interface to RS232C compatible terminals, cassettes and asynchronous and synchronous modems. The RS232C command lines, serial data lines and signal ground line are brought out to a 26-pin edge connector.

Table1. Input/Output Port Modes of Operation

Port	Lines (qty)	Mode of Operation					Control
		Unidirectional				Bidirectional	
		Input		Output			
		Latched	Latched & Strobed	Latched	Latched & Strobed		
1	8	X	X	X	X	X	
2	8	X	X	X	X		
3	4	X		X			X(1)
	4	X		X			X(1)

NOTE:
1. Part of port 3 must be used as a control port when either port 1 or port 2 are used as a latched and strobed input or a latched and strobed output port or port 1 is used as a bidirectional port.

Programmable Timers

The iSBC 88/25 board provides three independent, fully programmable 16-bit interval timers/event counters utilizing the Intel 8253 Programmable Interval Timer. Each counter is capable of operating in either BCD or binary modes. Two of these timers/counters are available to the systems designer to generate accurate time intervals under software control. Routing for the outputs and gate/trigger inputs of two of these counters is jumper selectable.

Table 2. Programmable Timer Functions

Function	Operation
Interrupt on Terminal Count	When terminal count is reached, an interrupt request is generated. This function is extremely useful for generation of real-time clocks.
Programmable One-Shot	Output goes low upon receipt of an external trigger edge or software command and returns high when terminal count is reached. This function is retriggerable.
Rate Generator	Divide by N counter. The output will go low for one input clock cycle, and the period from one low going pulse to the next is N times the input clock period.
Square-Wave Rate Generator	Output will remain high until one-half the count has been completed, and go low for the other half of the count.
Software Triggered Strobe	Output remains high until software loads count (N). N counts after count is loaded, output goes low for one input clock period.
Hardware Triggered Strobe	Output goes low for one clock period N counts after rising edge counter trigger input. The counter is retriggerable.
Event Counter	On a jumper selectable basis, the clock input becomes an input from the external system. CPU may read the number of events occurring after the counter "window" has been enabled or an interrupt may be generated after N events occur in the system.

The outputs may be independently routed to the 8259A Programmable Interrupt Controller and to the I/O terminators associated with the 8255A to allow external devices or an 8255A port to gate the timer or to count external events. The third interval timer in the 8253 provides the programmable baud rate generator for the iSBC 88/25 board RS232C USART serial port. The system software configures each timer independently to select the desired function. Seven functions are available as shown in Table 2. The contents of each counter may be read at any time during system operation.

ISBX™ MULTIMODULE™ On-Board Expansion

Two 8-bit iSBX MULTIMODULE connectors are provided on the iSBC 88/25 microcomputer. Through these connectors, additional on-board I/O functions may be added. iSBX MULTIMODULES optimally support functions provided by VLSI peripheral components such as additional parallel and serial I/O, analog I/O, small mass storage device controllers (e.g., cassettes and floppy disks), and other custom interfaces to meet specific needs. By mounting directly on the single board computer, less interface logic, less power, simpler packaging, higher performance, and lower cost result when compared to other alternatives such as MULTIBUS form factor compatible boards. The iSBX connectors on the iSBC 88/25 provide all signals necessary to interface to the local on-board bus. A broad range of iSBX MULTIMODULE options are available in this family from Intel. Custom iSBX modules may also be designed for use on the iSBC 88/25 board. An iSBX bus interface specification and iSBX connectors are available from Intel.

MULTIBUS® SYSTEM BUS AND MULTIMASTER CAPABILITIES

Overview

The MULTIBUS system bus is Intel's industry standard microcomputer bus structure. Both 8 and 16-bit single board computers are supported on the MULTIBUS structure with 24 address and 16 data lines. In its simplest application, the MULTIBUS system bus allows expansion of functions already contained on a single board computer (e.g., memory and digital I/O). However, the MULTIBUS structure also allows very powerful distributed processing configurations with multiple processor and intelligent slave I/O, and peripheral boards capable of solving the most demanding microcomputer applications. The MULTIBUS system bus is supported with a broad array of board level products, LSI interface components, detailed published specifications and application notes.

Expansion Capabilities

Memory and I/O capacity may be expanded and additional functions added using Intel MULTIBUS compatible expansion boards. Memory may be expanded by adding user specified combinations of RAM boards, EPROM boards, or combination boards. Input/output capacity may be added with digital I/O and analog I/O expansion boards. Mass storage capability may be achieved by adding single or double density diskette controllers, or hard disk controllers. Modular expandable backplanes and cardcages are available to support multiboard systems.

Multimaster Capabilities

For those applications requiring additional processing capacity and the benefits of multiprocessing (i.e., several CPUs and/or controllers logically sharing system tasks through communication of the system bus), the iSBC 88/25 board provides full MULTIBUS arbitration control logic. This control logic allows up to three iSBC 88/25 boards or other bus masters, including iSBC 80 and iSBC 86 family MULTIBUS compatible single board computers to share the system bus using a serial (daisy chain) priority scheme and allows up to 16 masters to share the MULTIBUS system bus with an external parallel priority decoder. In addition to the multiprocessing configurations made possible with multimaster capability, it also provides a very efficient mechanism for all forms of DMA (Direct Memory Access) transfers.

Interrupt Capability

The iSBC 88/25 board provides 9 vectored interrupt levels. The highest level is the NMI (Non-Maskable Interrupt) line which is directly tied to the 8088 CPU. This interrupt is typically used for signaling catastrophic events (e.g., power failure). The Intel 8259A Programmable Interrupt Controller (PIC) provides control and vectoring for the next eight interrupt levels. As shown in Table 3, a selection of four priority processing modes is available for use in designing request processing configurations to match system requirements for efficient interrupt servicing with minimal latencies. Operating mode and priority assignments may be reconfigured dynamically via software at any time during system operation. The PIC accepts interrupt requests from all on-board I/O resources and from the MULTIBUS system bus. The PIC then resolves requests according to the selected mode and, if appropriate, issues an interrupt to the CPU. Any combination of interrupt levels may be masked via software, by storing a single byte in the interrupt mask register of the PIC. In systems requiring additional interrupt levels, slave 8259A PICs may be interfaced via the MULTIBUS system bus, to generate additional vector addresses, yielding a total of 65 unique interrupt levels.

Table 3. Programmable Interrupt Mode

Mode	Operation
Fully Nested	Interrupt request line priorities fixed at 0 as highest, 7 as lowest.
Auto-Rotating	Equal priority. Each level, after receiving service, becomes the lowest priority level until next interrupt occurs.
Specific Priority	System software assigns lowest priority level. Priority of all other levels based in sequence numerically on this assignment.
Polled	System software examines priority-encoded system interrupt status via interrupt status register.

Interrupt Request Generation

Interrupt requests to be serviced by the iSBC 88/25 board may originate from 24 sources. Table 4 includes a list of devices and functions supported by interrupts. All interrupt signals are brought to the interrupt jumper matrix where any combination of interrupt sources may be strapped to the desired interrupt request level on the 8259A PIC or the NMI input to the CPU directly.

Power-Fail Control and Auxiliary Power

Control logic is also included to accept a power-fail interrupt in conjunction with the AC-low signal from the iSBC 635 and iSBC 640 Power Supply or equivalent, to initiate an orderly shut down of the system in the event of a power failure. Additionally, an active-low TTL compatible memory protect signal is brought out of the auxiliary connector which, when asserted, disables read/write access to RAM memory on the board. This input is provided for the protection of RAM contents during system power-down sequences. An auxiliary power bus is also provided to allow separate power to RAM for systems requiring battery backup of read/write memory. Selection of this auxiliary RAM power bus is made via jumpers on the board.

System Development Capabilities

The development cycle of iSBC 88/25 products can be significantly reduced and simplified by using the Intellec Series IV Microcomputer Development System.

PL/M-86

Intel's system's implementation language, PL/M-86, is available as an Intellec Microcomputer Development System option. PL/M-86 provides the capability to program in algorithmic language and eliminates the need to manage register usage or allocate memory while still allowing explicit control of the system's resources when needed.

Run-Time Support

Intel also offers two run-time support packages; iRMX 88 Realtime Multitasking Executive and the iRMX 86 Operating System. iRMX 88 is a simple, highly configurable and efficient foundation for small, high performance applications. Its multitasking structure establishes a solid foundation for modular system design and provides task scheduling and management, intertask communication and synchronization, and interrupt servicing for a variety of peripheral devices. Other configurable options include terminal handlers, disk file system, debuggers and other utilities. iRMX 86 is a high functional operating system with a very rich set of features and options based on an object-oriented architecture. In addition to being modular and configurable, functions beyond the nucleus include a sophisticated file management and I/O system, and powerful human interface. Both packages are easily customized and extended by the user to match unique requirements.

Table 4. Interrupt Request Sources

Device	Function	Number of Interrupts
MULTIBUS Interface	Requests from MULTIBUS resident peripherals or other CPU boards	8; may be expanded to 64 with slave 8259A PIC's on MULTIBUS boards
8255A Programmable Peripheral Interface	Signals into buffer full or output buffer empty; also BUS INTR OUT general purpose interrupt from driver/ terminator sockets	3
8251A USART	Transmit buffer empty and receive buffer full	2
8253 Timers	Timer 0, 1 outputs; function determined by timer mode	2
iSBX Connectors	Function determined by iSBX MULTIMODULE board	4 (2 per iSBX connector)
Bus Fail Safe Timer	Indicates addressed MULTIBUS resident device has not responded to command within 6 ms	1
Power Fail Interrupt	Indicates AC ower is not within tolerance	1
Power Line Clock	Source of 120 Hz signal from power supply	1
External Interrupt	General purpose interrupt from parallel port J1 connector	1
iSBC 337 MULTIMODULE Numeric Data Processor	Indicates error or exception condition	1

SPECIFICATIONS

Word Size

Instruction—8, 16, 24, or 32 bits
Data—8 bits

System Clock

5.00 MHz or 4.17 MHz ±0.1% (jumper selectable)

NOTE:
4.17 MHz required with the optional iSBC 337 module.

Cycle Time

BASIC INSTRUCTION CYCLE

At 5 MHz—1.2 μs
—400 ns (assumes instruction in the queue)

NOTES:
Basic instruction cycle is defined as the fastest instruction time (i.e., two clock cycles).

Memory Cycle Time

RAM—800 ns (no wait states)
EPROM—Jumper selectable from 800 ns to 1400 ns

Memory Capacity/Addressing

ON-BOARD EPROM

Device	Total Capacity	Address Range
2716	8 Kbytes	FE000-FFFFF$_H$
2732	16 Kbytes	FC000-FFFFF$_H$
2764	32 Kbytes	F8000-FFFFF$_H$
27128	64 Kbytes	F0000-FFFFF$_H$

WITH iSBC 341 MULTIMODULE EPROM

Device	Total Capacity	Address Range
2716	16 Kbytes	FC000-FFFFF$_H$
2732	32 Kbytes	F8000-FFFFF$_H$
2764	64 Kbytes	F0000-FFFFF$_H$
27128	128 Kbytes	E0000-FFFFF$_H$

NOTES:
iSBC 88/25 EPROM sockets support JEDEC 24/28-pin standard EPROMs and RAMs (2 sockets); iSBC 341 sockets also support E^2PROMs.

ON-BOARD RAM

4 Kbytes—0-0FFF$_H$

WITH iSBC 302 MULTIMODULE RAM

12 Kbytes—0-2FFF$_H$

WITH iSBC 302 MULTIMODULE BOARD AND TWO 4K x 4 RAM CHIPS

16 Kbytes—0-3FFF$_H$

I/O Capacity

Parallel—24 programmable lines using one 8255A
Serial—1 programmable line using one 8251A
iSBX Multimodule—2 iSBX MULTIMODULE boards

Serial Communications Characteristics

Synchronous—5 8-bit characters; internal or external character synchronization; automatic sync insertion
Asynchronous—5 8-bit characters; break character generation; 1, 1½, or 2 stop bits; false start bit detection

Baud Rates

Frequency (KHz) (Software Selectable)	Baud Rate (Hz)		
	Synchronous	Asynchronous	
		÷16	÷64
153.6	—	9600	2400
76.8	—	4800	1200
38.4	38400	2400	600
19.2	19200	1200	300
9.6	9600	600	150
4.8	4800	300	75
2.4	2400	150	—
1.76	1760	110	—

NOTES:
Frequency selected by I/O write of appropriate 16-bit frequency factor to baud rate register (8253 Timer 2).

Timers

INPUT FREQUENCIES

Reference: 2.458 MHz ±0.1% (406.9 ns period, nominal); or 1.229 MHz ±0.1% (813.8 ns period, nominal); or 153.6 KHz ± 0.1% (6.510 μs period, nominal)

NOTE:
Above frequencies are user selectable.

Event Rate: 2.46 MHz max

OUTPUT FREQUENCIES/TIMING INTERVALS

Function	Single Timer/Counter		Dual Timer/Counter (Two Timers Cascaded)	
	Min	Max	Min	Max
Real-Time Interrupt	1.63 μs	427.1 ms	3.26s	466.50 min
Programmable One-Shot	1.63 μs	427.1 ms	3.26s	466.50 min
Rate Generator	2.342 Hz	613.5 KHz	0.000036 Hz	306.8 KHz
Square-Wave Rate Generator	2.342 Hz	613.5 KHz	0.000036 Hz	306.8 KHz
Software Triggered Strobe	1.63 μs	427.1 ms	3.26s	466.50 min
Hardware Triggered Strobe	1.63 μs	427.1 ms	3.26s	466.50 min
Event Counter	—	2.46 MHz	—	—

Interfaces

Multibus: All signals TTL compatible

iSBX Bus: All signals TTL compatible

Parallel I/O: All signals TTL compatible

Serial I/O: RS232C compatible, configurable as a data set or data terminal

Timer: All signals TTL compatible

Interrupt Requests: All TTL compatible

CONNECTORS

Interface	Double-Sided Pins (qty)	Centers (in.)	Mating Connectors
MULTIBUS System	86	0.156	Viking 3KH43/9AMK12 Wire Wrap
iSBX Bus 8-Bit Data	36	0.1	iSBX 960-5
Parallel I/O (2)	50	0.1	3M 3415-000 Flat or TI H312125 Pins
Serial I/O	26	0.1	3M 3462-0001 Flat or AMP 88106-1 Flat

Line Drivers and Terminators

I/O Drivers: The following line drivers are all compatible with the I/O driver sockets on the iSBC 88/25 board.

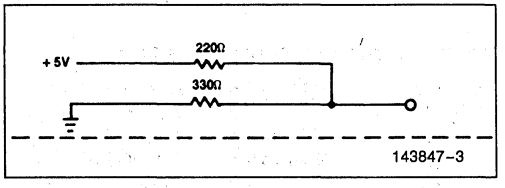
Driver	Characteristics	Sink Current (mA)
7438	I,OC	48
7437	I	48
7432	NI	16
7426	I,OC	16
7409	NI,OC	16
7408	NI	16
7403	I,OC	16
7400	I	16

NOTES:
I = inverting; NI = non-inverting; OC = open collector.

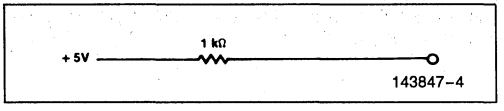
Port 1 of the 8255A has 32 mA totem-pole bidirectional drivers and 10Ω terminators.

I/O Terminators: 220Ω/330Ω divider or 1 KΩ pullup.

220Ω/330Ω Option 1



1 KΩ Option 2



MULTIBUS Drivers

Function	Characteristic	Sink Current (mA)
Data	Tri-State	32
Address	Tri-State	24
Commands	Tri-State	32
Bus Control	Open Collector	20

Physical Characteristics

Width: 12.00 in. (30.48 cm)

Height: 6.75 in. (17.15 cm)

Depth: 0.70 in. (1.78 cm)

Weight: 14 oz. (388 gm)

Electrical Characteristics

DC POWER REQUIREMENTS

Configuration	Current Requirements (All Voltages ±5%)		
	+5V	+12V	−12V
Without EPROM(1)	3.8A	25 mA	23 mA
RAM only(2)	104 mA		
With 8K EPROM(3) (using 2716)	4.3A	25 mA	23 mA
With 16K EPROM(3) (using 2732)	4.4A	25 mA	23 mA
With 32K EPROM(3) (using 2764)	4.4A	25 mA	23 mA

NOTES:
1. Does not include power for optional ROM/EPROM, I/O drivers and I/O terminators.
2. RAM chips powered via auxiliary power bus in power-down mode. Does not include power for optional RAM.
3. Includes power required for 4 ROM/EPROM chips, and I/O terminators installed for 16 I/O lines; all terminator inputs low.

Environmental Characteristics

Operating Temperature: 0°C to 55°C

Relative Humidity: to 90% (without condensation)

Reference Manual

143825-001—iSBC 88/25 Hardware Reference Manual (NOT SUPPLIED)

Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

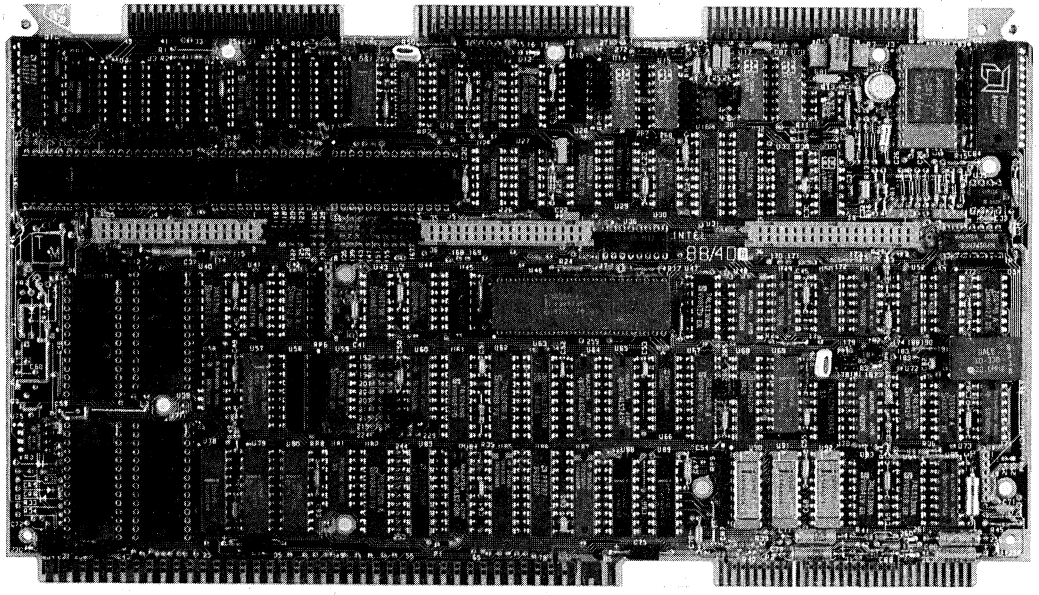
ORDERING INFORMATION

Part Number	Description
SBC 88/25	8-bit Single Board Computer with 4 Kbytes RAM

iSBC® 88/40A
MEASUREMENT AND CONTROL COMPUTER

- **High Performance 4.8/6.67 MHz 8088 8-Bit HMOS Processor**
- **12-Bit KHz Analog-to-Digital Converter with Programmable Gain Control**
- **16-Bit Differential/32 Single-Ended Analog Input Channels**
- **Three iSBX™ MULTIMODULE™ Connectors for Analog, Digital, and other I/O Expansion**
- **4K Bytes Static RAM, Expandable via iSBC® 301 MULTIMODULE™ RAM to 8K Bytes (1K Byte Dual-Ported)**
- **Four EPROM/E²PROM Sockets for up to 64K Bytes, Expandable to 128K Bytes with iSBC® 341 Expansion MULTIMODULE™**
- **MULTIBUS® Intelligent Slave or Multimaster**

The Intel iSBC 88/40A Measurement and Control Computer is a member of Intel's large family of Single Board Computers that takes full advantage of Intel's VLSI technology to provide an economical self-contained computer based solution for applications in the areas of process control and data acquisition. The on-board 8088 processor with its powerful instruction set allows users of the iSBC 88/40A board to update process loops as much as 5–10 times faster than previously possible with other 8-bit microprocessors. For example, the high performance iSBC 88/40A can concurrently process and update 16 control loops in less than 200 milliseconds using a traditional PID (Proportional-Integral-Derivative) control algorithm. The iSBC 88/40A board consists of a 16 differential/32 single ended channel analog multiplexer with input protected circuits, A/D converter, programmable central processing unit, dual port and private RAM, read only memory sockets, interrupt logic, 24 channels of parallel I/O, three programmable timers and MULTIBUS control logic on a single 6.75 by 12.00-inch printed circuit card. The iSBC 88/40A board is capable of functioning by itself in a stand-alone system or as a multimaster or intelligent slave in a large MULTIBUS system.



280220–1

October 1986
Order Number: 280220-001

FUNCTIONAL DESCRIPTION

Three Modes of Operation

The iSBC 88/40A Measurement and Control Computer (MACC) is capable of operating in one of three modes: stand-alone controller, bus multimaster or intelligent slave. A block diagram of the iSBC 88/40A Measurement and Control Computer is shown in Figure 1.

Stand-Alone Controller

The iSBC 88/40A Measurement and Control Computer may function as a stand-alone single board controller with CPU, memory and I/O elements on a single board. The on-board 4K bytes of RAM and up to 64K bytes of read only memory, as well as the analog-to-digital converter and programmable parallel I/O lines allow significant control and monitoring capabilities from a single board.

Bus Multimaster

In this mode of operation the iSBC 88/40A board may interface and control a wide variety of iSBC memory and I/O boards or even with additional iSBC 88/40 boards or other single board computer masters or intelligent slaves.

Intelligent Slave

The iSBC 88/40A board can perform as an intelligent slave to any Intel 8- or 16-bit MULTIBUS master CPU by not only offloading the master of the analog data collection, but it can also do a significant amount of pre-processing and decision-making on its own. The distribution of processing tasks to intelligent slaves frees the system master to do other system functions. The Dual port RAM with flag bytes for signaling allows the iSBC 88/40A board to process and store data without MULTIBUS memory or bus contention.

Central Processing Unit

The central processor unit for the iSBC 88/40A board is a powerful 8-bit HMOS 8088 microprocessor. By moving on-board jumpers, the user can select either a 4.8 or 6.67 MHz CPU clock rate. The iSBC 88/40A board can also run at 8 MHz by changing the CPU clock oscillator to a 24 MHz unit. For 8 MHz operation, the iSBC 88/40A board should either be the only MULTIBUS master in the system or be an intelligent slave that never directly accesses the MULTIBUS interface.

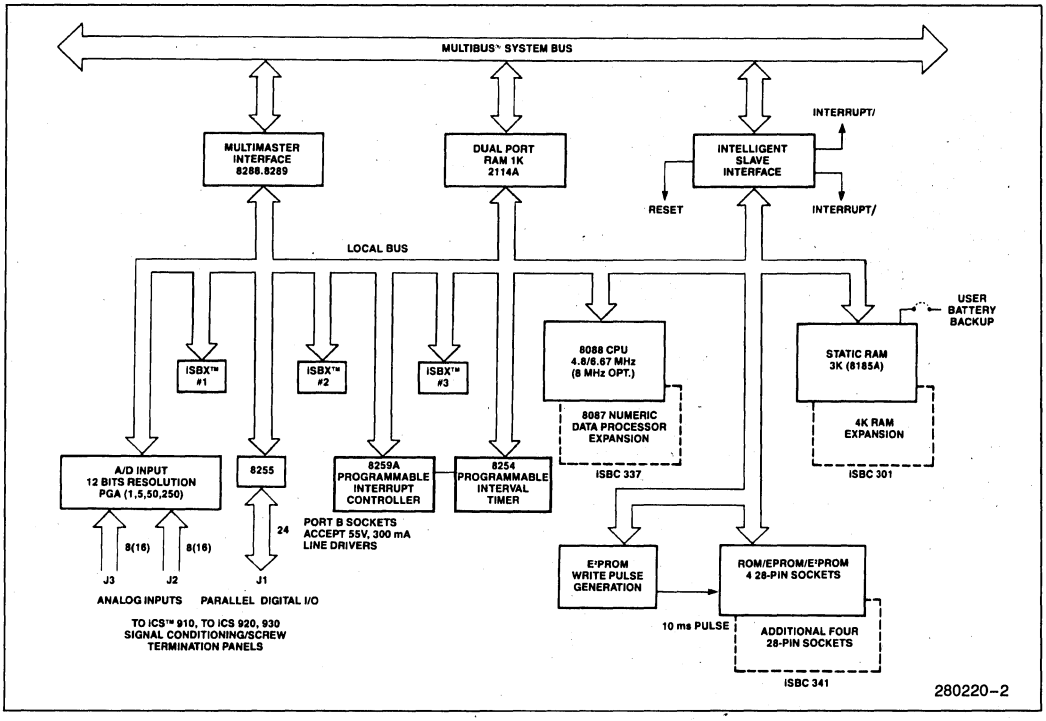


Figure 1. iSBC® 88/40A Measurement and Control Computer Block Diagram

INSTRUCTION SET—The 8088 instruction repertoire includes variable length instruction format (including double operand instructions), 8-bit and 16-bit signed and unsigned arithmetic operators for binary, BCD and unpacked ASCII data, and iterative word and byte string manipulation functions. The instruction set of the 8088 is a superset of the 8080A/8085A family and with available software tools, programs written for the 8080A/8085A can be easily converted and run on the 8088 processor. Programs can also be run that are implemented on the 8088 with little or no modification.

ARCHITECTURAL FEATURES—A 4-byte instruction queue provides pre-fetching of sequential instructions and can reduce the 1.04 ms minimum instruction cycle to 417 ns (at 4.8 MHz clock rate) for queued instructions. The stack oriented architecture facilitates nested subroutines and co-routines, reentrant code and powerful interrupt handling. The memory expansion capabilities offer a 1 megabyte addressing range. The dynamic relocation scheme allows ease in segmentation of pure procedure and data for efficient memory utilization. Four segment registers (code, stack, data, extra) contain program loaded offset values which are used to map 16-bit addresses to 20-bit addresses. Each register maps 64K bytes at a time and activation of a specific register is controlled explicitly by program control and is also selected implicitly by specific functions and instructions.

Bus Structure

The iSBC 88/40A single board computer has three buses: 1) an internal bus for communicating with on-board memory, analog-to-digital converter, ISBX MULTIMODULES and I/O options; 2) the MULTIBUS system bus for referencing additional memory and I/O options, and 3) the dual-port bus which allows access to RAM from the on-board CPU and the MULTIBUS system bus. Local (on-board) accesses do not require MULTIBUS communication, making the system bus available for use by other MULTIBUS masters (i.e., DMA devices and other single board computers transferring to additional system memory). This feature allows true parallel processing in a multiprocessor environment. In addition, the MULTIBUS interface can be used for system expansion through the use of other 8- and 16-bit iSBC computers, memory and I/O expansion boards.

RAM Capabilities

DUAL-PORT RAM—The dual-port RAM of the iSBC 88/40A board consists of 1K bytes of static RAM, implemented with Intel 2114A chips. The on-board base address of this RAM is 00C00 (3K) normally; it is relocated to 01C00 (7K) when the iSBC 301 MULTIMODULE RAM is added to the protected RAM. The MULTIBUS port base address of the dual-port RAM can be jumpered to any 1K byte boundary in the 1M byte address space. The dual-port RAM can be accessed in a byte-wide fashion from the MULTIBUS system bus. When accessed from the MULTIBUS system bus, the dual-port RAM decode logic will generate INH1/ (Inhibit RAM) to allow dual-port RAM to overlay other system RAM. The dual-port control logic is designed to favor an on-board RAM access. If the dual-port is not currently performing a memory cycle for the MULTIBUS system port, only one wait state will be required. The on-board port any require more than one wait state if the dual-port RAM was busy when the on-board cycle was requested. The LOCK prefix facility of the iAPX 88/10 assembly language will disallow system bus accesses to the dual-port RAM. In addition, the on-board port to the dual-port RAM can be locked by other compatible MULTIBUS masters, which allows true symmetric semaphore operation. When the board is functioning in the master mode, the LOCK prefix will additionally disable other masters from obtaining the system bus.

PRIVATE RAM—In addition to the 1K byte dual-port RAM, there is a 3K byte section of private static RAM not accessible from the system bus. This RAM has a base address of 00000, and consists of three Intel 8185 RAM chips which are interfaced to the multiplexed address/data bus of the 8088 microprocessor. Expansion of this private RAM from 3K to 7K byte scan be accomplished by the addition of an iSBC 301 MULTIMODULE RAM (4K bytes). When the 301 is added, protected RAM extends from 0 to 7K, and the base address of the dual-port RAM is relocated from 3K (00C00) to 7K (01C00). All protected RAM accesses require one wait state. The private RAM resides on the local on-board bus, which eliminates contention problems between on-board accesses to private RAM and system bus accesses to dual-port AM. The private RAM can be battery backed (up to 16K bytes).

Additional RAM can be added by utilizing JEDEC-compatible static RAMs in the available EPROM sockets.

Parallel I/O Interface

The iSBC 88/40A single board computer contains 24 programmable parallel I/O lines implemented using the Intel 8255A Programmable Peripheral Interface. The system software is used to configure the I/O lines in any combination of unidirectional input/output and bidirectional ports indicated in Table 1. There the I/O interface may be customized to meet specific peripheral requirements. In order to take full advantage of the large number of possible I/O

configurations, sockets are provided for interchangeable I/O line drivers and terminators. Port 2 can also accept TTL compatible peripheral drives, such as 75461/462, 75471/472, etc. These are open collector, high voltage drivers (up to 55 volts) which can sink 300 mA. Hence, the flexibility of the I/O interface is further enhanced by the capability of selecting the appropriate combination of optional line drivers and terminators to provide the required sink current, polarity, and drive/termination characteristics for each application. The 24 programmable I/O lines and signal ground lines are brought out to a 50-pin edge connector that mates with flat, woven, or round cable. This edge connector is also compatible with the Intel ICS™ 920 Digital I/O and iCS 930 AC Signal Conditioning/Termination Panels, for field wiring, optical isolation and high power (up to 3 amp) power drive.

EPROM Capabilities

Four 28-pin sockets are provided for the use of Intel 2716s, 2732s, 2764s, 27128s, future JEDEC-compatible 128K and 256K bit EPROMs and their respective ROMs. When using 27128s the on-board EPROM capacity is 64K bytes. Read only memory expansion is available through the use of the iSBC 341 EPROM/ROM memory expansion MULTIMODULE. When the iSBC 341 is used an additional four EPROM sockets are made available, for a total iSBC 88/40A board capacity of 128K bytes EPROM with Intel 27128s.

E²PROM Capabilities

The four 28-pin sockets can also accommodate Intel 2817A or 2816A E²PROMs, for dynamic storage of control loop setpoints, conversion parameters, or other data (or programs) that change periodically but must be kept in nonvolatile storage.

Timing Logic

The iSBC 88/40A board provides an 8254-2 Programmable Interval Timer, which contains three independent, programmable 16-bit timers/event counters. All three of these counters are available to generate time intervals or event counts under software control. The outputs of the three counters may be independently routed to the interrupt matrix. The inputs and outputs of timers 0 and 1 can be connected to parallel I/O lines on the J1 connector, where they replace 8255A port C lines. The third counter is also used for timing E²PROM write operations.

Interrupt Capability

The iSBC 88/40A board provides 9 vectored interrupt levels. The highest level is NMI (Nonmaskable Interrupt) line which is directly tied to the 8088 CPU. This interrupt cannot be inhibited by software and is typically used for signalling catastrophic events (i.e., power failure). On servicing this interrupt, program control will be implicitly transferred through location 00008_H. The Intel 8259A Programmable Interrupt Controller (PIC) provides vectoring for the next eight interrupt levels. As shown in Table 2, a selection of four priority processing modes is available to the designer to match system requirements. Operating mode and priority assignments may be reconfigured dynamically via software at any time during system operation. The PCI accepts interrupt requests from the programmable parallel and/or iSBX interfaces, the programmable timers, the system bus, or directly from peripheral equipment. The PIC then determines which of the incoming requests is of the highest priority than the level currently being serviced, and, if appropriate, issues an interrupt to the CPU. Any combination of interrupt levels may be masked, via software, by storing a single byte in the interrupt make register of the PIC. The PIC generates a

Table 1. Input/Output Port Modes of Operation

Port	Lines (qty)	Mode of Operation					
		Unidirectional				Bidirectional	Control
		Input		Output			
		Latched	Latched & Strobed	Latched	Latched & Strobed		
1	8	X	X	X	X	X	
2	8	X	X	X	X		
3	4	X		X			X(1)
	4	X		X			X(1)

NOTE:
1. Part of port 3 must be used as a control port when either port 1 or port 2 are used as a latched and strobed input or a latched and strobed output port or port 1 is used as a bidirectional port.

unique memory address for each interrupt level. These addresses are equally spaced at 4-byte intervals. This 32-byte lock may begin at any 32-byte boundary in the lowest 1K bytes of memory, and contains unique instruction pointers and code segment offset values (for expanded memory operation) for each interrupt level. After acknowledging an interrupt and obtaining advice identifier byte from the 8259A PIC, the CPU will store its status flags on the stack and execute an indirect CALL instruction through the vector location (derived from the device identifier) to the interrupt service routine.

NOTE:
The first 32 vector locations are reserved by Intel for dedicated vectors. Users who wish to maintain compatibility with present and future Intel products should not use these locations for user-defined vector addresses.

Table 2. Programmable Interrupt Modes

Mode	Operation
Fully Nested	Interrupt request line priorities fixed at 0 as highest, 7 as lowest.
Auto-rotating	Equal priority. Each level, after receiving service, becomes the lowest priority level until next interrupt occurs.
Specific Priority	System software assigns lowest priority level. Priority of all other levels based in sequence numerically on this assignment.
Polled	System software examines priority-encoded system interrupt status via interrupt status register.

INTERRUPT REQUEST GENERATION—Interrupt requests may originate from 26 sources. Two jumper selectable interrupt requests can be automatically generated by the programmable peripheral interface when a byte of information is ready to be transferred to the CPU (i.e., input buffer is full) or a byte of information has been transferred to a peripheral device (i.e., output buffer is empty). A jumper selectable request can be generated by each of the programmable timers. An additional interrupt request line may be jumpered directly from the parallel I/O driver terminator section. Eight prioritized interrupt request lines allow the iSBC 88/40A board to recognize and service interrupts originating from peripheral boards interfaced via the MULTIBUS system bus. The fail safe timer can be selected as an interrupt source. Also, interrupts are provided from the iSBX connectors (6), end-of-conversion, PFIN and from the power line clock.

Power-Fail Control

Control logic is also included to accept a power-fail interrupt in conjunction with the AC-low signal from the iSBC 635, iSBC 640, and iCS 645 Power Supply or equivalent.

iSBX™ MULTIMODULE™ Expansion Capabilities

Three iSBX MULTIMODULE connectors are provided on the iSBC 88/40A board. Up to three single wide MULTIMODULE or one double wide and one single wide iSBX MULTIMODULE can be added to the iSBC 88/40A board. A wide variety of peripheral controllers, analog and digital expansion options are available. For more information on specific iSBX MULTIMODULES consult the Intel OEM Microcomputer System Configuration Guide.

Processing Expansion Capabilities

The addition of a iSBC 337 Multimodule Numeric Data Processor offers high performance integer and floating point math functions to users of the iSBC 88/40A board. The iSBC 337 incorporates the Intel 8087 and because of the MULTIMODULE implementation, it allows on-board expansion directly on the iSBC 88/40A board, eliminating the need for additional boards or floating point requirements.

MULTIBUS® Expansion

Memory and I/O capacity may be expanded further and additional functions added using Intel MULTIBUS compatible expansion boards. Memory may be expanded by adding user specified combination of RAM boards, EPROM boards, or memory combination boards. Input/output capacity may be increased by adding digital I/O and analog I/O MULTIBUS expansion boards. Mass storage capability may be achieved by adding single or double density diskette controllers, or hard disk controllers either through the use of expansion boards and iSBX MULTIMODULES. Modular expandable backplanes and cardcages are available to support multiboard systems.

NOTE:
Certain system restrictions may be incurred by the inclusion of some of the iSBC 80 family options in an iSBC 88/40 system. Consult the Intel OEM Microcomputer System Configuration Guide for specific data.

Analog Input Section

The analog section of the iSBC 88/40A board receives all control signals through the local bus to

initiate channel selection, gain selection, sample and hold operation, and analog-to-digital conversion. See Figure 2.

INPUT CAPACITY—32 separate analog signals may be randomly or sequentially sampled in single-ended mode with the 32 input multiplexers and a common ground. For noisier environments, differential input mode can be configured to achieve 16 separate differential signal inputs, or 32 pseudo differential inputs.

RESOLUTION—The analog section provides 12-bit resolution with a successive approximation analog-to-digital converter. For bipolar operation (−5 to +5 or −10 to +10 volts) it provides 11 bits plus sign.

SPEED—The A-to-D converter conversion speed is 50 μs (20 kHz samples per second). Combined with the programming interface, maximum throughput via the local bus and into memory will be 55 microseconds per sample, or 18 kHz samples per second, for a single channel, a random channel, or a sequential channel scan at a gain of 1, 5 ms at a gain of 5,250 ms at a gain of 50, and 20 ms at a gain of 250. A-to-D conversion is initiated via a programmed command from the 8088 central processor. Interrupt on end-of-conversion is a standard feature to ease programming and timing constraints.

ACCURACY—High quality components are used to achieve 12 bits resolution and accuracy of 0.035% full scale range ±½ LSB at gain = 1. Offset is adjustable under program control to obtain a nominal ±0.024% FSR ±½ LSB accuracy at any fixed temperature between 0°C and 60°C (gain = 1). See specifications for other gain accuracies.

GAIN—To allow sampling of millivolt level signals such as strain gauges and thermocouples, gain is made configurable via user program commands up to 250 × (20 millivolts full scale input range). User can select gain ranges of 1 (5V), 5 (1V), 50 (100 mV), 250 (20 mV) to match his application.

OPERATIONAL DESCRIPTION—The iSBC 88/40A single board computer addresses the analog-to-digital converter by executing IN or OUT instructions to the port address. Analog-to-digital conversions can be programmed in either of two modes: 1) start conversion and poll for end-of-conversion (EOC), or 2) start conversion and wait for interrupt at end of conversion. When the conversion is complete as signaled by one of the above techniques, INput instructions read two bytes (low and high bytes) containing the 12-bit data word.

Output Command—Select input channel and start conversion.

	GAIN		CONNECTOR		CHANNEL SELECT			
BIT POSITION	7	6	5	4	3	2	1	0
INPUT CHANNEL	G1	G2		J	C3	C2	C1	C0

Input Data—Read converted data (low byte) or Read converted data (high byte).

	DATA							
BIT POSITION	7	6	5	4	3	2	1	0
LOW/STATUS BYTE	D3	D2	D1	D0				EOC

	DATA							
HIGH BYTE	D11	D10	D9	D8	D7	D6	D5	D4

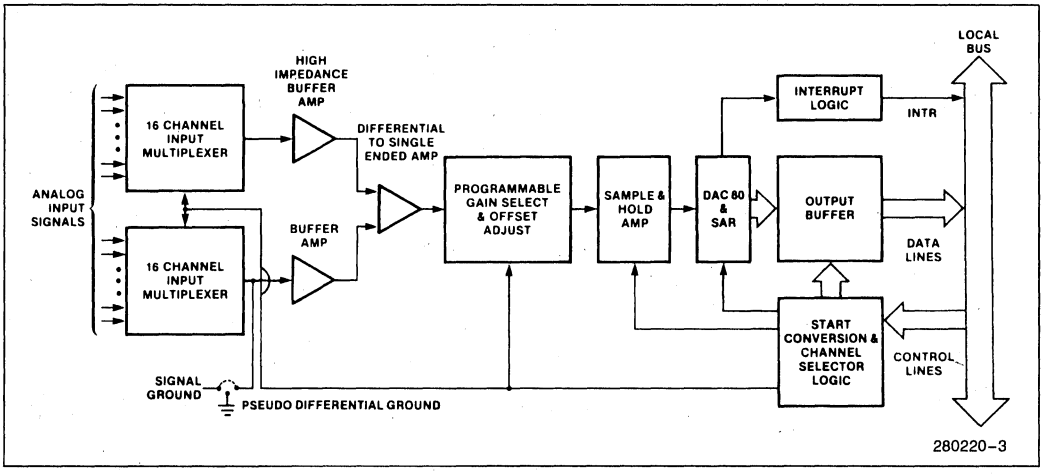


Figure 2. iSBC® 88/40 Analog Input Section

Offset Correction—At higher gains (×50, ×250) the voltage offset tempco in the A/D circuitry can sometimes cause unacceptable inaccuracies. To correct for this offset, one channel can be dedicated to be used as a reference standard. This channel can be read from the program to determine the amount of offset. The reading from this channel will then be subtracted from all other channel readings, in effect eliminating the offset tempco.

SYSTEM SOFTWARE DEVELOPMENT

The development cycle of the iSBC 88/40 board may be significantly reduced using an Intel Intellec Microcomputer Development System and Intel's FORTRAN, PASCAL, or PL/M 86/88 Software packages.

SPECIFICATIONS

Word Size

Instruction—8, 16, or 32 bits
Data—8 bits

Instruction Cycle Time (minimum)

Instruction	8088 Clock Rate			Number of Clock Cycles
	4.8 MHz	6.67 MHz	8.0 MHz	
In Queue	417 ns	300 ns	250 ns	2
Not in Queue	1.04 ns	750 ns	625 ns	5

MEMORY CAPACITY

On-Board ROM/EPROM/E²PROM

Up to 64K bytes; user installed in 2K, 4K, 8K or 16K byte increments or up to 128K if iSBC 341 MULTIMODULE EPROM option installed. Up to 8K bytes of E²PROM using Intel 2816As or 2817As may be user-installed in increments of 2, 4, or 8 bytes.

On-Board RAM

4K bytes or 8K bytes if the iSBC 301 MULTIMODULE RAM is installed. Integrity maintained during power failure with user-furnished batteries. 1K bytes are dual-ported.

Off-Board Expansion

Up to 1 megabyte of user-specified combination of RAM, ROM, and EPROM.

MEMORY ADDRESSING

On-Board ROM/EPROM

FE000-FFFFF (using 2716 EPROMs)
FC000-FFFFF (using 2732 EPROMs)
F8000-FFFFF (using 2764 EPROMs)
F0000-FFFFF (using 27128 EPROMs)

On-Board ROM/EPROM (With iSBC 341 MULTIMODULE EPROM option installed)

FC000-FFFFF (using 2716 EPROMs)
F8000-FFFFF (using 2732 EPROMs)
F0000-FFFFF (using 2764 EPROMs)
E0000-FFFFF (using 27128 EPROMs)

On-Board RAM (CPU Access)

00000-00FFF
00000-01FFF (if iSBC 301 MULTIMODULE RAM option installed)

On-Board RAM

Jumpers allow 1K bytes of RAM to act as slave RAM for access by another bus master. Addressing may be set within any 1K boundary in the 1-megabyte system address space.

Slave RAM Access

Average: 350 ns

INTERVAL TIMER

Output Frequencies

Function	Single Timer		Dual Timers (Two Timers Cascaded)
	Min	Max	
Real-Time Interrupt Interval	0.977 μs	64 ms	69.9 minutes maximum
Rate Generator (Frequency	15.625 Hz	1024 KHz	0.00024 Hz minimum

CPU CLOCK

4.8 MHz ±0.1% or 6.67 MHz ±0.1%. (User selectable via jumpers);

8.0 MHz (with user installed 24 MHz oscillator)

I/O Addressing

All communications to parallel I/O ports, iSBX bus, A/D port, timers, and interrupt controller are via read and write commands from the on-board 8088 CPU.

Interface Compatability

Parallel I/O—24 programmable lines (8 lines per port); one port includes a bidirectional bus driver. IC sockets are included for user installation of line drivers and/or I/O terminators and/or peripheral drivers as required for interface ports.

Interrupts

8088 CPU includes a non-maskable interrupt (NMI). NMI interrupt is provided for catastrophic events such as power failure. The on-board 8259A PIC provides 8-bit identifier of interrupting device to CPU. CPU multiplies identifier by four to derive vector address. Jumpers select interrupts from 26 sources without necessity of external hardware. PIC may be programmed to accommodate edge-sensitive or level-sensitive inputs.

Analog Input

16 differential (bipolar operation) or 32 single-ended (unipolar operation).

Full Scale Voltage Range—−5 to +5 volts (bipolar), 0 to +5 volts (unipolar).

NOTE:
Ranges of 0 to 10V and ±10V achievable with externally supplied ±15V power.

Gain—Program selectable for gain of 1, 5, 50, or 250.

Resolution—12 bits (11 bits plus sign for ±5, ±10 volts).

Accuracy—Including noise and dynamic errors.

Gain	25°C
1	±0.035% FSR*
5	±0.06% FSR*
50	±0.07% FSR*
250	±0.12% FSR*

NOTE:
FSR = Full Scale Range ±½ LSB. Figures are in percent of full scale reading. At any fixed temperature between 0°C and 60°C, the accuracy is adjustable to ±0.05% of full scale.

Gain TC (at gain = 1)—30 PPM (typical), 56 PPM (max) per degree centigrade, 40 PPM at other gains.

Offset TC— (in % of FSR/°C)	Gain	Offset TC (typical)
	1	0.0018%
	5	0.0036%
	50	0.024%
	250	0.12%

Sample and Hold-Sample Time: 15 μs
Aperature-Hold Aperature Time: 120 ns
Input Overvoltage Protection: 30 volts
Input Impedance: 20 megohms (min.)
Conversion Speed: 50 μs (max.) at gain = 1
Common Mode Rejection Ratio: 60 dB (min.)

Physical Characteristics

Width: 30.48 cm (12.00 in.)

Length: 17.15 cm (6.75 in.)

Height: 1.78 cm (0.7 in.)

2.82 cm (1.13 in.) with iSBC Memory Expansion, MULTIMODULES, iSBX Numeric Data Processor or iSBX MULTIMODULES.

Electrical Requirements

Power Requirements

Voltage	Current	
	Maximum	Typical
+5V	5.5A	4A
+5V Aux	150 mA	100 mA
+12V	120 mA	80 mA
−12V	40 mA	30 mA

NOTES:
1. The current requirement includes one worst case (active-standby) EPROM current.
2. If +5V Aux is supplied by the iSBC 88/40A board, the total +5V current is the sum of the +5V and the +5V Aux.

Environmental Requirements

Operating Temperature: 0° to +60°C with 6 CFM min. air flow across board

Relative Humidity: to 90% without condensation

Equipment Supplied

iSBC 88/40A Measurement and Control Computer Schematic diagram

REFERENCE MANUALS

147049-001— SBC 88/40A Measurement and Control Computer Hardware Reference Manual (Order Separately).

Manuals may be ordered from an Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

ORDERING INFORMATION

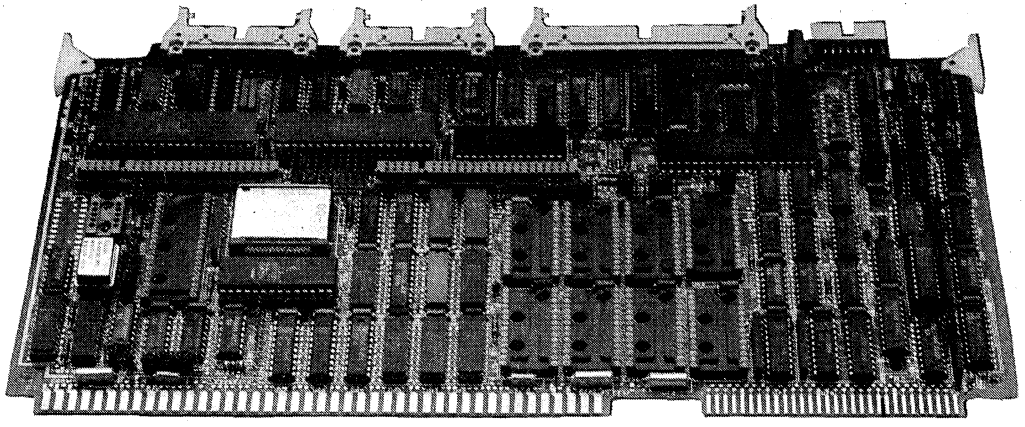
Part Number	Description
SBC 88/40A	Measurement and Control Computer

iSBC® 186/03A
SINGLE BOARD COMPUTER

- **8.0 MHz 80186 Microprocessor with Optional 8087 Numeric Data Processor**
- **Eight (Expandable to 12) JEDEC 28-Pin Sites**
- **Six Programmable Timers and 27 Levels of Vectored Interrupt Control**
- **MULTIBUS® Interface for System Expansion and Multimaster Configuration**
- **24 Programmable I/O Lines Configurable as a SCSI Interface, Centronics Interface or General Purpose I/O**
- **Two iSBX™ Bus Interface Connectors for Low Cost I/O Expansion**
- **iLBX™ (Local Bus Extension) Interface for High-Speed Memory Expansion**
- **Two Programmable Serial Interfaces; One RS 232C, the Other RS 232C or RS 422 Compatible**

The iSBC 186/03A Single Board Computer is a member of Intel's complete line of microcomputer modules and systems that take advantage of Intel's VLSI technology to provide economical, off-the-shelf, computer-based solutions for OEM applications. The board is a complete microcomputer system on a 7.05 x 12.0 inch printed circuit card. The CPU, system clock, memory, sockets, I/O ports and drivers, serial communications interface, priority interrupt logic and programmable timers, all reside on the board.

The iSBC 186/03A board incorporates the 80186 CPU and SCSI interface on one board. The extensive use of high integration VLSI has produced a high-performance single-board system. For large memory applications, the iLBX local bus expansion maintains this high performance.



230988-1

September 1987
Order Number: 230988-005

OVERVIEW

Operating Environment

The iSBC 186/03A single board computer features have been designed to meet the needs of numerous microcomputer applications. Typical applications include:

- Multiprocessing single board computer
- BITBUS master controller
- Stand-alone singel board system

MULTIPROCESSING SINGLE BOARD COMPUTER

High-performance systems often need to divide system functions among multiple processors. A multiprocessing single board computer distributes an applications processing load over multiple processors that communicate over a system bus. Since these applications use the system bus for inter-processor communication, it is required that each processor has local execution memory.

The iSBC 186/03A board supports loosely coupled multiprocessing (where each processor performs a specific function) through its MULTIBUS compatible architecture. The IEEE 796 system bus facilitates processor to processor communication, while the iLBX bus makes high-speed data and execution memory available to each CPU as shown in Figure 1. This architecture allows multiple processors to run in parallel enabling very high-performance applications.

BITBUS™ MASTER CONTROLLER

The BITBUS interconnect environment is a high performance low-cost microcontroller interconnect technology for distributed control of intelligent industrial machines such as robots and process controllers. The BITBUS interconnect is a special purpose serial bus which is ideally suited for the fast transmission of short messages between the microcontroller nodes in a modularly distributed system.

The iSBC 186/03A board can be implemented as the MULTIBUS-based master controller CPU which monitors, processes and updates the control status of the distributed system. The iSBX 344 board is used to interface the iSBC 186/03A board to the BITBUS interconnect. Actual message transfer over the iSBX bus can be accomplished by either software polling by the CPU or by using the on-chip 80186 DMA hardware instead of the CPU. Using DMA, the CPU is only required to start the DMA process and then poll for the completion of the message transfer, thus dramatically improving the data transmission rate and master control processor efficiency. The maximum transfer rates over the iSBX bus for the iSBC 186/03A board are about 900 messages/second in polled mode and 2500 messages/second in DMA mode. An 8 MHz iSBC 186/03A board in DMA mode is 3 times as fast as a typical 5 MHz iSBC 86/30 board running in polled mode. The iSBC 186/03A board in DMA mode provides the highest performance/price solution for BITBUS message transmission out of all of Intel's complete line of 16-bit CPU modules.

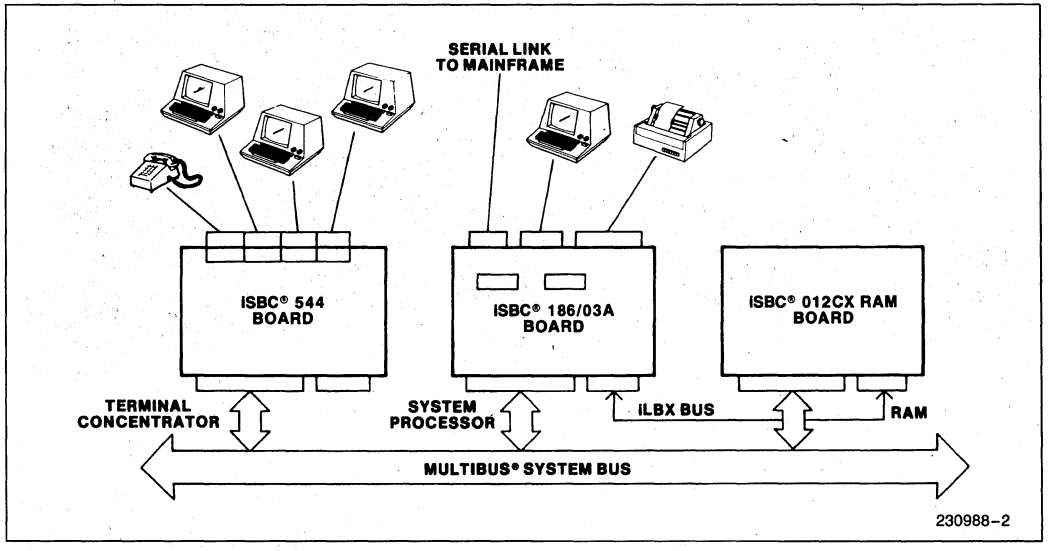


Figure 1. A Multiprocessing Single Board Computer Application

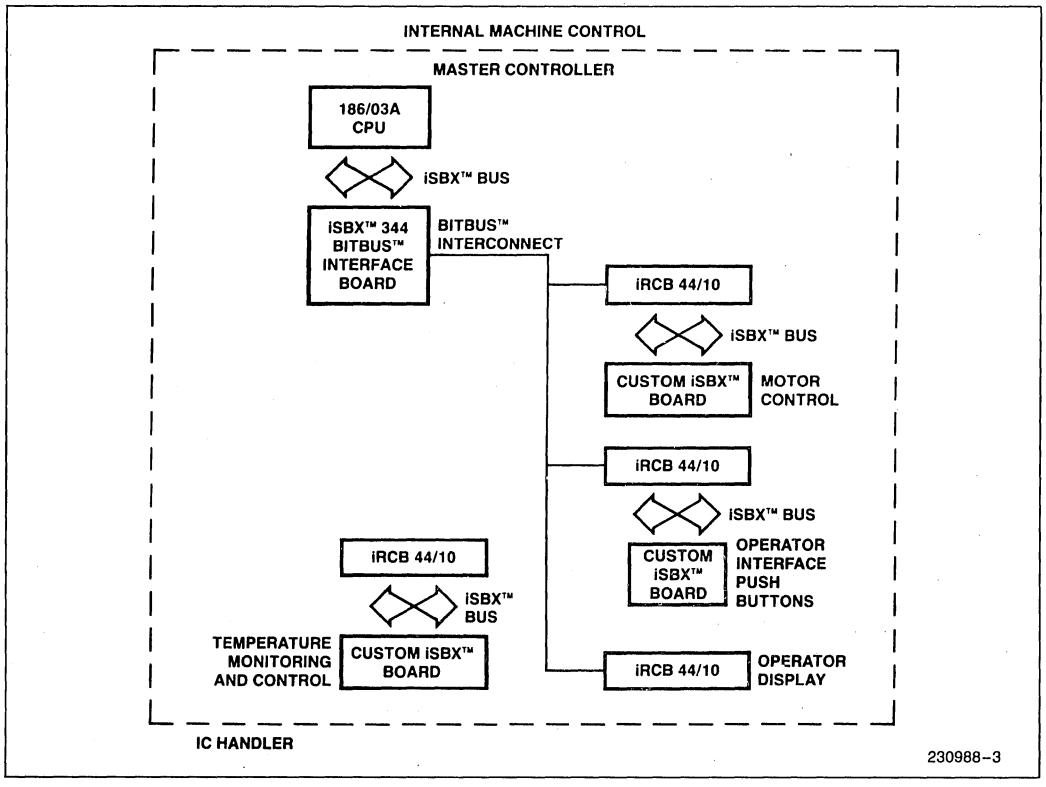


Figure 2. Sample iSBC® 186/03A BITBUS™ Master Application

STAND-ALONE SINGLE BOARD SYSTEM

A stand-alone single board system is a complete computer system on one board. By reducing the system's board count, the single board system saves space, power, and ultimately, costs. The on-board resources need to be capable of performing all of the basic system functions. These applications typically require terminal support, peripheral control, local RAM and program execution. In previous generations of single board computers, these functions could only be obtained with multiple board solutions.

The iSBC 186/03A board integrates all the functions of a general purpose system (CPU, memory, I/O and peripheral control) onto one board. The iSBC 186/03A board can also be customized as a single board system by the selection of memory and iSBX I/O options. The board's 8 JEDEC 28-pin sockets can accommodate a wide variety of byte-wide memory devices. For example, four 27256 EPROMS and four 2186 IRAMs can be installed for a total of 128 KB of EPROM program storage and 32 KB of RAM data storage. In addition, Intel's JEDEC site compatible 27916 KEPROM™ (Keyed Access EPROM) memory device may be configured for use on the iSBC 186/03A board. The KEPROM memory device employs a data protection mechanism which makes the memory array unreadable until unlocked by an authorized 64-bit "key". KEPROMs protect system software from unauthorized use. If more memory is needed, an optional iSBC 341 memory site expansion board can be added to provide an additional four JEDEC sites. Two iSBX MULTIMODULE™ boards can be added to the iSBC 186/03A board to customize the board's I/O capabilities. As shown in Figure 3, the iSBX connectors can support a single-board system with the analog input and output modules needed by machine or process control systems.

FUNCTIONAL DESCRIPTION

Architecture

The iSBC 186/03A board is functionally partitioned into six major sections: central processor, memory, SCSI compatible parallel interface, serial I/O, interrupt control and MULTIBUS bus expansion. These areas are illustrated in Figure 4.

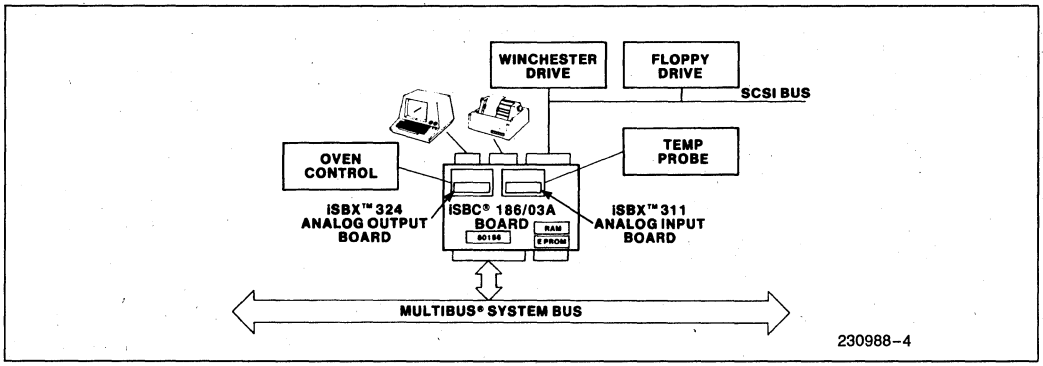


Figure 3. A Stand-Alone Single Board System Application

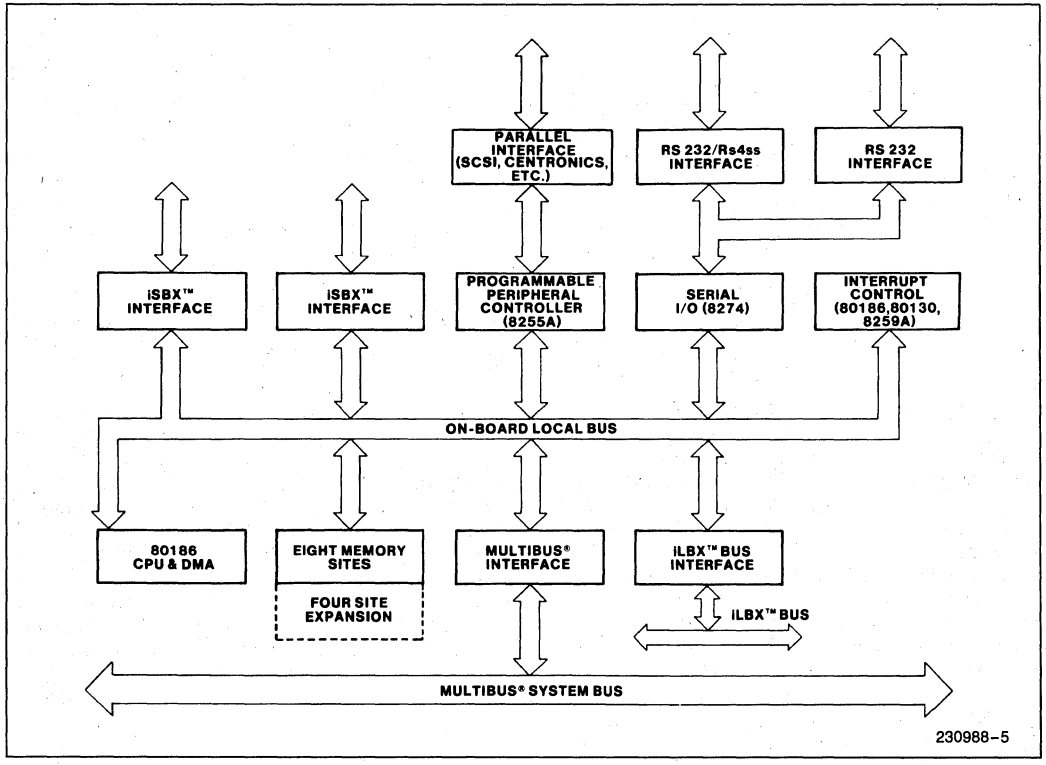


Figure 4. iSBC® 186/03A Board Block Diagram

CENTRAL PROCESSOR

The 80186 component is a high-integration 16-bit microprocessor. It combines several of the most common system components onto a single chip (i.e. Direct Memory Access, Interval Timers, Clock Generator and Programmable Interrupt Controller). The 80186 instruction set is a superset of the 8086. It maintains object code compatability while adding ten new instructions. Added instructions include: Block I/O, Enter and Leave subroutines, Push Immediate, Multiply Quick, Array Bounds Checking, Shift and Rotate by Immediate, and Pop and Push All.

Use of the 80130 component is limited to the 3 timers and 8 levels of interrupts available. Direct processor execution of the 16K bytes of iRMX 86 Operating System nucleus primitives is not supported.

An optional 8087 Numeric Data Processor may be installed by the user to dramatically improve the 186/03A board's numerical processing power. The interface between the 8087 and 80186 is provided by the factory-installed 82188 Integrated Bus Controller which completes the 80186 numeric data processing system. The 8087 Numeric Data Processor option adds 68 floating-point instructions and eight 80-bit floating point registers to the basic iSBC 186/03A board's programming capabilities. Depending on the application, the 8087 will increase the performance of floating point calculations by 50 to 100 times.

TIMERS

The 80186 provides three internal 16-bit programmable timers. Two of these are highly flexible and are connected to four external pins (two per timer). They can be used to count external events, time external events, generate nonrepetitive waveforms, etc. As shipped on the iSBC 186/03A board, these two timers are connected to the serial interface, and provide baud rate generation. The third timer is not connected to any external pins, and is useful for real-time coding and time-delay applications. In addition, this third timer can be used as a prescaler to the other two, or as a DMA request source. The 80130 provides three more programmable timers. One is a factory default baud rate generator and outputs an 8254 compatible square wave that can be used as an alternate baud rate source to either serial channel. The 80130's second timer is used as a system timer. The third timer is reserved for use by the iRMX Operating System. The system software configures each timer independently to select the desired function. Available functions include: interrupt on terminal count, programmable one-shot, rate generator, square-wave generator, software triggered strobe, hardware triggered strobe and event counter. The contents of each counter may be read at any time during system operation.

MEMORY

There are eight JEDEC 28-pin memory sites on the iSBC 186/03A board providing flexible memory expansion. Four of these sites (EPROM sites) may be used for EPROM or E^2PROM program storage, while the other four (RAM sites) may be used for static RAM or iRAM data storage or used as additional program storage. The eight sites can be extended to twelve by the addition of an iSBC 341 MULTIMODULE board. These additional sites will provide up to 64K bytes of RAM using 8K x 8 SRAM or iRAM devices. The EPROM sites (Bank B) are compatible with 8K x 8 (2764), 16K x 8 (27128A), 32K x 8 (27256), 64K x 8 (27512) as well as 2K x 8 (2817A) and 8K x 8 (2864) E^2PROMs. The RAM sites (Bank A) are compatible with all bytewide SRAM, iRAM or NVRAM devices. NVRAM usage requires additional circuitry in order to guarantee data retention. (Refer to AP-173 for further information.) Bank A can be reassigned to upper memory just below the assigned memory space for Bank B to support additional EPROM or E^2PROMs.

Memory addressing for the JEDEC sites depends on the device type selected. The four EPROM sites are top justified in the 1 MB address space and must contain the power-on instructions. The device size determines the starting address of these devices. The four RAM sites are, by default, located starting at address 0. The addressing of these sites may be relocated to upper memory (immediately below the EPROM site addresses) in applications where these sites will contain additional program storage. The optional iSBC 341 MULTIMODULE sites are addressable immediately above the RAM site addresses.

Power-fail control and auxiliary power are provided for protection of the RAM sites when used with static RAM devices. A memory protect signal is provided through an auxiliary connector (J4) which, when asserted, disables read/write access to RAM memory on the board. This input is provided for the protection of RAM contents during system power-down sequences. An auxiliary power bus is also provided to allow separate power to RAM for systems requiring battery back-up of read/write memory. Selection of this auxiliary RAM power bus is made via jumpers on the board.

SCSI PERIPHERAL INTERFACE

The iSBC 186/03A board includes a parallel peripheral interface that consists of three 8-bit parallel ports. As shipped, these ports are configured for general purpose I/O. The parallel interface may be reconfigured to be compatible with the SCSI disk interface by adding two user-supplied and programmed Programmable Array Logic (PAL) devices, moving jumpers and installing a user-supplied 74LS640-1 device. Alternatively, the parallel interface may be reconfigured as a DMA controlled Centronics compatible line printer interface by adding one PAL and changing jumpers. Refer to the iSBC 186/03A Hardware Reference Manual for PAL equations and a detailed implementation procedure.

The SCSI (Small Computer Systems Interface) interface allows up to 8 mass storage peripherals such as Winchester disk drives, floppy disk drives and tape drives to be connected directly to the iSBC 186/03A board. Intel's iSBC 186/03A board utilizes a single initiator, single target implementation of the SCSI bus specification. Bus arbitration and deselect/reselect SCSI features are not supported. Single host, multiple target configurations can be used. However, the iSBC 186/03A board will stay connected to one target until the transaction is completed before switching to the second target. The iSBC 186/03A board's SCSI interface implements a 5 megabit/second transfer rate. A sample SCSI application is shown in Figure 5. Intel tested iSBC 186/03A board compatible SCSI controllers include Adaptek 4500, DTC 1410, Iomega Alpha 10, Shugart 1601 and 1610, Vermont Research 8103 and Xebec 1410.

The Centronics interface requires very little software overhead since a PAL device is used to provide necessary handshake timing. Interrupts are generated for printer fault conditions and a DMA request is issued for every character. The interface supports Centronics type printers compatible with models 702 and 737.

SERIAL I/O

The iSBC 186/03A Single Board Computer contains two programmable communications interfaces using the Intel 8274 Multi-Protocol Serial Controller (MPSC).

Two 80186 timer outputs are used as software selectable baud rate generators capable of supplying the serial channels with common communications frequencies. An 80130 baud rate timer may be jumpered to either serial port to provide higher frequency baud rates. The mode of operation (i.e., asynchronous, byte synchronous or bisynchronous protocols), data format, control character format, parity, and baud rate are all under program control. The 8274 provides full duplex, double buffered transmit and receive capability. Parity, overrun, and framing error detection are all incorporated in the MPSC. The iSBC 186/03A board supports operation in the polled, interrupt and DMA driven interfaces through jumper options. The default configuration is with channel A as RS422A/RS449, channel B as RS232C. Channel A can optionally be configured to support RS232C. Both channels are default configured as data set (DCE). Channel A can be reconfigured as data terminal (DTE) for connection to a modem-type device.

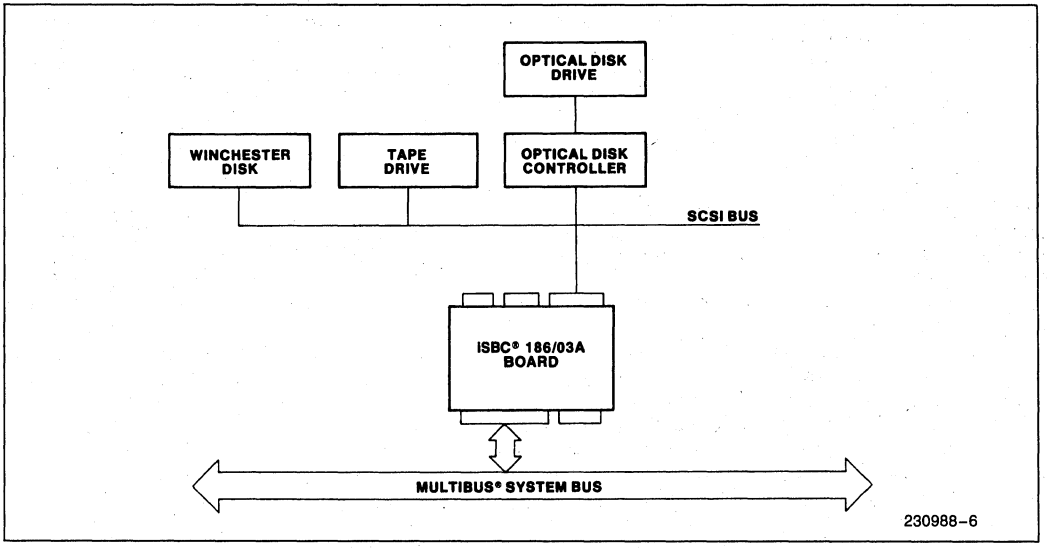


Figure 5. Sample SCSI Application

INTERRUPT CONTROL

The iSBC 186/03A board provides 27 on-board vectored interrupt levels to service interrupts generated from 33 possible sources.

The interrupts are serviced by four programmable interrupt controllers (PICs): one in the 80186 component, one in the 80130 component, one in the 8259A component and one in the 8274 component. The 80186, 8259A and 8274 PICs act as slaves to the 80130 master PIC. The highest priority interrupt is the Non-Maskable Interrupt (NMI) line which is tied directly to the 80186 CPU. This interrupt is typically used to signal catastrophic events (e.g. power failure). The PICs provide prioritization and vectoring for the other 26 interrupt requests from on-board I/O resources and from the MULTIBUS system bus. The PICs then resolve the requests according to the programmable priority resolution mode, and if appropriate, issue an interrupt to the CPU.

Table 1 contains a list of devices and functions capable of generating interrupts. These interrupt sources are jumper configurable to the desired interrupt request level.

Expansion

OVERVIEW

The iSBC 186/03A board architecture includes three bus structures: the MULTIBUS system bus, the iLBX local bus expansion and the iSBX MULTIMODULE expansion bus as shown in Figure 6. Each bus structure is optimized to satisfy particular system requirements. The system bus provides a basis for general system design including memory and I/O expansion as well as multiprocessing support. The iLBX bus allows large amounts of high performance memory to be accessed by the iSBC 186/03A board over a private bus. The iSBX MULTIMODULE expansion board bus is a means of adding inexpensive I/O functions to the iSBC 186/03A board. Each of these bus structures are implemented on the iSBC 186/03A board providing a flexible system architecture solution.

MULTIBUS® SYSTEM BUS—IEEE 796

The MULTIBUS system bus is an industry standard (IEEE 796) microcomputer bus structure. Both 8- and 16-bit single board computers are supported on the IEEE 796 structure with 20 or 24 address and 16 data lines. In its simplest application, the system bus allows expansion of functions already contained on a single board computer (e.g., memory and I/O). However, the IEEE 796 bus also allows very powerful distributed processing configurations with multiple processors and intelligent slave, I/O and peripheral boards capable of solving the most demanding microcomputer applications. The MULTIBUS system bus is supported with a broad array of board-level products, LSI interface components, detailed published specifications and application notes.

Table 1. Interrupt Request Sources

Device	Function	Number of Interrupts
MULTIBUS Bus Interface INT0–INT7	Requests from MULTIBUS Bus Resident Peripherals or Other CPU	8
8274 Serial Controller	Transmit Buffer Empty, Receive Buffer Full and Channel Errors	8
Internal 80186 Timer and DMA	Timer 0, 1, 2, Outputs (Function Determined by Timer Mode) and 2 DMA Channel Interrupts	5
80130 Timer Output	iRMX System Timer (SYSTICK)	1
iSBX Bus Connectors	Function Determined by iSBX MULTIMODULE Board	6 (3 per iSBX Connector)
Bus Fail-Safe Timer	Indicates Addressed MULTIBUS Bus Resident Device Has Not Responded to Command within 10 ms	1
8255A Parallel I/O Controller	Parallel Port Control	2
J4 Connector	External/Power-Fail Interrupts	2

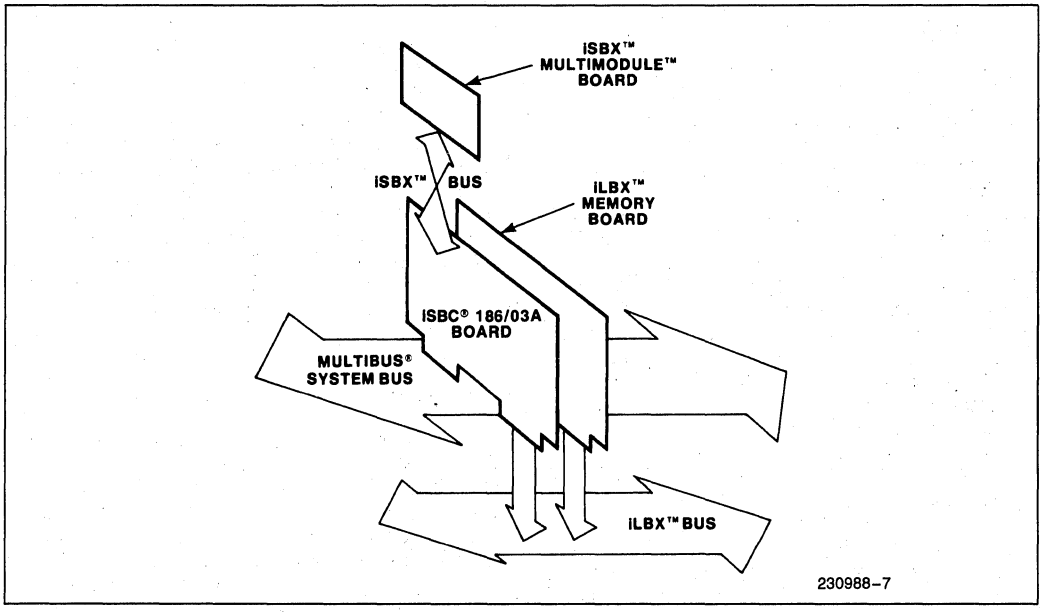


Figure 6. iSBC® 186/03A Board System Architecture

iLBX™ BUS—LOCAL BUS EXTENSION

The iSBC 186/03A board provides a local bus extension (iLBX) interface. This standard extension allows on-board memory performance with physically off-board memory. The combination of a CPU board and iLBX memory boards is architecturally equivalent to a single board computer and thus can be called a "virtual single board computer". The iLBX bus is implemented over the P2 connector and requires independent cabling or backplane connection.

iSBX™ BUS MULTIMODULE™ ON-BOARD EXPANSION

Two iSBX MULTIMODULE board connectors are provided on the iSBC 186/03A microcomputer board. Through these connectors, additional on-board I/O functions may be added. iSBX MULTIMODULE boards optimally support functions provided by VLSI peripheral components such as additional parallel and serial I/O, analog I/O, and graphics control. The iSBX bus connectors on the iSBC 186/03A board provide all signals necessary to interface to the local on-board bus, including 16 data lines for maximum data transfer rates. MULTIMODULE boards designed with 8-bit data paths and using the 8-bit iSBX connector are also supported on the iSBC 186/03A board. A broad range of iSBX MULTIMODULE options are available from Intel. Custom iSBX bus modules may also be designed. An iSBX bus interface specification is available from Intel.

OPERATING SYSTEM SUPPORT

Intel's iRMX 86 Operating System is a highly functional operation system with a very rich set of features and options based on an object-oriented architecture. In addition to being modular and configurable, functions include a sophisticated file management and I/O system, and a powerful human interface. The iRMX 86 Release 6 Operating System can be used with the iSBC 186/03A board to generate application code for iRMX 86 based systems.

NOTE:
Intel does not support the direct processor execution of the 16K bytes of the iRMX 86 Operating System nucleus primitives from the 80130 component.

DEVELOPMENT ENVIRONMENT

Intel offers numerous tools to aid in the development of iSBC 186/03A board applications. These include on-target development, full development systems, in-circuit emulators and programming languages. Some of the features of each are described below.

Using the iRMX 86 Operating System, software development can be performed directly on the iSBC 186/03A board. This on-target development is the most economical way to develop iSBC 186/03A board based projects.

The development cycle of iSBC 186/03A board products can be significantly reduced and simplified by using either the System 86/3XX (iRMX 86-based) or the Intellec® Series Microcomputer Development Systems.

The Integrated Instrumentation In-Circuit Emulator (I^2ICE™) provides the necessary link between an Intellec development system and the "target" iSBC 186/03A execution system. In addition to providing the mechanism for loading executable code and data into the iSBC 186/03A boards, the I^2ICE 186 emulator provides a sophisticated command set to assist in debugging software and final integration of the user hardware and software.

Intel has two systems implementation languages, PL/M 86 and C 86. Both are available for use on the iRMX 86 Operating System, on the System 86/3XX and on the Intellec Microcomputer Development System. PL/M 86 provides the capability to program in algorithmic language and eliminates the need to manage register usage or allocate memory while still allowing explicit control of the system's resources when needed. C 86 is especially appropriate in applications requiring portability and code density. FORTRAN 86, PASCAL 86, and BASIC 86 are also available on the iRMX 86 operating system, on the System 86/3XX and on the Intellec development system.

SPECIFICATIONS

Word Size

Instruction—8, 16, 24 or 32 bits
Data—8 or 16 bits

System Clock

8.0 MHz

Numeric Data Processor (Optional)

8087-1

Basic Instruction Cycle Time

750 ns
250 ns (assumes instruction in the queue)

NOTE:
Basic instruction cycle is defined as the fastest instruction time (i.e. two clock cycles plus instruction fetch). Zero wait-state memory is assumed.

MEMORY RESPONSE TIMES

Device Type	Max Access Time (from Chip Enable)	Min Cycle Time
EPROM Memory Sites		
0 Wait States	245 ns	318 ns
1 Wait State	370 ns	443 ns
RAM Memory Sites with SRAMs or EPROMs		
0 Wait States	197 ns	318 ns
1 Wait States	322 ns	443 ns
with 2186 IRAMs		
1 Wait State	261 ns	443 ns
2 Wait States	386 ns	568 ns

NOTE:
The number of wait states inserted is jumper selected depending on memory device specifications.

MEMORY CAPACITY/ADDRESSING

Four EPROM Sites		
Device	**Capacity**	**Address Range**
2764 EPROM	32 KB	$F8000_H$–$FFFFF_H$
27128 EPROM	64 KB	$F0000_H$–$FFFFF_H$
27256 EPROM	128 KB	$E0000_H$–$FFFFF_H$
27512 EPROM	256 KB	$C0000_H$–$FFFFF_H$
Four RAM Sites		
Device	**Capacity**	**Address Range**
2K SRAM	8 KB	0–$01FFF_H$
8K SRAM	32 KB	0–$07FFF_H$
32K SRAM	128 KB	0–$1FFFF_H$
2186 RAM	32 KB	0–$07FFF_H$
2817A E^2PROM	8 KB	$F0000_H$–$F7FFF_H$*
2764 EPROM	32 KB	$F0000_H$–$F7FFF_H$ (below EPROM Sites)
27128 EPROM	64 KB	$E0000_H$–$EFFFF_H$ (below EPROM Sites)
27256 EPROM	128 KB	$C0000_H$–$DFFFF_H$ (below EPROM Sites)
Four iSBC® 341 Expansion Sites		
Device	**Capacity**	**Address Range**
2K SRAM	8 KB	02000_H–$03FFF_H$
8K SRAM	32 KB	08000_H–$0FFFF_H$
32K SRAM	128 KB	10000_H–$1FFFF_H$
2186 RAM	32 KB	08000_H–$0FFFF_H$
2817A E^2PROM	8 KB	02000_H–$03FFF_H$**

NOTE:
All on board memory is local to the CPU (i.e. not dual-ported).

*Must use 8k x 8 decode option, there are four copies of the E^2PROM in the 8K x 8 address area.

**(May be mixed with 2K x 8 SRAM)

Serial Communications Characteristics

Synchronous— 5–8 bit characters, internal or external character synchronization; automatic sync insertion; break character generation

Asynchronous— 5–8 bit characters; 1, ½, or 2 stop bit; false start bit detection.

Common Baud Rates	
Using 80186 Timers:	**Using 80130 Timer:**
500K	750K
125K	500K
64K	125K
48K	64K
19.2K	48K
9600	19.2K
4800	9600
2400	4800
1200	2400
600	1200
300	600
150	300
110*	150
75*	110*
	75*

*Asynchronous use only

NOTE:
Frequency selected by I/O write of appropriate 16-bit frequency factor to baud rate register of 80186 or 80130 timers.

Timer Input Frequency

80186 Reference: 2.0 MHz ±0.1%
80130 Reference: 8.0 MHz ±0.1%

Interface Compliance

MULTIBUS— IEEE 796 compliance: Master D16 M24 116 VO EL

iSBX Bus— Two 8/16 bit iSBX bus connectors allow use of up to 2 single-wide modules or 1 single-wide and 1 double-wide module. Intel iSBX bus compliance: D16/16 DMA

iLBX— Intel iLBX bus compliance: PM D16

Serial— Channel A: Configurable as RS 422A or RS 232C compatible, configurable as a data set or data terminal

Channel B: RS 232C compatible, configured as data set

Parallel I/O— SCSI (ANSI—X3T9, 2/82-s) compatible or Centronics 702 or 737 compatible (requires user supplied PALs and 74LS640-1)

CONNECTORS

Interface	Double-sided Pins	Mating Connectors
MULTIBUS System	86 (P1)	Viking 3KH43/9AMK12 Wire Wrap
	60 (P2)	Viking 3KH30/9JNK
iSBX Bus 8-Bit Data	36	Viking 000292-0001
16-Bit Data	44	Viking 000293-0001
Serial I/O	26	3M 3452-0001 Flat AMP88106-1 Flat
iLBX Bus	60	Kelam RF30-2853-542
Parallel Interface	50	3M 3425-6000 3M 3425-6050 w/strain Ansley 609-5001M

ORDERING INFORMATION

Part Number	Description
SBC 186/03A	186-based single board computer

REFERENCE MANUAL

iSBC® 186/03A Single Board Computer Hardware Reference Manual—Order Number 148060

PHYSICAL CHARACTERISTICS

Width: 12.00 in. (30.48 cm)
Length: 7.05 in (17.90 cm)
Height: 0.50 in. (1.78 cm)
Weight: 13 ounces

ENVIRONMENTAL CHARACTERISTICS

Operating Temperature: 0°C to 60°C at 6 CFM airflow over the board.

Relative Humidity: to 90% (without condensation)

ELECTRICAL CHARACTERISTICS

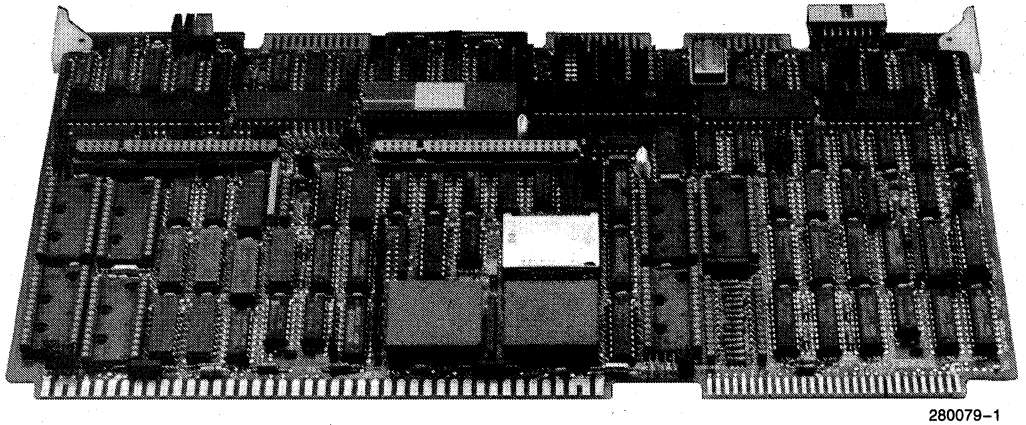
The maximum power required per voltage is shown below. These numbers do not include the power required by the optional memory devices, SCSI PALs, battery back-up or expansion modules.

Voltage (volts)	Max. Current (amps)	Max Power (watts)
+5	5.4	27
+12	0.04	0.48
−12	0.04	0.48

iSBC® 286/10A SINGLE BOARD COMPUTER

- 8 MHz 80286 Microprocessor
- Supports User Installed 80287 Numeric Data Processor
- iLBX™ Interface for iLBX Memory Board Expansion
- 0 Wait-State Synchronous Interface to EX Memory Expansion Boards
- Eight JEDEC 28-Pin Sites for Optional SRAM/iRAM/EPROM/E²PROM Components
- Optional Expansion to Sixteen JEDEC 28-Pin Sites with Two iSBE® 341 Boards
- Maximum On-Board Memory Capacity 384 KB
- Two iSBX™ Bus Interface Connectors for I/O Expansion
- 16 Levels of Vectored Interrupt Control
- Centronics-Compatible Parallel I/O Printer Interface
- Two Programmable Multiprotocol Synchronous/Asynchronous Serial Interfaces; One RS232C, the Other RS232C or RS422/449 Compatible

The iSBC® 286/10A Single Board Computer is a member of Intel's complete line of microcomputer modules and systems which take advantage of Intel's VLSI technology to provide economical, off-the-shelf, computer-based solutions for OEM applications. The board is a complete microcomputer system on a 6.75 x 12.0 inch printed circuit card. The CPU, system clock, memory sockets, I/O ports and drivers, serial communications interface, priority interrupt logic and programmable timers all reside on the board. The iSBC 286/10A board offers both a standard iLBX interface for high-speed memory access to Intel's series of iLBX memory boards and a new, 0 wait-state, synchronous interface for use with Intels EX series of memory boards. The iSBC 286/10A Single Board Computer is fully compatible with its predecessor, the iSBC 286/10A board, and can be used in applications originally designed for the earlier model.



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* XENIX™ is a trademark of MICROSOFT Inc.
* UNIX® is a registered trademark of BELL Labs.

September 1987
Order Number: 280079-005

FUNCTIONAL DESCRIPTION

Overview

The iSBC 286/10A board utilizes the powerful 80286 CPU within the MULTIBUS® system architecture, enhanced by the industry standard iLBX bus and a new, 0 wait-state, synchronous memory interface, to provide a high performance 16-bit solution. This board also includes on-board interrupt, memory and I/O features facilitating a complete signal board computer system. The iSBC 286/10A board is designed to be fully compatible with the iSBC 286/10 board, and only minor changes to software timing loops may be required.

Central Processing Unit

The central processor for the iSBC 286/10A board is the 80286 CPU operating at a 8.0 MHz clock rate. The 80286 CPU is upwardly compatible with Intel's 8088 and iAPX 86 CPUs. The 80286 CPU runs 8088 and 86 code at substantially higher speeds due to it's parallel chip architecture. In some cases, software timing loops may have to be adjusted to accommodate the faster CPU clock. In addition, the 80286 CPU provides on chip memory management and protection and virtual memory addressing of up to 1 gigabyte per task. Numeric processing power may be enhanced with the user installed 80287 numerics processor. The clock rates for the 80286 and the 80287 are independent with the 80287 rate jumper selectable at either 5.3 or 8.0 MHz.

Instruction Set

The 80286 instruction repertoire includes variable length instruction format (including double operand instructions), 8-bit and 16-bit signed and unsigned arithmetic operators for binary, BCD and unpacked ASCII data, and iterative word and byte string manipulation functions.

For enhanced numerics processing capability, the 80287 Numeric Data Processor extends the 80286 architecture and data set. Over 60 numeric instructions offer arithmetic, trigonometric, transcendental, logarithmic and exponential instructions. Supported data types include 16-, 32-, and 64-bit integer, 32- and 64-bit floating point, 18-digit packed BCD and 80-bit temporary. The 80287 meets the proposed IEEE P754 standard for numeric data processing and maintains compatibility with 8087-based systems.

Architectural Features

The 8086, 8088, 80186 and the 80286 microprocessor family contains the same basic set of registers, instructions, and addressing modes. The 80286 processor is upward compatible with the 8086, 8088, and 80186 CPUs.

The 80286 operates in two modes: 8086 real address mode, and protected virtual address mode. In 8086 real address mode, programs use real address with up to one megabyte of address space. Programs use virtual addresses in protected virtual address mode, also called protected mode. In protected mode, the 80286 CPU automatically maps 1 gigabyte of virtual addresses per task into a 16 megabyte real address space. This mode also provides memory protection to isolate the operating system and ensure privacy of each task's programs and data. Both modes provide the same base instruction set, registers, and addressing modes.

VECTORED INTERRUPT CONTROL

Incoming interrupts are handled by two on-board 8259A programmable interrupt controllers and by the 80286's NMI line. Interrupts originating from up to 16 sources are prioritized and then sent to the CPU as a vector address. Further interrupt capability is available through bus vectored interrupts where slave 8259 interrupt controllers are resident on separate iSBC boards and are then cascaded into the on-board interrupt control.

INTERRUPT SOURCES

Twenty-three potential interrupt sources are routed to the interrupt jumper matrix where the user can connect the desired interrupt sources to specific interrupt levels. Table 1 includes a list of devices and functions supported by interrupts.

MEMORY CAPABILITIES

There are a total of eight 28-pin JEDEC sites on board. Four sites are for local memory and can contain up to 256K bytes of EPROM devices. The four other sites are known as the dual-port memory and may be addressed by the MULTIBUS interface and the on-board CPU bus. Up to 128K bytes of either iRAM, SRAM, EPROM, or E^2PROM can reside in these sites. Both the local and dual-port memory can be expanded to eight sites each by using two iSBC 341 JEDEC expansion modules. In this way, smaller size memory devices can be used up to the 256KB (local) and 128KB (dual-port) memory capacities.

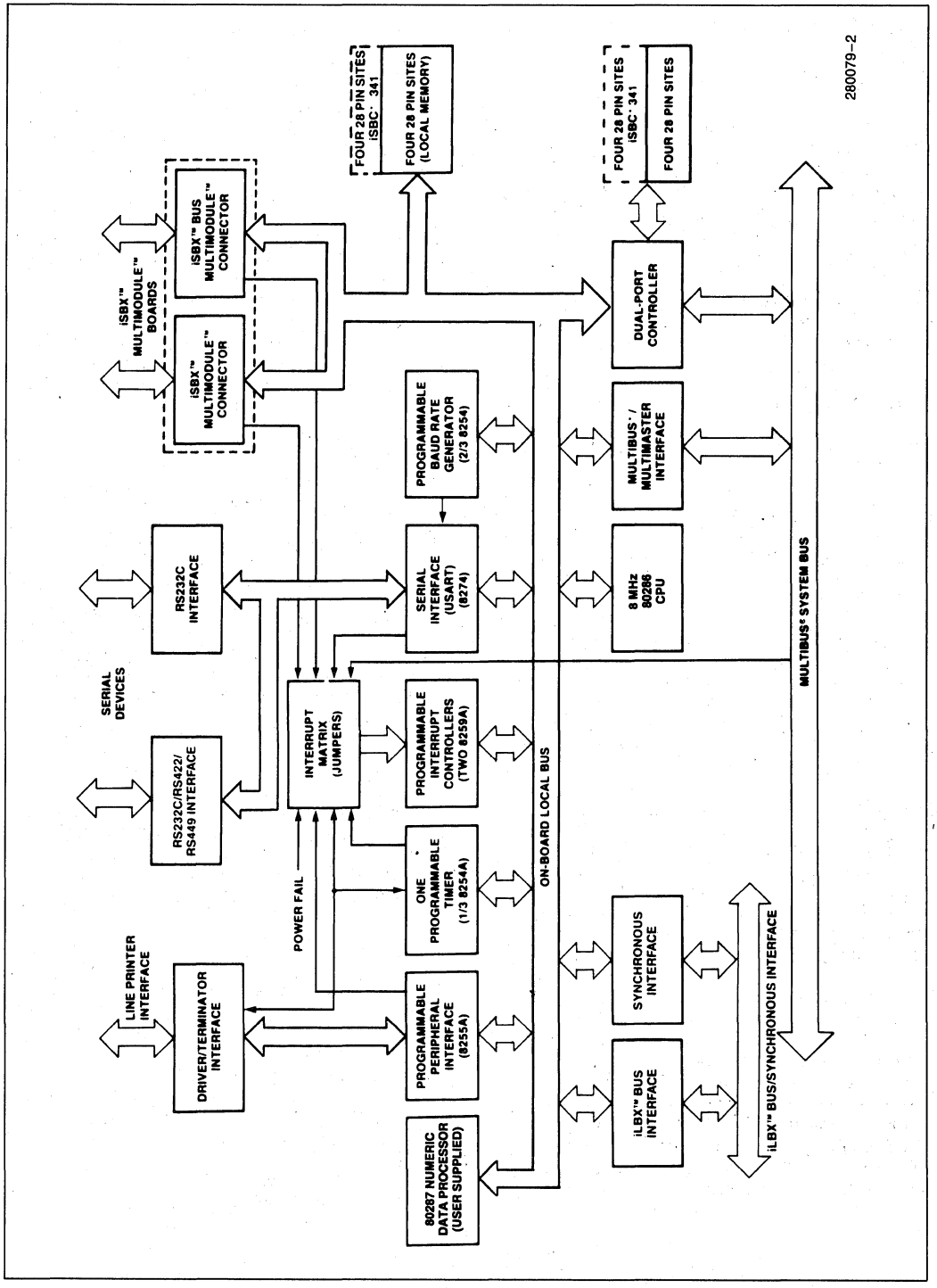


Figure 1. iSBC® 286/10A Block Diagram

Table 1. Interrupt Request Sources

Device	Function	Number of Interrupts
MULTIBUS Interface	Requests from MULTIBUS Resident Peripherals or Other CPU Boards	8*
8259A Programmable Interrupt Conroller	8 Level Vectored Interrupt Request Cascaded to Master 8259A	1
8274 Serial Controller	8 Level Vectored Interrupt Request Cascaded to Master 8259A	1
8255A Line Printer Interface	Signals Output Buffer Empty	1
8254 Timers	Timer 0, 1 Outputs; Function Determined by Timer Mode	2
iSBX Connectors	Function Determined by iSBX MULTIMODULE Board	4 (2 per iSBX™ Connector)
Bus Fail Safe Timer	Indicates Addressed MULTIBUS Resident Device Has not Responded to Command within 6 ms	1
Power Fail Interrupt	Indicates AC Power Is not within Tolerance	1
External Interrupt	General Purpose Interrupt from Auxiliary Connector, Commonly Used as Front Panel Interrupt	1
On-Board Logic	Conditioned Interrupt Source from Edge Sense Latch, Inverter, or OR Gate	3

* May be expanded to 56 with slave 8259A PICs on MULTIBUS* boards

SERIAL I/O

A two channel serial communications interface using Intel's 8274 Multi-Protocol Serial Controller (MPSC) is contained on the iSBC 286/10 board. Two independent software selectable baud rate generators provide the MPSC with all common communication frequencies. The protocol (i.e., asynchronous, IBM* bisync, or SDLC/HDLC), data format, control character format, parity and baud rate are all under program control. Software interfacing to the MPSC can be via either a polled or interrupt driven routine. One channel may be configured for an RS232C or RS422/RS449 interface with the other channel RS232C only. The data, command and signal ground lines for each channel are brought out to two 26-pin edge connectors.

PROGRAMMABLE TIMERS

The iSBC 286/10A board provides three independent, fully programmable 16-bit interval timers/event counters utilizing the Intel 8254 Programmable Interval Timer. Each counter is capable of operating in either BCD or binary modes. Two of these timers/counters are available to the systems designer to generate accurate time intervals under software control. Routing for the outputs of these counters is jumper selectable. The outputs may be independently routed to the 8259A Programmable Interrupt Controller or to the 8274 MPSC to count external events or provide baud rate generation. The third interval timer in the 8254 is dedicated to providing a clock for the programmable baud rate generator in the iSBC 286/10A board's MPSC serial controller. The system software configures each timer independently to select the desired function. Seven functions are available as shown in Table 2. The contents of each counter may be read at any time during system operation.

LINE PRINTER INTERFACE

An 8255A Programmable Peripheral Interface (PPI) provides a line printer interface, several on-board functions, and four non-dedicated input bits. Drivers are provided for a complete Centronics compatible line printer interface. The on-board functions implemented with the PPI are power fail sense, override, NMI mask, non-volatile RAM enable, clear timeout interrupt, LED 0 and 1, clear edge sense flop, MULTIBUS interrupt, and serial channel A loopback. The PPI's I/O lines are divided into three eight bit ports: A, B, and C. Four non-dedicated input bits allow the state of four user-configured jumper connections to be input. The PPI must be programmed for mode 0 with ports A and C used as outputs and port B as input. A 16-bit write to Port B is used to set the iSBC 286/10A board into 24-bit address mode. The parallel port assignment is shown in Table 3.

Table 2. Programmable Time Functions

Function	Operation
Interrupt on Terminal Count	When terminal count is reached, an interrupt request is generated. This function is extremely useful for generation of real-time clocks.
Programmable One-Shot	Output goes low upon receipt of an external trigger edge or software command and returns high when terminal count is reached. This function is retriggerable.
Rate Generator	Divide by N counter. The output will go low for one input clock cycle, and the period from one low going pulse to the next is N times the input clock period.
Square-Wave Rate Generator	Output will remain high until one-half the count has been completed, and go low for the other half of the count.
Software Triggered Strobe	Output remains high until software loads count (N). N counts after count is loaded, output goes low for one input clock period.
Hardware Triggered Strobe	Output goes low for one clock period N counts after rising edge counter trigger input. The counter is retriggerable.
Even Counter	On a jumper selectable basis, the clock input becomes an input from the external system. CPU may read the number of events occurring after the counter "window" has been enabled or an interrupt may be generated after N events occur in the system.

Table 3. Parallel Port Bit Assignment

Port A—Output	
Bit	**Function**
0	Line Printer Data Bit 0
1	Line Printer Data Bit 1
2	Line Printer Data Bit 2
3	Line Printer Data Bit 3
4	Line Printer Data Bit 4
5	Line Printer Data Bit 5
6	Line Printer Data Bit 6
7	Line Printer Data Bit 7
Port B—Input	
Bit	**Function**
0	General Purpose Input 0
1	General Purpose Input 1
2	General Purpose Input 2
3	General Purpose Input 3
4	Line Printer ACK/ (Active Low)
5	Power Fail Sense/ (Active Low)
6	Line Printer Error (Active Hi)
7	Line Printer Busy (Active Hi)
Port C—Output	
Bit	**Function**
0	Line Printer Data Strobe (Active Hi)
1	Override/ (Active Low)
2	NMI Mask (0 = NMI Enabled)
3	Non-Volatile RAM Enable; Clear Timeout Interrupt/
4	LED 0 (1 = On); Clear Edge Sense Flop/
5	MULTIBUS Interrupt (1 = Active)
6	Serial CHA Loopback (0 = Online, 1 = Loopback)
7	LED 1 (1 = On); Clear Line Printer Ack Flop/

MULTIBUS® SYSTEM ARCHITECTURE

Overview

The MULTIBUS system architecture includes three bus structures: the system bus, the local bus extension and the MULTIMODULE expansion bus as shown in Figure 2. Each bus structure is optimized to satisfy particular system requirements. The system bus provides a basis for general system design including memory and I/O expansion as well as multiprocessing support. The local bus extension allows large amounts of high performance memory to be accessed from a CPU board over a private bus. The MULTIMODULE extension bus is a means of adding inexpensive I/O functions to a base CPU board. Each of these three bus structures are implemented on the iSBC 286/10A board providing a total system architecture solution.

SYSTEM BUS—IEEE 796

The MULTIBUS system bus is Intel's industry standard, IEEE 796, microcomputer bus structure. Both 8- and 16-bit single board computers are supported on the IEEE 796 structure with 24 address and 16 data lines. In its simplest application, the system bus allows expansion of functions already contained on a single board computer (e.g., memory and digital I/O). However, the IEEE 796 bus also allows very powerful distributed processing configurations using multiple processors, I/O boards, and peripheral boards. The MULTIBUS system bus is supported with a board array of board level products. VLSI interface components, detailed published specifications and application notes.

SYSTEM BUS—EXPANSION CAPABILITIES

Memory and I/O capacity may be expanded and additional functions added using Intel MULTIBUS compatible expansion boards. Memory may be expanded by adding user specified combinations of RAM boards, EPROM boards, bubble memory boards, or combination boards. Input/output capacity may be added with digital I/O and analog I/O expansion boards. Mass storage capability may be achieved by adding single or double density diskette controllers, or hard disk controllers. Modular expandable backplanes and cardcages are available to support multiboard systems.

SYSTEM BUS—MULTIMASTER CAPABILITIES

For those applications requiring additional processing capacity and the benefits of multiprocessing (i.e., several CPUs and/or controllers logically sharing system tasks through communication of the system bus), the iSBC 286/10A board provides full system bus arbitration control logic. This control logic allows up to three iSBC 286/10A board or other bus masters, including the iSBC 80 board family of MULTIBUS compatible 8-bit single board computers to share the system bus using a serial (daisy chain) priority scheme and allows up to 16 masters to share the MULTIBUS system bus with an external parallel priority decoder. In addition to multiprocessing configuration made possible with multimaster capability, it also provides a very efficient mechanism for all forms of DMA (Direct Memory Access) transfers.

HIGH SPEED OFF-BOARD MEMORY

The iSBC 286/10A board can access off-board memory either over the MULTIBUS (P1) interface, or over the P2 interface as shown in Figure 3. Memory transfers over the P2 interface are faster because the CPU board doesn't have to arbitrate for access to the MULTIBUS interface.

Using the P2 interface, the iSBC 286/10A Board can be configured to operate with either a standard iLBX interface or with a high-performance, synchronous interface.

The iSBC 286/10A Board as supplied is configured to operate with a synchronous, P2 interface. This high-performance interface is designed to connect to Intel's new EX series of memory expansion boards to yield a CPU to memory read/write time of 0 wait-states. The EX memory expansion boards are available in sizes ranging from 512K bytes up to 4M

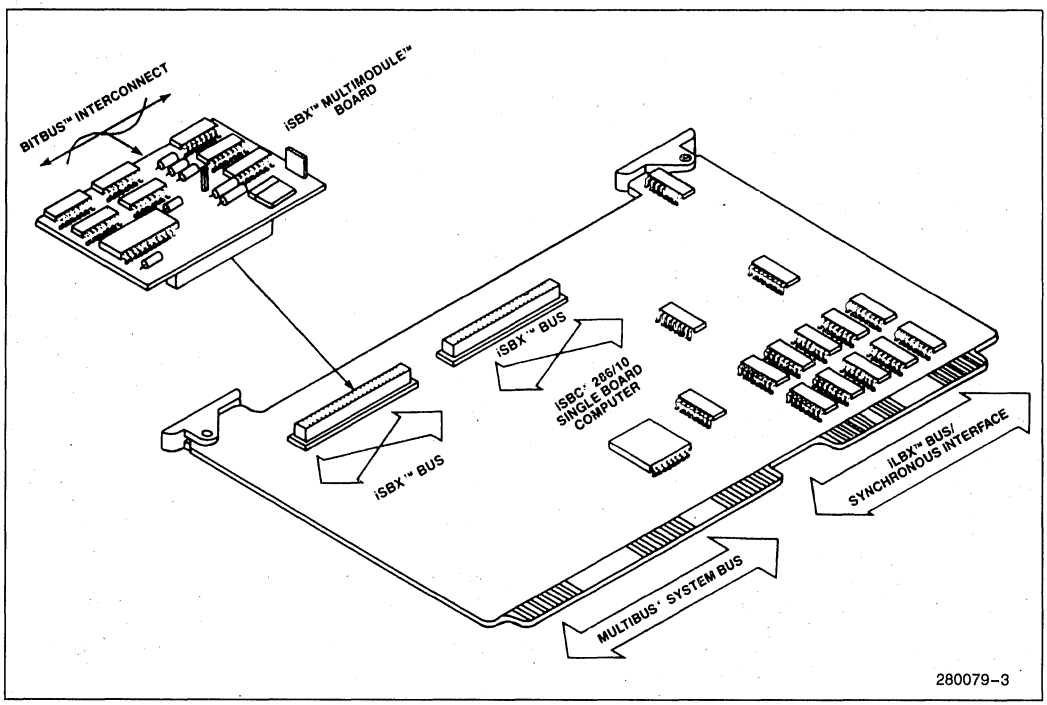


Figure 2. MULTIBUS® System Architecture

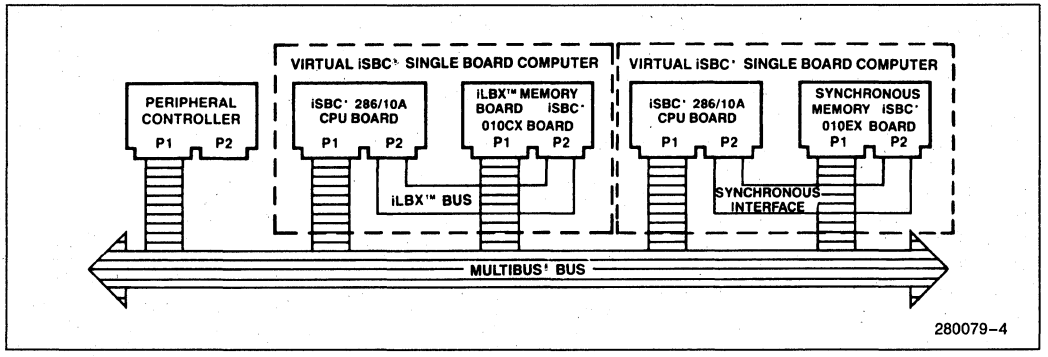


Figure 3. MULTIBUS®/iLBX™/Synchronous Interface Configurations

bytes and available in sizes ranging from 512K bytes up to 2M bytes. Memory expansion boards from other manufacturers that meet the iLBX standard may also be used. CPU to memory access time is usually 1 or more wait-states depending on the speed of the memory used.

A total of four memory boards can be placed on the iLBX or synchronous interface bus. With 4M byte memory boards, this results in a total of 16M bytes on the memory expansion bus.

iSBX™ BUS MULTIMODULE™ ON-BOARD EXPANSION

Two 8/16-bit iSBX MULTIMODULE connectors are provided on the iSBC 286/10A microcomputer board. Through these connectors, additional on-board I/O functions may be added. iSBX MULTIMODULEs optimally support functions provided by VLSI peripheral components such as additional parallel and serial I/O, analog I/O, small mass storage device controllers (e.g., bubble cassettes and floppy disks), and other custom interfaces to meet specific needs. By mounting directly on the single board computer, less interface logic, less power, simpler packaging, higher performance, and lower cost result when compared to other alternatives such as MULTIBUS Board form factor compatible boards. The iSBX interface connectors on the iSBC 286/10A provide all signals necessary to interface to the local on-board bus, including 16 data lines for maximum data transfer rates. iSBX MULTIMODULE boards designed with 8-bit data paths and using the 8-bit iSBX connector are also supported on the iSBC 286/10A microcomputer board. A broad range of iSBX MULTIMODULE options are available from Intel. Custom iSBX modules may also be designed. An iSBX bus interface specification and iSBX connectors are available from Intel.

Software Support

Software support from Intel includes the iRMX 86, iRMX 286, and XENIX* operating systems, assembly and high level languages, development systems, in-circuit emulators, and various other hardware and software tools.

For those applications needing a real-time, multitasking operating system, Intel offers the iRMX 86 and iRMX 286 operating systems. The iRMX operating systems are particularly well suited for industrial or commercial applications where the processor is simultaneously controlling multiple, real-time, interrupt intensive processes. Typical applications include machine and process control, data aquisition, signal processing, front-end processing, and digital PABX control. The iRMX operating systems employ a highly configurable, modular structure that allows easy system configuration and expansion.

The iRMX 86 operating system enables the iSBC 286/10A board to address up to 1MB of memory in real address mode. Using the iRMX 286 operating system, this address range is extended to 16 MB in native mode. The iRMX 286 operating system also allows the user to take advantage of the hardware traps built into the 80286 processor that provide expanded debug capabilities and increased code reliability.

Application code written for the iRMX 86 operating system can be compiled using 286 compilers to run under the iRMX 286 operating system. Application code will require only minor changes.

Assembly and many high level languages are supported by the iRMX operating systems and Intellec® Series IV development systems. Language support for the iSBC 286/10A board in real address board

includes Intel's ASM 86, PL/M 86, PASCAL 86, FORTRAN 86, and C86, as well as many third party 8086 languages. Language support for native address mode include ASM 286, PL/M 286, PASCAL 286 and FORTRAN 286. Programs developed in these languages can be downloaded from an Intel System 310 or Series IV Development System to the iSBC 286/10A board via the iSDM System Debug Monitor. The iSDM monitor also provides on-target program debugging support including breakpoint and memory examination features.

Intel also offers the XENIX operating system which is designed for those applications needing an interactive, multiple user system. Typical applications include small business systems, software development/engineering workstations, distributed data processing, communications, and graphics.

Intel's XENIX operating system is a fully licensed derivative of UNIX*, enhanced by Intel to provide device driver support for Intel board and component products plus other features that yield greater flexibility, increased reliability, and easier configurability. Intel's XENIX operating system has been optimized for use with the 80286 microprocessor and supports such features as on-chip memory management and protection which provide ease of portability and higher performance.

Applications software can be written in either Intel's FORTRAN, COBOL, or BASIC languages using a XENIX-based, Intel 286/310 or 286/380 system, or by using an Intel iDIS™ Database Information System. The user can also select from a wide variety of existing third party languages and applications software.

SPECIFICATIONS

Word Size

Instruction—8, 16, 24, 32 or 40 bits
Data—8 or 16 bits

System Clock

CPU—8.0 MHz
Numeric Processor—5.3 or 8.0 MHz (Jumper Selectable)

Cycle Time

Basic Instruction—8.0 MHz—375 ns; 250 ns (assumes instruction in queue)

NOTE:
Basic instruction cycle is defined as the fastest instruction time (i.e., two clock cycles)

Local Memory

Number of sockets—Four 28-pin JEDEC sites, expandable to 8 sites using iSBC 341 JEDEC Expansion Module

Maximum Size—256 KB

Compatible Devices—EPROM, up to 64K x 8 (Intel 27512)

Dual-Port Memory

Number of sockets—Four 28-pin JEDEC sites, expandable to 8 sites using iSBC 341 JEDEC Expansion Module

Maximum Size—128 KB

Compatible Devices—EPROM, up to 32K x 8 (Intel 27256)

SRAM
iRAM, up to 8K x 8 (Intel 2186)
E^2PROM, up to 2K x 8 (Intel 2817A)

Off-Board Physical Memory

Operating System	Address Mode	Size
iRMX 86 Rlse. 6	Real	1MB
iRMX 286 Rlse. 1	Native	16 MB
XENIX Rlse. 3	Native	16 MB

I/O Capability

Parallel—Line printer interface, on-board functions, and four non-dedicated input bits

Serial—Two programmable channels using one 8274 device

Timers—Three programmable timers using one 8254 device

Expansion—Two 8/16-bit iSBX MULTIMODULE connectors

BAUD RATES

Frequency (kHz) (Software Selectable)	Baud Rate (Hz)				
	Synchronous	Asynchronous			
Reference: 1.23 MHz	÷1	÷1	÷16	÷32	÷64
615.	615,000	615,000	38,400	19,200	9,600
307.	307,000	307,000	19,200	9,600	4,800
154.	154,000	154,000	9.600	4,800	2,400
76.8	76,800	76,800	4,800	2,400	1,200
56.0	56,000	—	—	—	—
38.4	38,400	38,400	2,400	1,200	600
19.2	19,200	19,200	1,200	600	300
9.6	9,600	9.600	600	300	150
4.6	4,800	4,800	300	150	75
2.4	2,400	2,400	150	75	—
1.2	1,200	1,200	75	—	—
0.6	600	600	—	—	—

Serial Communications Characteristics

Synchronous—5–8 bit characters; internal or HDLC/SDLC character synchronization; automatic sync insertion; even or odd parity

Asynchronous—5–8 bit characters; break character generation; 1, 1½, or 2 stop bits; false start bit detection; even or odd parity

Interrupt Capacity

Potential Interrupt Sources—25, 5 fixed, 20 jumper selectable

Interrupt Levels—16 vectored requests using two 8259As and the 80286's NMI line.

Timers

Input Frequencies—1.23 MHz ±0.1% or 3.00 MHz ±0.1% (Jumper Selectable)

OUTPUT FREQUENCIES/TIMING INTERVALS

Function	Single Timer/Counter		Dual Timer/Counter (two timers cascaded)	
	Min	Max	Min	Max
Real-Time Interrupt	667 ns	53.3 ms	1.33 μs	58.2 min
Programmable One-Shot	667 ns	53.3 ms	1.33 μs	58.2 min
Rate Generator	18.8 Hz	1.50 MHz	0.000286 Hz	750 kHz
Square-Wave Rate Generator	18.8 Hz	1.50 MHz	0.000286 Hz	750 kHz
Software Triggered Strobe	667 ns	53.3 ms	1.33 μs	58.2 min
Hardware Triggered Strobe	667 ns	53.3 ms	1.33 μs	58.2 min
Event Counter	—	8.0 MHz	—	—

MATING CONNECTORS (OR EQUIVALENT PART)

Function	# of Pins	Centers (in)	Connector Type	Vendor	Vendor Part No.
iSBX Bus Connector 16-Bit (J5, J6)	44	0.1	Soldered	Viking	000293-001
I/O Connectors (J1–J3)	26	0.1	Flat Crimp	3M	3462-0001
Front Panel Connector (J4)	14	0.5	Flat Crimp	3M	3385-6014
iLBX/Synch. Interface Edge Connector (P2)	60	0.1	Flat Crimp	KEL-AM T & B Ansley	RF30-2803-5 A3020

INTERFACES

MULTIBUS Bus—All signals TTL compatible

iSBX Bus—All signals TTL compatible

iLBX Bus—All signals TTL compatible

Synchronous Interface—All signals TTL compatible

Serial I/O—Channel A: RS232C/RS422/RS449 compatible, DCE or DTE; Channel B; RS232C compatible, DCE only

NOTE:
User supplied 34487 line driver and SIP termination resistor need to be installed for RS422/RS499 operation.

Timer—All signals TTL compatible

Interrupt Requests—All TTL compatible

MULTIBUS® DRIVERS

Function	Characteristic	Sink Current (mA)
Data	Tri-State	16
Address	Tri-State	16
Commands	Tri-State	32
Bus Control	Open Collector	20

iLBX™ DRIVERS

Function	Characteristic	Sink Current (mA)
Data	Tri-State	9
Address	Tri-State	20
Commands	Tri-State	8
Bus Control	TTL	8

Physical Characteristics

Width: 12.00 in. (30.48 cm)
Height: 6.75 in. (17.15 cm)
Depth: 0.4 in. (1.0 cm)
Minimum Slot Spacing: 0.6 in. (1.5 cm)
Weight: 14 oz. (397 gm)

Electrical Characteristics

DC Power Requirements: +5V, 7.0A; ±12V, 50 mA (serial I/O)

NOTE:
Does not include power for optional EPROM, E^2PROM, or RAM memory devices, or installed MULTIMODULE boards

Environmental Characteristics

Operating Temperature: 0°C to 60°C with 7 CFM airflow across board

Relative Humidity: to 90% (without condensation)

Reference Manual

147532-001—iSBC® 286/10A Hardware Reference Manual (order separately)

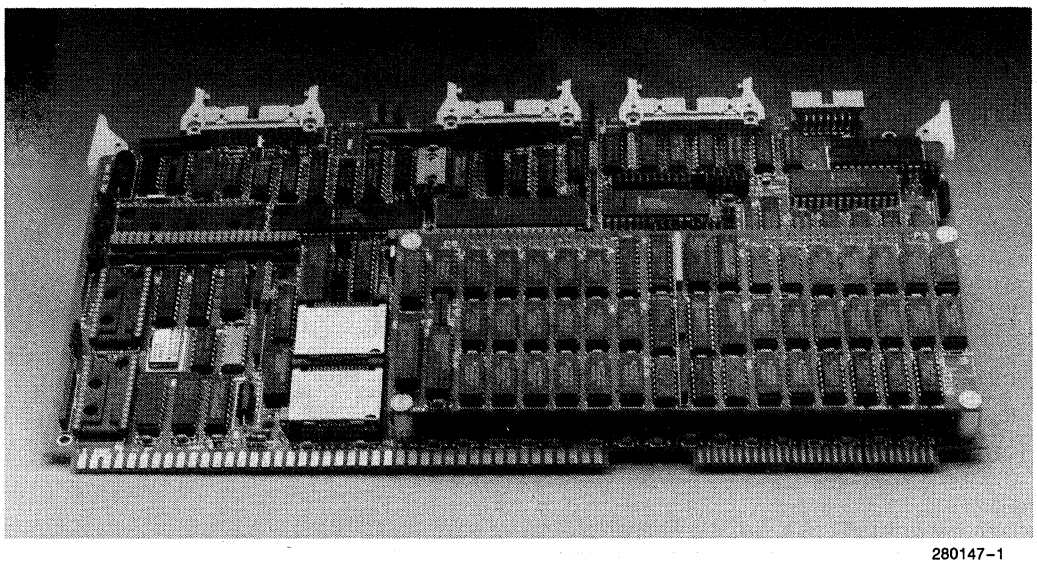
ORDERING INFORMATION

Part Number	Description
SBC 286/10A	Single Board Computer

iSBC® 286/12, 286/14, 286/16 SINGLE BOARD COMPUTERS

- **8 MHz 80286 Microprocessor**
- **Two JEDEC 28-Pin Sites for up to 128K Bytes of Local EPROM Memory, Expandable to 256K Bytes Using an iSBC® 341 Expansion Module**
- **1, 2, or 4 Megabyte, 0 Wait-State, Dual-Port, Parity Memory**
- **Supports User Installed 80287 Numeric Data Processor and 82258 Advanced DMA Controller Devices**
- **Two iSBX™ Bus Interface Connectors for I/O Expansion**
- **Synchronous High-Speed Interface for 0 Wait-State Read/Write to EX Memory Expansion Boards**
- **iLBX™ Interface for iLBX Memory Board Expansion**
- **16 Levels of Vectored Interrupt Control**
- **Centronics-Compatible Parallel I/O Printer Interface**
- **Two Programmable Multiprotocol Synchronous/Asynchronous Serial Interfaces; One RS232C, the Other RS232C or RS422/449 Compatible**

The iSBC 286/12, iSBC 286/14, and iSBC 286/16 Single Board Computers are members of Intel's high performance family of 16-bit microcomputers. The boards feature an 80286 microprocessor running at 8 MHz together with 1, 2, or 4 megabytes of dual-ported, 0 wait-state, parity memory. These features make the iSBC 286/12/14/16 boards the ideal single board solution for applications requiring high performance and up to 1, 2, or 4 megabytes of memory. For those applications needing more memory, up to four memory expansion boards may be connected to the iSBC 286/12/14/16 boards over its P2 interface. The P2 interface supports both standard iLBX memory boards and Intel's EX series of synchronous, 0 wait-state, memory boards that provide up to 16 megabytes of system memory. The iSBC 286/12/14/16 boards also feature two sockets for user installed 80287 Numeric Data Processor and 82258 Advanced Direct Memory Access Controller devices. These components further increase board performance by off-loading time intensive tasks from the 80286 microprocessor. The iSBC 286/12/14/16 CPU boards are true single-board solutions that also include two serial I/O channels, one parallel line printer channel, local memory, interrupt controllers and programmable timers all on one board.



280147-1

*XENIX is a registered trademark of Microsoft Corp.

**UNIX is a trademark of Bell Laboratories.

September 1986
Order Number: 280147-002

FUNCTIONAL DESCRIPTION

Overview

The iSBC 286/12/14/16 boards utilizes the powerful 80286 CPU within the MULTIBUS® system architecture, enhanced by the industry standard iLBX bus and a new, 0 wait-state, synchronous memory interface, to provide a high-performance 16-bit solution. This board features 1, 2, or 4 megabytes of dual-port, 0 wait-state, parity memory, plus interrupt, memory and I/O features facilitating a complete single-board computer system. The iSBC 286/12/14/16 boards can be used in many applications originally designed for Intel's other 16-bit microcomputers. Only minor changes to the system hardware or applications software may be required to match the application to the iSBC 286/12/14/16 boards. These changes may include adjusting software timing loops, changing the (jumper) default configuration of the board, and using pin and socket I/O connectors in place of edge connectors.

Central Processing Unit

The central processor for the iSBC 286/12/14/16 board is the 80286 CPU operating at an 8.0 MHz clock rate. The 80286 CPU is upwardly compatible with Intel's 8088 and 8086 CPUs. The 80286 CPU runs 8088 and 8086 code at substantially higher speeds due to its parallel architecture. In addition, the 80286 CPU provides on-chip memory management and protection and virtual memory addressing of up to 1 gigabyte per task. Processing speed and efficiency may be further enhanced by installing an 80287 numerics coprocessor and an 82258 ADMA controller. The clock rates for the 80286 and the 80287 are independent with the 80287 rate jumper selectable at either 5.3 MHz or 8.0 MHz.

Instruction Set

The 80286 instruction repertoire includes variable length instruction format (including double operand instructions), 8-bit and 16-bit signed and unsigned arithmetic operators for binary, BCD and unpacked ASCII data, and iterative word and byte string manipulation functions.

Numeric Data Processor

For enhanced numerics processing capability, the 80287 Numeric Data Processor extends the 80286 architecture and data set. Over 60 numeric instructions offer arithmetic, trigonometric, transcendental,

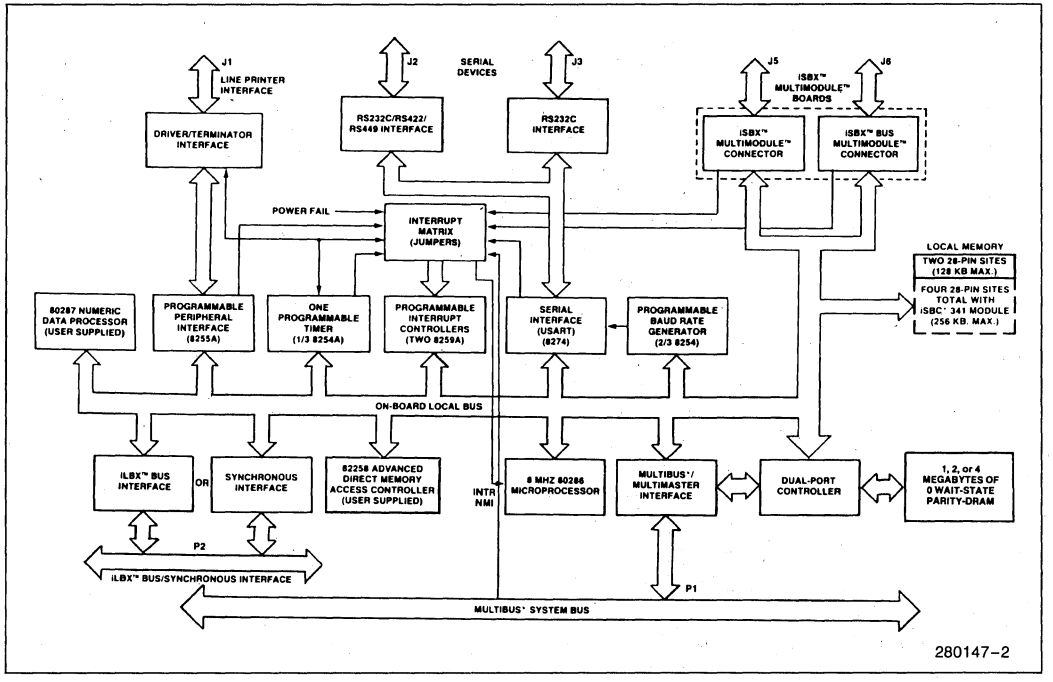


Figure 1. iSBC® 286/12 Block Diagram

logarithmic and exponential instructions. Supported data types include 16-, 32-, and 64-bit integer, 32- and 64-bit floating point, 18-digit packed BCD and 80-bit temporary. The 80287 meets the IEEE P754 standard for numeric data processing and maintains compatibility with 8087-based systems.

Advanced DMA Controller

For those applications that require frequent moving of large blocks of data, the user may install an Intel 82258, 4 channel, advanced DMA (ADMA) controller to further increase system performance. The ADMA Controller supports DMA requests from the 8274 USART (2 channels) and the iSBX interfaces on the board (1 per interface). The ADMA can also perform data transfers over the on-board CPU bus, the MULTIBUS (P1) interface, and the iLBX/synchronous (P2) interface. With this arrangement, the device can rapidly move blocks of data between the iSBC 286/12/14/16 boards and iSBX MULTIMODULE™ Boards installed on the baseboard, between the iSBC 286/12/14/16 boards and other boards installed in the system, or between any other memory/controller/I/O boards installed in the system.

ARCHITECTURAL FEATURES

The 8086, 8088, 80186 and 80286 microprocessor family contains the same basic set of registers, instructions, and addressing modes. The 80286 processor is upward compatible with the 8086, 8088, and 80186 CPUs.

The 80286 operates in two modes: 8086 real address mode, and protected virtual address mode. In 8086 real address mode, programs use real address with up to one megabyte of address space. Programs use virtual addresses in protected virtual address mode, also called protected mode. In protected mode, the 80286 CPU automatically maps 1 gigabyte of virtual addresses per task into a 16 megabyte real address space. This mode also provides memory protection to isolate the operating system and ensure privacy of each task's programs and data. Both modes provide the same base instruction set and registers.

Vectored Interrupt Control

Incoming interrupts are handled by two on-board 8259A programmable interrupt controllers (PIC) and by the 80286's NMI line. Interrupts originating from up to 15 sources are prioritized and then sent to the CPU. The 8259 devices support both polled and vectored mode of operation. Further interrupt capability is available through bus vectored interrupts where slave 8259 interrupt controllers resident on separate iSBC Boards supply an interrupt vector to the on-board CPU.

Table 1. Interrupt Request Sources

Device	Function	Number of Interrupts
MULTIBUS Interface	Requests from MULTIBUS resident peripherals or other CPU boards	8*
8259A Programmable Interrupt Controller	8 level vectored interrupt request from slave 8259A	1
8274 Serial Controller	6 internal interrupt requests directed to master 8259A	1
8255A Line Printer Interface	Signals output buffer empty. Directed to slave PIC	1
8254 Timers	Timer 0, 1 outputs; function determined by timer mode	2
iSBX connectors	Function determined by iSBX MULTIMODULE board Directed to slave PIC	2 per iSBX Connector
Bus Fail Safe Timer	Indicates addressed MULTIBUS resident device has not responded to command within 10 ms	1
Power Fail Interrupt	Indicates AC power is not within tolerance (from power supply)	1
ADMA Interrupt	Common interrupt for 4 DMA channels	1
Parity Interrupt	Parity error indicator from memory module	1
On-Board Logic	Conditioned interrupt source from edge sense latch, inverter, or OR gate	3
Bus Request Error	Indicates CPU was unable to access the MULTIBUS interface	1
External Interrupt	Supports system front panel reset switch	1

NOTE:
*May be expanded to 56 with slave 8259A PICs on MULTIBUS boards.

Interrupt Sources

Twenty-six potential interrupt sources are routed to the slave PIC device and to the interrupt jumper matrix where the user can connect the desired interrupt sources to specific interrupt levels. Table 1 includes a list of devices and functions supported by interrupts.

Memory Capabilities

DUAL-PORT MEMORY

The iSBC 286/12/14/16 boards feature 1, 2, or 4 megabytes of 0 wait-state, parity memory installed on the board. This memory, which is implemented using 256 Kb or 1 Mb DRAMs installed on a daughter board, is dual-ported to the on-board CPU bus and the MULTIBUS (P1) interface. For those applications requiring more memory, the iSBC 286/12/14/16 boards also feature an iLBX and synchronous memory interface to increase physical memory capacity to 16 megabytes.

LOCAL MEMORY

Two, 28-pin sites are provided for installing up to 128 KB of EPROM firmware.

By installing an iSBC 341 EPROM expansion module, local memory can be increased to four sites to support up to 256 KB of EPROM. Local memory access time is selectable at one, two, or three wait-states and is a function of the speed of the devices used.

Serial I/O

A two-channel serial communications interface using Intel's 8274 Multi-Protocol Serial Controller (MPSC) is contained on the iSBC 286/12/14/16 boards. Two independent software selectable baud rate generators (⅔ of the 8254 timer) provide the MPSC with all common communication frequencies. The protocol (i.e. asynchronous, bisync, or SDLC/HDLC), data format, control character format, parity and baud rate are all under program control. Software interfacing to the MPSC can be via either a polled or interrupt driven routine. Channel A may be configured for an RS232C or RS422/RS449 interface; channel B is set for RS232C operation only. DMA operation for channel A is available if the optional 82258 (ADMA) is installed. The data, clock, control, and signal ground lines for each channel are brought out to two 26-pin, pin and socket connectors.

Programmable Timers

The iSBC 286/12/14/16 boards provide three independent, fully programmable 16-bit interval timers/event counters utilizing the Intel 8254 Programmable Interval Timer. Each counter is capable of operating in either BCD or binary modes. Two of these timers/counters are available to the systems designer to generate accurate time intervals under software control. Routing for the outputs of these counters is jumper selectable. The outputs may be independently routed to the 8259A Programmable Interrupt Controller or to the 8274 MPSC to count external events or provide baud rate generation. The third interval timer in the 8254 is dedicated to providing a clock for the programmable baud rate generator in the iSBC 286/12/14/16 boards' MPSC serial controller. The system software configures each timer independently to select the desired function. Seven functions are available as shown in Table 2. The contents of each counter may be read at any time during system operation.

Table 2. Programmable Timer Functions

Function	Operation
Interrupt on Terminal Count	When a terminal count is reached, an interrupt request is generated. This function is extremely useful for generation of real-time clocks.
Programmable One-Shot	Output goes low upon receipt of an external trigger edge or software command and returns high when terminal count is reached. This function is retriggerable.
Rate Generator	Divide by N counter. The output will go low for one input clock cycle, and the period from one low going pulse to the next is N times the input clock period.
Square-Wave Rate Generator	Output will remain high until one-half the count has been completed, and go low for the other half of the count.
Software Triggered Strobe	Output remains high until software loads count (N). N counts after count is loaded, output goes low for one input clock period.
Hardware Triggered Strobe	Outputs goes low for one clock period N counts after rising edge counter trigger input. The counter is retriggerable.
Event Counter	On a jumper selectable basis, the clock input becomes an input from the external system. CPU may read the number of events occurring after the counter "window" has been enabled or an interrupt may be generated after N events occur in the system.

Line Printer Interface/Board ID

An 8255A Programmable Peripheral Interface (PPI) provides a Centronics compatible line printer interface, several on-board functions, and four non-dedicated input bits. Drivers are provided for a complete Centronics compatible line printer interface. The on-board functions implemented with the PPI are Power Fail Sense, Lock Override, NMI Mask, Clear Timeout Interrupt, LED 1 and 4, Clear Edge Sense flop, and MULTIBUS interface directed interrupts (2). The PPI's I/O lines are divided into three eight bit ports; A, B, and C. The PPI must be programmed for mode 0 with ports A and C used as outputs and port B as input. A 16-bit write to Port B is used to set the iSBC 286/12/14/16 boards into 24 bit address mode.

Table 3. Parallel Port Bit Assignment

Port A—Output	
Bit	**Function**
0	Line Printer Data Bit 0
1	Line Printer Data Bit 1
2	Line Printer Data Bit 2
3	Line Printer Data Bit 3
4	Line Printer Data Bit 4
5	Line Printer Data Bit 5
6	Line Printer Data Bit 6
7	Line Printer Data Bit 7
Port B—Input	
Bit	**Function**
0	Board ID Bit 0
1	Board ID Bit 1
2	Board ID Bit 2
3	LPT Interrupt (Active High)
4	Line Printer ACK/(Active Low)
5	Power Fail Sense/(Active Low)
6	Line Printer Error (Active High)
7	Line Printer Busy (Active High)
Port C—Output	
Bit	**Function**
0	Line Printer Data Strobe (Active High)
1	Override/(0 = lock asserted)
2	NMI Mask (0 = NMI Enabled)
3	Clear Timeout Interrupt (Active High)
4	LED 0 (1 = On); Clear Edge Sense Flop/
5	MULTIBUS Interrupt 1 (Active High)
6	MULTIBUS Interrupt 2 (Active High)
7	LED 1 (1 = On); Clear Line Printer ACK Flop/(Active High)

Three jumpers on the iSBC 286/12/14/16 boards let the software determine, by examining bits 0, 1, and 2 of port B, the board type (iSBC 286/10A board or iSBC 286/12/14/16 board), and the presence of hardware options (82258 ADMA and 80287 Numeric Data Processor devices) installed on the board. The parallel port assignment is shown in Table 3.

Software Reset

The software reset feature allows the 80286 microprocessor to return to Real Address mode operation from PVAM under software control. The system reset line (INIT*) and the dual-port memory are not affected, and all I/O context is preserved. The software reset is activated by a byte write to I/O location 00E0H. To distinguish the software reset from a true system initialization reset, a flag is provided. Another flag is provided that indicates whether the iSBC 286/12/14/16 board hardware (not the 80286 device) is currently configured for PVAM or Real Address Mode.

Front Panel Connector—J4

A 14-pin connector is mounted on the top edge of the board and is designed to connect to the front panel and power supply of the system enclosure. Leads supported include Reset and Interrupt input lines from (conditioned) front panel switches, a Run signal to drive a front panel LED, a Power Fail Interrupt line that connects to the power supply, and extra power and ground leads to support miscellaneous front panel circuitry.

MULTIBUS® SYSTEM ARCHITECTURE

Overview

The MULTIBUS system architecture includes three bus structures: the system bus, the local bus extension and the iSBX MULTIMODULE expansion bus as shown in Figure 2. Each bus structure is optimized to satisfy particular system requirements. The system bus provides a basis for general system design including memory and I/O expansion as well as multiprocessing support. The local bus extension allows large amounts of high performance memory to be accessed from a CPU board over a private bus. The MULTIMODULE extension bus is a means of adding inexpensive I/O functions to a base CPU board. Each of these three bus structures are implemented on the iSBC 286/12/14/16 boards providing a total system architecture solution.

System Bus—IEEE 796

The MULTIBUS system bus is Intel's industry standard, IEEE 796, microcomputer bus structure. Both 8- and 16-bit single board computers are supported on the IEEE 796 structure with 24 address and 16 data lines. In its simplest application, the system bus allows expansion of functions already contained on a single board computer (e.g., memory and digital I/O). However, the IEEE 796 bus also allows very powerful distributed processing configurations using multiple processors, I/O boards, and peripheral boards. The MULTIBUS system bus is supported with a broad array of board level products, VLSI interface components, detailed published specifications and application notes.

System Bus—Expansion Capabilities

Memory and I/O capacity may be expanded and additional functions added using Intel MUTLIBUS compatible expansion boards. Memory may be expanded by adding user specified combinations of RAM boards, EPROM boards, bubble memory boards, or combination boards. Input/output capacity may be added with digital I/O and analog I/O expansion boards. Mass storage capability may be achieved by adding single or double density diskette controllers, or hard disk controllers. Modular expandable backplanes and cardcages are available to support multiboard systems.

System Bus—Multimaster Capabilities

For those applications requiring additional processing capacity and the benefits of multiprocessing (i.e., several CPUs and/or controllers logically sharing system tasks through communication of the system bus), the iSBC 286/12/14/16 boards provide full system bus arbitration control logic. This control logic allows up to three iSBC 286/12/14/16 boards or other bus masters, including the iSBC 80 Board family of MULTIBUS compatible 8-bit single board computers to share the system bus using a serial (daisy

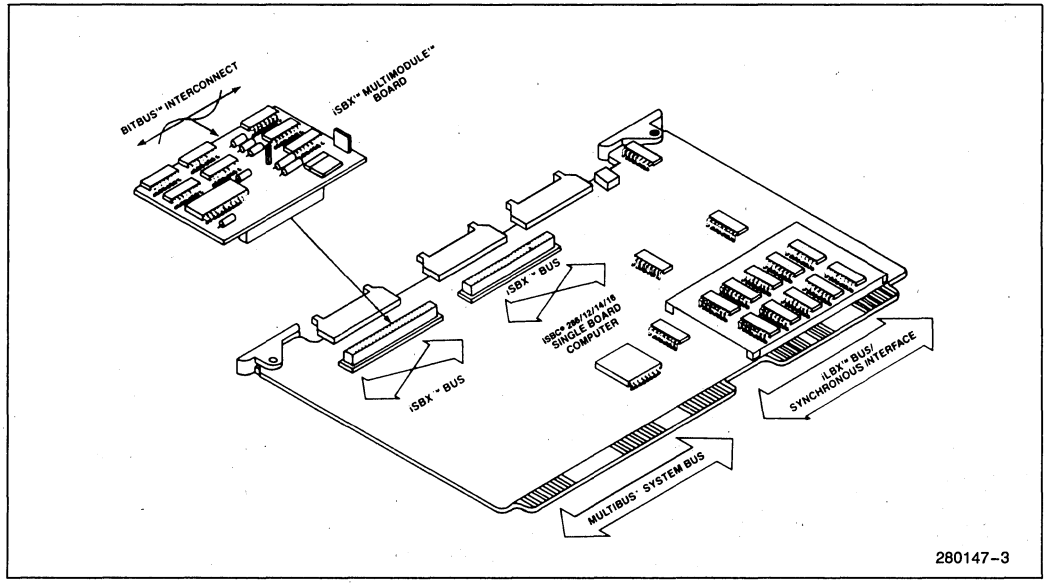


Figure 2. MULTIBUS® System Architecture

chain) priority scheme and allows up to 16 masters to share the MULTIBUS system bus with an external parallel priority decoder. In addition to multiprocessing configuration made possible with multimaster capability, it also provides a very efficient mechanism for all forms of DMA (Direct Memory Access) transfers.

Memory Map

The memory map of the iSBC 286/12/14/16 board is shown in Figure 3. The memory maps for the iSBC 286/14 and iSBC 286/16 boards are similar, except the total amount of on-board DRAM memory is 2 or 4 MB, and the dual-port memory space is larger. The memory map, which shows the default configuration of the board, may be easily changed by the user to meet the needs of almost any system design. As a result, the iSBC 286/12/14/16 boards are particularly suited for complex multiple processor and/or multiple intelligent I/O board-based systems.

The memory map can be changed by moving on-board jumpers or by installing user-programmed PALs (programmable array logic devices).

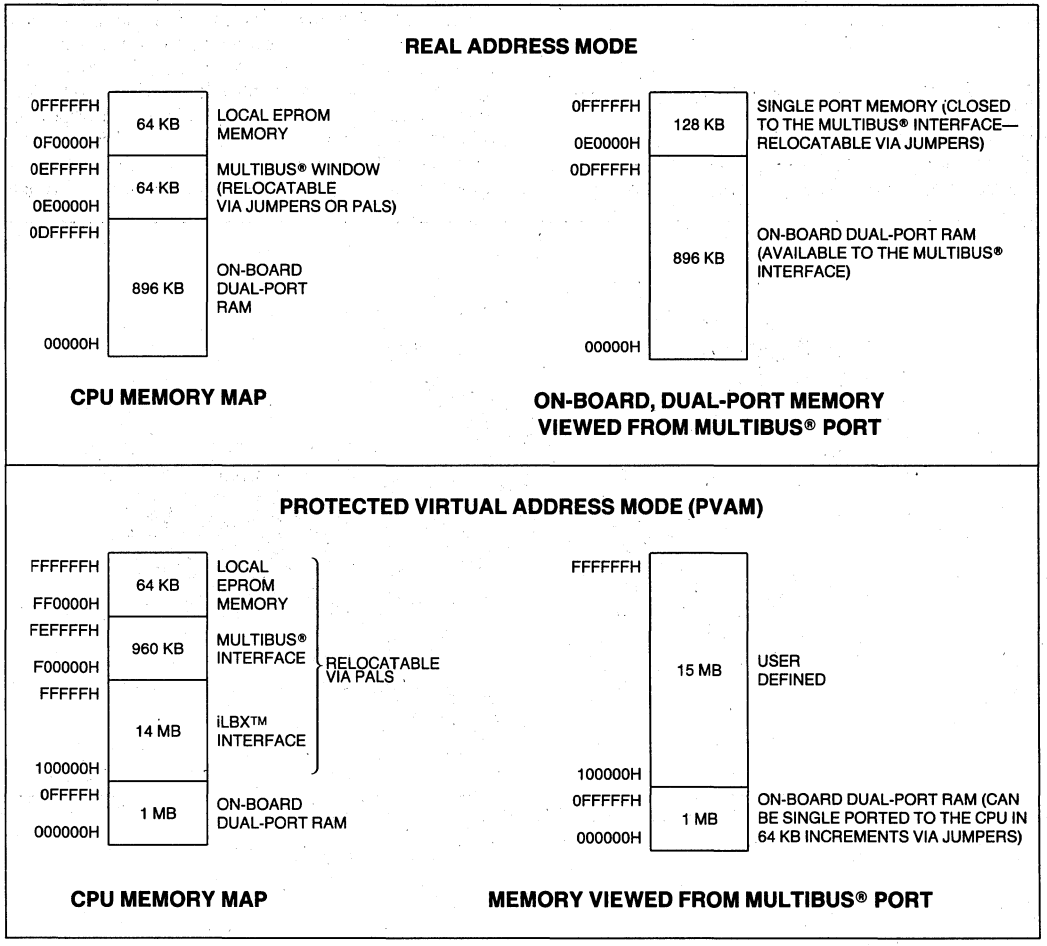


Figure 3. Memory Map for iSBC® 286/12 Board (Default Configuration)

Using only the jumpers on the iSBC 286/12/14/16 board, the MULTIBUS window size can be set at 0 (no window), 64 KB, 128 KB, 256 KB, or 1 MB in real address mode. The MULTIBUS window is normally not available in PVAM, however, a PAL may be programmed to provide this feature. Jumpers are also used to set aside a portion of the dual-port memory so that it may only be accessed by the CPU (single-ported memory). Block sizes of 64 KB, 128 KB, 256 KB, 512 KB or 1 MB may be selected. Finally, jumpers are used to select any of 6 EPROM memory sizes ranging from 4 KB (using 2716 devices) up to 256 KB (using 27512 devices and an iSBC 341 module).

If the user needs to alter the memory map further, five PALs on the baseboard are socketed and may be replaced by custom designed devices. Using programmed PALs, the designer can:

— Set the base DRAM memory starting address (as viewed by the 80286 microprocessor) at 0 (default configuration) or to any ½ megabyte boundary up through 16 MB (0 or 512 KB in real address mode).

— Set the base DRAM memory starting address (as viewed by other boards over the MULTIBUS interface) at 0 (default configuration) or to any megabyte boundary up through 16 MB (fixed at 0 in real address mode).

— Set single or multiple MULTIBUS windows as small as 64 KB or as large as 1 MB within the first megabyte of address space. MULTIBUS windowing can be enabled both in real address mode and PVAM. The window size can also be set at 0 (no window) so that the CPU can only access its own DRAM memory.

The jumper and PAL changes may be used in combination with each other. For example, jumpers can be installed to set EPROM address space and to exclusively allocate (single-port) a portion of the dual-port memory to the CPU. Then, PALs can be installed to establish two MULTIBUS windows of different sizes and to set the DRAM base starting addresses.

High Speed Off-Board Memory

The iSBC 286/12/14/16 boards can access off-board memory either over the MULTIBUS (P1) interface, or over the P2 interface as shown in Figure 4. Memory transfers over the P2 interface are faster because the CPU board doesn't have to arbitrate for access to the MULTIBUS interface.

Using the P2 interface, the iSBC 286/12/14/16 boards can be configured to operate with either a standard iLBX interface or with a high-performance, synchronous interface.

The iSBC 286/12/14/16 boards as supplied are configured to operate with a synchronous, P2 inter-

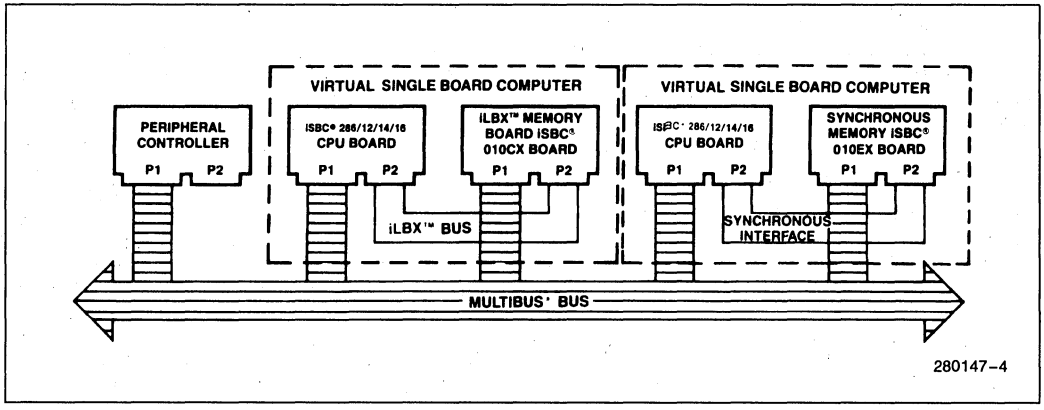


Figure 4. MULTIBUS®/iLBX™/Synchronous Interface Configurations

face. This high-performance interface is designed to connect to Intel's EX series of memory expansion boards to yield a CPU to memory read/write time of 0 wait-states. The EX memory expansion boards are available in sizes ranging from 512K bytes up to 4M bytes.

By moving several jumpers on the board, the iSBC 286/12/14/16 Single Board Computers may be reconfigured for an iLBX interface, and are compatible with Intel's CX series of memory expansion boards, which are available in sizes ranging from 512K bytes up to 2M bytes. Memory expansion boards from other manufacturers that meet the iLBX standard may also be used. CPU to memory access time is usually 1 or more wait-states depending on the speed of the memory used.

A total of four memory boards can be placed on the iLBX or synchronous interface bus. With 4M byte memory boards, this results in a total of 16M bytes on the memory expansion bus.

iSBX™ Bus MULTIMODULE™ On-Board Expansion

Two 8-, 16-bit iSBX MULTIMODULE connectors are provided on the iSBC 286/12/14/16 boards. Through these connectors, additional on-board I/O functions may be added. The iSBX MULTIMODULE Boards optimally support functions provided by VLSI peripheral components such as additional parallel and serial I/O, analog I/O, small mass storage device controllers (e.g., floppy disks), and other custom interfaces to meet specific needs. By mounting directly on the single board computer, less interface logic, less power, simpler packaging, higher performance, and lower cost result when compared to other alternatives such as MULTIBUS Board form factor compatible boards. The iSBX interface connectors on the iSBC 286/12/14/16 boards provide all signals necessary to interface to the local on-board bus, including 16 data lines for maximum data transfer rates. The iSBX MULTIMODULE Boards designed with 8-bit data paths and using the 8-bit iSBX connector are also supported on the iSBC 286/12/14/16 microcomputer boards. A broad range of iSBX MULTIMODULE Board options are available from Intel. Custom iSBX modules may also be designed. An iSBX bus interface specification is available from Intel.

SOFTWARE SUPPORT

Software support from Intel includes the iRMX 86, iRMX 286, and XENIX* Operating Systems, assembly and high level languages, development systems, in-circuit emulators, and various other hardware and software tools.

For those applications needing a real time, multitasking operating system, Intel offers the iRMX 86 Release 6 and iRMX 286 Release 1 Operating Systems. The iRMX operating systems are particularly well suited for industrial or commercial applications where the processor is simultaneously controlling multiple, real time, interrupt-intensive processes. Typical applications include machine and process control, data acquisition, signal processing, front-end processing, and digital PABX control. The iRMX operating systems employ a highly configurable, modular structure that allows easy system configuration and expansion.

The iRMX 86 Release 6 Operating System enables the iSBC 286/12/14/16 boards to address up to 1 MB of memory in real address mode. Using the iRMX 286 Operating System, this address range is extended to 16 MB in protected mode. The iRMX 286 Operating System also allows the user to take advantage of the hardware traps built into the iAPX 286 processor that provide expanded debug capabilities and increased code reliability.

Applications software written for earlier releases of the iRMX 86 Operating System is upwardly compatible through Release 6. Furthermore, application code written for the iRMX 86 Operating System can be compiled using 286 compilers to run under the iRMX 286 Operating System. Application code will require only minor changes.

Assembly and many high level languages are supported by the iRMX Operating Systems and Intellec® Series III and Series IV development systems. Language support for the iSBC 286/12/14/16 boards in real address mode includes Intel's ASM 86, PL/M 86, PASCAL 86, FORTRAN 86, and C86, as well as many third party 8086 languages. Language support for protected address mode include ASM 286, PL/M 286, PASCAL 286, and FORTRAN 286. Programs developed in these languages can be downloaded from an Intel Series III or IV Development System to the iSBC 286/12/14/16 boards via the iSDM™ 286 System Debug Monitor. The iSDM 286 monitor also provides on-target program debugging support including breakpoint and memory examination features.

Intel also offers the XENIX operating system which is designed for those applications needing an interactive, multiple user system. Typical applications include small business systems, software develop-

ment/engineering workstations, distributed data processing, communications, and graphics.

Intel's XENIX operating system is a fully licensed derivative of UNIX**, enhanced by Intel to provide device driver support for Intel board and component products plus other features that yield greater flexibility, increased reliability, and easier configurability. Intel's XENIX operating system has been optimized for use with the 80286 microprocessor and supports such features as on-chip memory management and protection which provide ease of portability and higher performance.

Applications software can be written in either Intel's FORTRAN, COBOL, or BASIC languages using a XENIX based, Intel 286/310 or 286/380 system, or by using an Intel iDIS™ Database Information System. The user can also select from a wide variety of existing third party languages and applications software.

SPECIFICATIONS

Word Size

Instruction—8, 16, 24, 32 or 40 bits

Data—8 or 16 bits

System Clock

CPU—8.0 MHz

Numeric Processor—5.3 MHz or 8.0 MHz (Jumper Selectable)

Cycle Time

Basic Instruction—8.0 MHz - 250 ns (assumes instruction in queue)

NOTE:
Basic instruction cycle is defined as the fastest instruction time (i.e. two clock cycles)

Dual-Port Memory

1, 2, or 4 megabyte, 0 wait-state, parity DRAM dual-ported to the on-board CPU bus and the MULTIBUS interface.

Local Memory

Number of sockets—two 28-pin JEDEC sites, expandable to 4 sites using iSBC 341 JEDEC Expansion Module

Maximum Size—128 KB expandable to 256 KB by installing an iSBC 341 EPROM Expansion Module. Memory size is set by jumpers on the iSBC 286/12/14/16 board.

Compatible Devices—EPROM, up to 64K x 8 (Intel 27512)

Off-Board Physical Memory

Operating System	Address Mode	Size
iRMX 86 Release 6 O.S.	Real	1 MB
iRMX 286 Release 1 O.S.	Protected	16 MB
XENIX Release 3 O.S.	Protected	16 MB

Socket provided for Intel 82258, 4 channel, advanced DMA controller. Data transfer rate = 4 MB per second (two cycle transfer mode, memory to memory); 2.67 MB per second (16-bit iSBX I/O to dual-port memory).

Interrupt Capacity

26 interrupt sources (total); 5 hard-wired to the 8259A PIC; 21 jumper selectable

Interrupt Levels—16 vectored requests using two 8259A devices and the 80286 microprocessor's NMI line

I/O Capability

Parallel — Line printer interface, on-board functions, and 3-bit board installed options code

Serial — Two programmable channels using one 8274 device

Timers — Three programmable timers using one 8254 device

Expansion— Two 8/16-bit iSBX MULTIMODULE connectors

Timers

Input Frequencies—1.23 MHz ±0.1% or 4.00 MHz ±0.1% (Jumper Selectable)

OUTPUT FREQUENCIES/TIMING INTERVALS

Function	Single Timer/Counter		Dual Timer/Counter (two timers cascaded)	
	Min	Max	Min	Max
Real-Time Interrupt	500 ns	53.3 ms	1.0 μs	58.2 min
Programmable One-Shot	500 ns	53.3 ms	1.0 μs	58.2 min
Rate Generator	18.8 Hz	2.0 MHz	0.000286 Hz	1 MHz
Square-Wave Rate Generator	18.8 Hz	2.0 MHz	0.000286 Hz	1 MHz
Software Triggered Strobe	500 ns	53.3 ms	1.0 μs	58.2 min
Hardware Triggered Strobe	500 ns	53.3 ms	1.0 μs	58.2 min
Event Counter	—	8.0 MHz	—	—

Interfaces

MULTIBUS Bus—All signals TTL compatible

iSBX Bus—All signals TTL compatible

iLBX Bus—All signals TTL compatible

Synchronous Interface—All signals TTL compatible

Serial I/O— Channel A: RS232C/RS422/RS449 compatible, DCE or DTE

Channel B: RS232C compatible, DCE

NOTE:
For RS422/RS449 operation, user supplied line drivers and resistor terminators must be installed.

Timer—All signals TTL compatible

Interrupt Requests—All TTL compatible

MULTIBUS® DRIVERS

Function	Type	Sink Current (mA)
Data	Tri-State	64
Address	Tri-State	24
Commands	Tri-State	32
Bus Control	Open Collector	16/32

iLBX™ DRIVERS

Function	Type	Sink Current (mA)
Data	Tri-State	64
Address	Tri-State	24
Commands	Tri-State	24
Bus Control	TTL	24

Serial Communications Characteristics

Synchronous—5–8 bit characters; internal or HDLC/SDLC character synchronization; automatic sync insertion; even or odd parity

Asynchronous—5–8 bit characters; break character generation; 1, 1½, or 2 stop bits; false start bit detection; even or odd parity

BAUD RATES

Synchronous—600, 1.2 KB, 2.4 KB, 4.8 KB, 9.6 KB, 19.2 KB, 38.4 KB, 56 KB, 76.8 KB, 154 KB, 307 KB, 615 KB.

Asynchronous—75, 150, 300, 600, 1.2 KB, 2.4 KB, 4.8 KB, 9.6 KB, 19.2 KB.

NOTE:
Baud rates are software selectable.

Physical Characteristics

Width: 12.00 in. (30.48 cm)

Height: 7.05 in. (18.00 cm)

Depth: 0.88 in. (2.24 cm)
1.16 in. (2.95 cm) with iSBX MULTIMODULE board installed

Recommended Slot spacing (without iSBX MULTIMODULE): 1.2 in. (3.0 cm)

Weight: 26 oz. (731 gm)

Mating Connectors (or Equivalent Part)

Function	# of Pins	Centers (In)	Connector Type	Vendor	Vendor Part No.
iSBX Bus Connector 16-Bit (J5, J6)	44	0.1	Soldered	Viking	000293-0001
I/O Connectors (J1–J3)	26	0.1	Flat Crimp	3M	3399-6026
Front Panel Connector (J4)	14	0.5	Flat Crimp	3M	3385-6014
iLBX/Synch. Interface Edge Connector (P2)	60	0.1	Flat Crimp	KEL-AM T & B Ansley	RF30-2803-5 A3020

Electrical Characteristics

DC Power Requirements:

Maximum: +5V, 8.7A; ±12V, 35 mA (for serial I/O)

Typical: +5V, 5.7A; ±12V, 20 mA

NOTE:
Power requirements are for the default configuration. Does not include power for optional EPROM, 80287 or 82258 devices, or installed iSBX MULTIMODULE boards.

Environmental Characteristics

Operating Temperature: 0°C to 60°C with 8 CFM airflow across board (default configuration)

Relative Humidity: to 90% (without condensation)

Reference Manual

147533— iSBC 286/12/14/16 Hardware Reference Manual (order separately)

ORDERING INFORMATION

Part Number Description

SBC 286/12 Single Board Computer with 1 MB of Memory

SBC 286/14 Single Board Computer with 2 MB of Memory

SBC 286/16 Single Board Computer with 4 MB of Memory

C80287-3 Numeric Processor Ext., 5 MHz
D80287-8 Numeric Processor Ext., 8 MHz
R82258-8 ADMA Coprocessor, 8 MHz

iSBC® 386/20
SINGLE BOARD COMPUTER STARTER KITS

- **Starter Kit Includes iSBC® 386/20P CPU Board, 2 or 4MB Memory Board, and P-MON386ES Monitor or iRMX® 286/386 ES Software**
- **High Performance 32-bit Processor System Using the 80386 Microprocessor**
- **High Speed Numerics Coprocessor**
- **Cache Memory Provides 0 Wait-state Memory Reads**
- **High Speed 32-bit Memory Interface**
- **iSBX™ Interface Supports I/O Expansion Using iSBX MULTIMODULE™ Boards**
- **Up to 128KB of EPROM Local Memory**
- **MULTIBUS® Interface for Multimaster Configurations and System Expansion**

The Starter Kits include an iSBC 386/20P CPU board, a 2 or 4 megabyte memory board, the choice of the P-MON386ES monitor or the iRMX 286/386 ES operating system/monitor software, interconnecting cables, and documentation. This kit allows the board or system level designer to quickly assemble an 80386-based MULTIBUS I System and evaluate the iSBC 386/20P board and 80386 microprocessor and begin system design and software development. All of the hardware pieces are provided, preconfigured to speed start-up time.

The iSBC 386/20P Single Board Computer, included in the kit, is Intel's highest performance MULTIBUS I CPU board. The iSBC 386/20P board features an 80386 32-bit microprocessor, a 16 kilobyte cache memory, and a high speed, dual-port memory interface that supports up to 16 megabytes of physical memory. The board also features a math coprocessor to offload the CPU and greatly enhance system performance in floating point, math-intensive applications. To take advantage of the 80386 32-bit architecture, all data transfers between the microprocessor and the dual-port memory are 32 bits wide.

280161-1

November 1986
Order Number: 280161-002

FUNCTIONAL DESCRIPTION

Overview—iSBC® 386/20 Starter Kit

The iSBC 386/20 Starter Kits are a set of hardware and software products designed to allow the user to easily evaluate the iSBC 386/20P CPU board and 80386 microprocessor, and to begin system design and software development. The kits include an iSBC 386/20P CPU board, either an iSBC 402P 2-megabyte or iSBC 404P 4-megabyte memory board, the choice of P-MON386ES debug monitor or iRMX 286/386 ES software, interconnecting cables and user documentation. Each of these kits is described below.

iRMX® 286/386 ES-Based iSBC® 386/20P Starter Kit

The iRMX Starter Kit is designed to support 16-bit iRMX-based applications and enables a new or an existing iRMX 286 Release 1 application to run on the iSBC 386/20P board. The starter kit also includes a 16-bit debug monitor that supports 16-bit application software development either in an on-target development environment using an Intel 286/310 system or in a host-target development environment using a Series III/IV system. These two development environments are shown in Figure 1.

The starter kit contains diskettes, two 27256 EPROMS, serial cables for connection to the host Series III/IV development system or separate console terminal, and installation/operating instructions.

The diskettes provide Update 3 of the iRMX 286 Release 1 Operating System, modified iRMX 286 software ported to run on the iSBC 386/20P board, and 16-bit 80286/80386 ES monitor software. Both 8" ISIS format and 5-¼" iRMX format diskette media are provided. The EPROMS, which the user installs on the iSBC 386/20P board, contain the bootloader, device initialization code, and the debug monitor. The user must separately provide and license the iRMX 286 Release 1 operating system software. The iRMX 286/310 system or Intellec® Series III/IV development system are also user provided.

The 80286/80386 monitor allows the designer to debug both real mode and protected mode applications that run on the iSBC 386/20P board.

The monitor provides commands that perform the following functions:

- Bootstrap load the program of your choice
- Examine and modify the contents of the 80386 registers and board memory
- Display the contents of memory and descriptor tables
- Load and execute relocatable and absolute object files
- Move blocks of memory from one location to another
- Perform I/O to a specified port
- Disassemble and execute instructions
- Single-step execution of instructions
- Define and examine symbols in a program

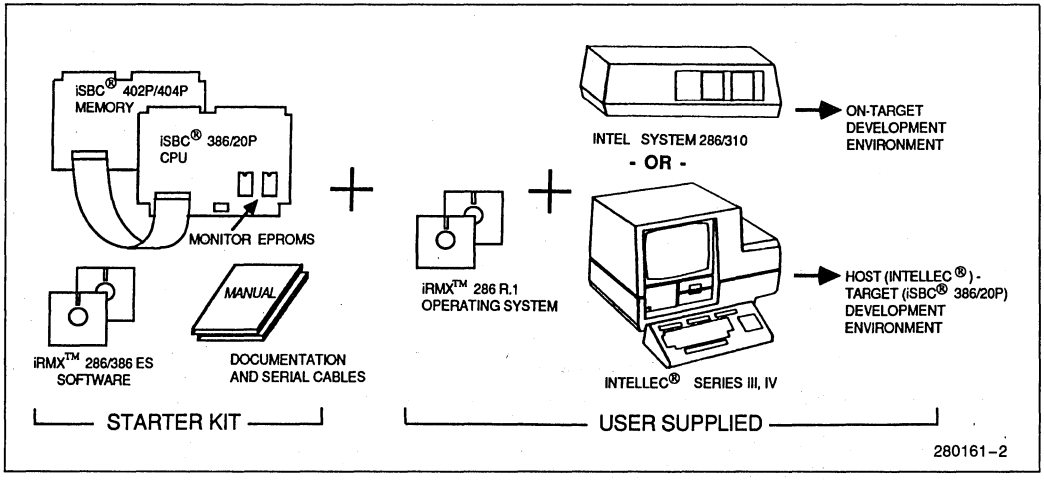


Figure 1. iRMX® Starter Kit Development Environments

Using the starter kit, designers can generate and debug 16-bit application software either on the host Intellec system or on the iSBC 386/20P-based system. The iRMX 286 Operating System together with the 80286/80386 ES monitor support the use of iRMX 286 16-bit languages and tools including ASM 86, ASM 286, PL/M 286, BIND 286, BUILD 286, and AEDIT text editor. Thirty-two-bit languages are not supported.

The starter kit also allows designers to download all or part of an existing iRMX 286-based application to the iSBC 386/20P board for execution. In some cases, software timing loops may need to be readjusted to compensate for the increased clock rate of the 80386 microprocessor. Furthermore, I/O address references may also need changing to match the I/O map of the iSBC 386/20P board.

iRMX 86-based 8086 applications will also run on the iSBC 386/20P board. The code is first recompiled to run under iRMX 286 operating system using 286 compilers. The code is then downloaded to the iSBC 386/20P board using the iRMX 286/386 ES software. As with other code, the iRMX 86 application code may have to be modified to adjust software timing loops and I/O address references.

Configuring the On-Target Development Environment

If the designer chooses to configure an on-target development environment using an Intel 286/310 system, either a standard SYS 310-40(A), -41(A), or -17(A) system may be used.

In addition to the iSBC 386/20P board and memory, other boards that the iRMX 286/386 ES software supports may be installed in the system. These boards include the iSBC 214/215G/217/218A series of disk controller boards, the iSBC 188/48 and iSBC 544A 8- and 4-channel communications boards, the iSBC 350 line printer board, the iSBX 351 2-channel communications MULTIMODULE™ and a RAM (disk) driver.

P-MON386-based iSBC® 386/20 Starter Kit

The P-MON-based starter kit uses the XENIX hosted P-MON386ES debug monitor and is intended for non-iRMX-based and component-based applications. The monitor, when used with an Intel XENIX 286/310 system as shown in Figure 2, enables the designer to develop software on the host system, then download the code to the target iSBC 386/20P board for execution. Code from an existing 16-bit application may also be downloaded to the iSBC 386/20P board from the host system. Using the P-MON386ES monitor, designers can access and control all of the 80386 visible user-hardware resources without any assistance from an operating system.

The starter kit includes 5-¼" diskettes that contain the host portion of the monitor software, two 27512 EPROMS, two cables for connection to either a DCE or DTE RS232C interface at the host system and installation/operation instructions. The EPROMS, which the user installs on the iSBC 386/20P board, contain the bootloader, device initialization code, and the target resident portion of the monitor soft-

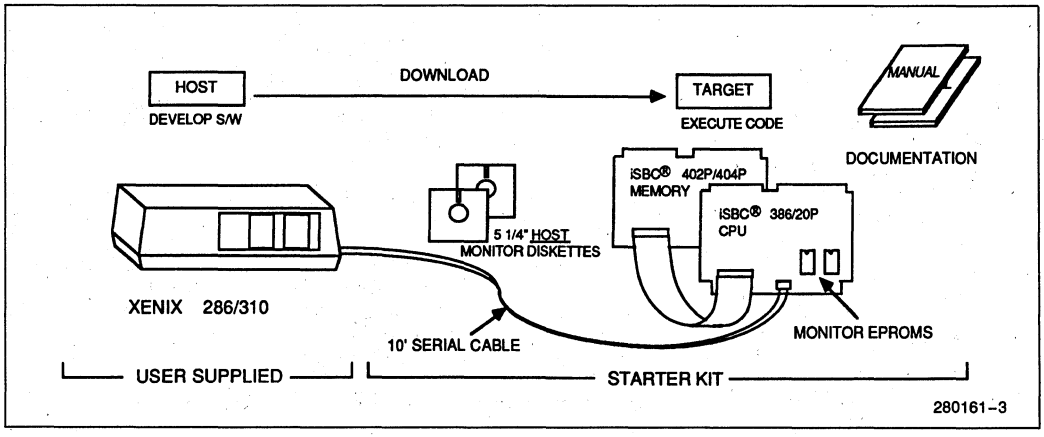


Figure 2. P-MON386ES Host-Target Development Environment

ware. The XENIX* 286/310 system is not part of the kit and may be ordered separately from Intel.

The P-MON386ES monitor provides the following user assistance programming tools and system debug capabilities:

- Download Intel 8086, 80286, and 80386 object module formats (with no symbolics)
- Examine/modify memory, I/O ports, processor registers, descriptor tables, and the task state segment
- Convert addresses from virtual to linear, linear to physical, and virtual to physical
- Evaluate expressions
- Control execution both in real and protected mode
- Set software breakpoints on execution addresses
- Set hardware breakpoints on execution and data addresses
- Disassemble memory

Both 16-bit and 32-bit XENIX hosted languages and tools are supported, including COBOL, FORTRAN, BASIC, 80386 Assembler, C386 Compiler, PL/M 386 Compiler, and 80386 Relocation/Linkage/Library tools.

*Xenix is a trademark of Microsoft Corporation

The monitor software also allows the designer to download all or part of an existing 8086 or 80286-based 16-bit application to the iSBC 386/20P board for execution. The P-MON386ES-based starter kit does not provide operating system (O.S.) support. If the application software uses an O.S. interface, the O.S. must be ported to run with the 80386 microprocessor, the 8251A Serial Controller, and the 80287 math coprocessor (if used).

Overview—iSBC® 386/20P CPU Board

The iSBC 386/20P board is Intel's first 32-bit MULTIBUS I single board computer using the 80386 microprocessor. The board employs a dual-bus structure: a 32-bit CPU bus for data transfers between the CPU and memory; and a 16-bit bus for data transfers over the MULTIBUS, iSBX, local memory, and 8-bit I/O interfaces. In this manner, the board takes advantage of the 80386 CPU's 32-bit wide data bus while maintaining full compatibility with the MULTIBUS interface and iSBX MULTIMODULE boards. A block diagram of the board is shown in Figure 3.

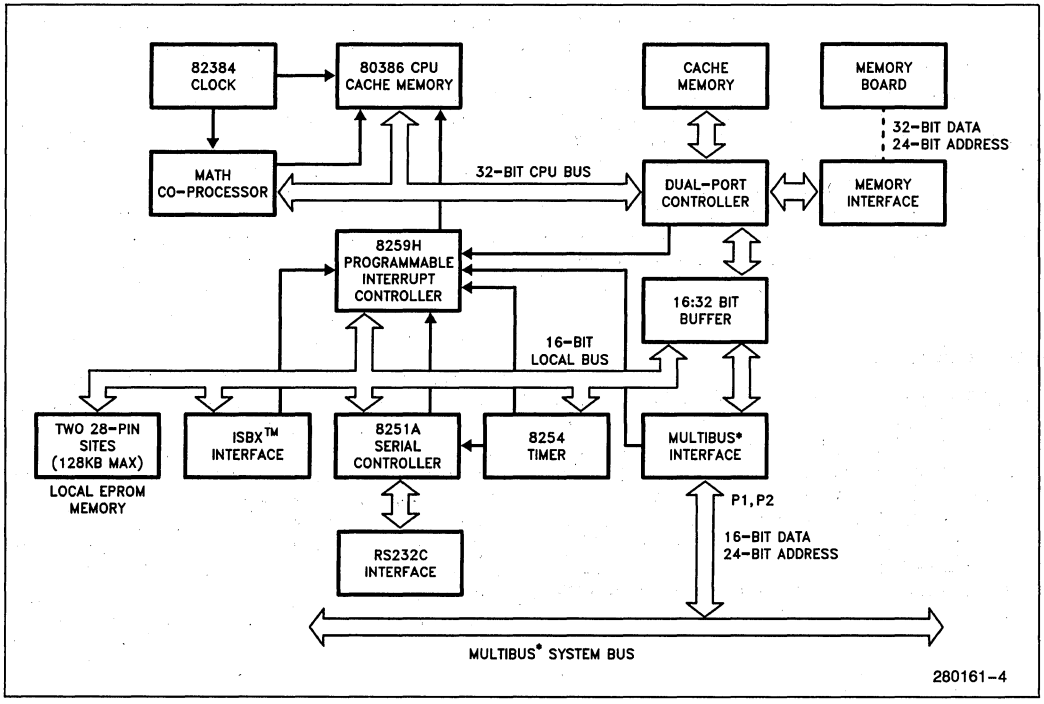


Figure 3. iSBC® 386/20P CPU Board Block Diagram

The iSBC 386/20P board can be used in many applications originally designed for Intel's 16-bit microcomputers, such as the iSBC 286/10A and iSBC 286/12, 8 MHz, 80286-based, single board computers. In this way, performance can be easily upgraded without requiring major hardware or software changes.

The iSBC 386/20P CPU board, which is in the starter kit, is an early release version of the iSBC 386/20 production board.

Central Processor Unit

The heart of the iSBC 386/20P board is an 80386 microprocessor. This device utilizes address pipelining, a high speed execution unit, and on-chip memory management/protection to provide the highest level of system performance. The 80386 microprocessor also features an Address Translation Unit that supports up to 64 terabytes of virtual memory.

The 80386 CPU is upwardly compatible with Intel's 8088, 8086, 80186, and 80286 CPUs. Application software written for these other 8 and 16 bit microprocessor families can be easily recompiled to run on the 80386 microprocessor.

The 80386 microprocessor resides on the 32-bit wide CPU bus which interconnects the CPU with the math coprocessor and dual-port memory. This arrangement tightly couples the CPU to the memory to form a high performance processor/memory 'engine'. A separate 16-bit bus couples the CPU and dual-port memory to the MULTIBUS and iSBX interfaces, local EPROM memory, and other on-board I/O resources. With this arrangement, the iSBC 386/20P board can take full advantage of the 80386 microprocessor's 32-bit architecture while maintaining full compatibility with the MULTIBUS and iSBX interfaces.

Instruction Set

The 80386 instruction set includes variable length instruction format (including double operand instructions), 8-, 16-, and 32-bit signed and unsigned arithmetic operators for binary, BCD and unpacked ASCII data, and iterative word and byte string manipulation functions. All existing instructions have been extended to support 32-bit addresses and operands. New bit manipulation and other instructions have been added for extra flexibility in designing complex software.

Numeric Data Processor

For enhanced numerics processing compatibility, the iSBC 386/20 Starter Kit includes an 80287-based math module which is installed on the iSBC 386/20P board. Over 60 numeric instructions offer arithmetic, trigonometric, transcendental, logarithmic and exponential instructions. Supported data types include 16-, 32-, and 64-bit integer, 32- and 64-bit floating point, 18-digit packed BCD and 80-bit temporary. The numeric data processor meets the IEEE P754 (Draft 7) standard for numeric data processing and maintains compatibility with 8087-based systems. Data transfers to/from the on-board CPU bus are 16-bits wide. On future iSBC 386/20 boards, this module will be replaced by an 80387 numeric coprocessor. This device will provide higher performance through a 32-bit data path to the CPU bus, added numeric instructions, and a faster clock.

Architectural Features

The 8086, 8088, 80186, 80188, 80286, and 80386 microprocessor family contains the same basic sets of registers, instructions, and addressing modes. The 80386 processor is upward compatible with the 8086, 8088, 80186, 80188, and 80286 CPUs.

The 80386 operates in two modes: protected virtual address mode, and 8086 real address mode. In protected virtual address mode (also called protected mode), programs use virtual addresses. In this mode, the 80386 CPU automatically translates logical addresses to physical addresses. This mode also provides memory protection to isolate the operating system and ensure privacy of each task's programs and data. In 8086 real address mode, programs use real address with up to one megabyte of address space. Both modes provide the same base instruction set, registers, and addressing mode.

Interrupt Control

Incoming interrupts are handled by two cascaded on-board 8259A programmable interrupt controllers and by the 80386's NMI line. Twenty potential interrupt sources are routed to the programmable controllers and the interrupt jumper matrix. Using this jumper matrix, the user can connect the desired interrupt sources to specific interrupt levels. Interrupts originating from up to 15 sources are then prioritized and sent to the CPU. A sixteenth interrupt source may be connected to the 80386 NMI line. Table 1 includes a list of devices and functions supported by interrupts.

Table 1. Interrupt Request Sources

Device	Function	Number of Interrupts
MULTIBUS Interface	Requests from MULTIBUS resident peripherals or other CPU boards	8
8251A Serial Controller	Indicates status of transmit and receive buffers and Ring Indicator lead of the RS232C interface	3
8254 Timers	Timer 0, 1 outputs; function determined by timer mode (hardwired to interrupt controller)	2
iSBX Connector	Function determined by iSBX MULTIMODULE board	4
Bus Timeout	Indicates addressed MULTIBUS or iSBX resident device has not responded to command within 10 msec	1
Power Fail Interrupt	Indicates AC power is not within tolerance. Signal generated by system power supply	1
Parity Interrupt	Indicates on-board parity error	1

Memory Capabilities

The iSBC 386/20P board supports both EPROM local memory located on board and DRAM dual-port memory which connects to the iSBC 386/20P board. The dual-port memory is supported by a high speed on-board cache memory.

DUAL-PORT MEMORY INTERFACE

The iSBC 386/20P preproduction board supports a high-speed, 32-bit memory interface that connects to the iSBC 402P 2 megabyte or iSBC 404P 4 megabyte memory expansion board using a pair of ribbon cables supplied in the kit. The iSBC 402P/404P board is a standard MULTIBUS I form-factor board. Production iSBC 385/20 CPU boards will use low-profile memory modules that plug directly onto the iSBC 386/20 board. The modules use surface mount technology devices and will be available in 1, 2, 4, and 8 megabyte sizes. Two modules may be used together to provide up to 16MB of system memory. Both the board and modules support byte-parity error detection and have 32-bit wide data paths to the 80386 CPU and 16-bit wide data path, to the MULTIBUS interface.

CACHE MEMORY

A 16KB cache memory on the iSBC 386/20P board by the 80386 provides 0 wait-state reads by the 80386 for data and program code resident in the cache memory. The cache memory is updated whenever data is written into the dual-port memory or when the CPU executes a read cycle and the data or program code is not already present in cache memory. This process is controlled by the cache replacement algorithm.

The cache memory supports 4K entries, with each entry comprised of a 32-bit data field and an 8-bit tag field. The tag field is used to determine which actual memory word currently resides in a cache entry. The cache memory size and effective replacement algorithm are designed to optimize both the probability of cache 'hits' and local bus utilization.

LOCAL MEMORY

The local memory consists of two 28-pin JEDEC sites that support EPROM devices, and are intended for boot-up and system diagnostic/monitor routines. Maximum local memory capacity is 128KB using high capacity Intel 27512 EPROM devices. The iSBC 386/20P board provided in the starter kit includes two EPROM devices which are programmed with monitor software.

The local memory resides at the upper end of the 80386 device's memory space for both real and protected mode operation. Local memory access time is selectable at from three to six wait-state and is a function of the speed of the device used.

Programmable Timer

Three 16-bit, programmable interval timer/counters are provided using an 8254 device, with one timer dedicated to the serial port for use as a baud rate generator. The other two timers can be used to generate accurate time intervals under software control or to count external events and raise an interrupt to the CPU when a certain count is reached. The timers are not cascadable. Seven timer/counter modes are available as listed in Table 2. Each counter is capable of operating in either BCD or binary modes. The contents of each counter may be read at any time during system operation.

Table 2. Programmable Timer Functions

Function	Operation
Interrupt on terminal count	When terminal count is reached, an interrupt request is generated. This function is extremely useful for generation of real-time clocks.
Programmable one-shot	Output goes low upon receipt of an external trigger edge or software command and returns high when terminal count is reached. This function is retriggerable.
Rate generator	Divide by N counter. The output will go low for one input clock cycle, and the period from one low going pulse to the next is N times the input clock period.
Square-wave rate generator	Output will remain high until one-half the count has been completed, and go low for the other half of the count.
Software triggered strobe	Output remains high until software loads count (N). N counts after count is loaded, output goes low for one input clock period.
Hardware triggered strobe	Output goes low for one clock period N counts after rising edge counter trigger input. The counter is retriggerable.
Event counter	On a jumper selectable basis, the clock input becomes an input from the external system. CPU may read the number of events occurring after the counter 'window' has been enabled or an interrupt may be generated after N events occur in the system.

Serial I/O

The iSBC 386/20P board includes one RS232C serial channel, which is configured as an asynchronous, DTE interface. Data rates up to 19.2 kilobaud may be selected. The serial channel can connect either to a host system for software development or to a standalone terminal for field diagnostic support. For standalone use, unhosted monitor software needs to be programmed by the user into the local EPROM memory. The physical interface is a 10-pin ribbon-style connector located on the front edge of the board. Included in the starter kit are mating serial cables to connect to a terminal or host system.

iSBX™ Interface

For iSBX MULTIMODULE support, the iSBC 386/20P CPU board provides a 16-bit iSBX connector which may be configured for use with either 8- or 16-bit, single or double-wide iSBX MULTIMODULE boards. Using the iSBX interface, a wide variety of specialized I/O functions can be easily and inexpensively added to the iSBC 386/20P board.

Reset Functions

The iSBC 386/20P board is designed to accept an AUX (auxilliary) reset signal via the board's P2 interface. In this way, system designs which require front panel reset switches are supported. The iSBC 386/20P board uses the AUX reset signal to reset all on-board logic (excluding DRAM refresh circuitry). The iSBC 386/230P board will also respond to an INIT Reset Signal generated by another board in the system.

LED Status Indicators

Mounted on the top edge of the iSBC 386/20P board are four LED indicators that indicate the operating status of the board and system. One indicator is used to show that an on-board parity error or a MULTIBUS bus parity error has occurred. A second LED indicates that a MULTIBUS or iSBX bus access timeout has occurred. The third LED is triggered by the start of an 80386 bus cycle and will go off if the 80386 CPU stops executing bus cycles. The fourth LED can be set under program control to illuminate by writing to a specific I/O location.

MULTIBUS® SYSTEM ARCHITECTURE

Overview

The MULTIBUS system architecture includes three bus structures: the system bus, the local bus extension and the iSBX MULTIMODULE expansion bus. Each bus structure is optimized to satisfy particular system requirements. The system bus provides a basis for general system design including memory and I/O expansion as well as multiprocessing support. The MULTIBUS System architecture also includes the iLBX™ memory interface which is not supported by the iSBC 386/20P board.

System Bus—IEEE 796

The MULTIBUS system bus is Intel's industry standard, IEEE 796, microcomputer bus structure. Both 8- and 16-bit single board computers are supported on the IEEE 796 structure with 24 address and 16 data lines. In its simplest application, the system bus allows expansion of functions already contained on a single board computer (e.g., memory and digital I/O). However, the IEEE 796 bus also allows very powerful distributed processing configurations using multiple processors, I/O boards, and peripheral boards. The MULTIBUS system bus is supported with a broad array of board level products, VLSI interface components, detailed published specifications and application notes.

System Bus—Expansion Capabilities

Memory and I/O capacity may be expanded and additional functions added using Intel MULTIBUS compatibility expansion boards. Memory may be expanded by adding user specified combinations of EPROM boards, DRAM boards, or bubble memory boards. Input/Output capacity may be added with digital I/O and analog I/O expansion boards. Mass storage capability may be achieved by adding single or double density diskette controllers, or hard disk controllers. Modular expandable backplanes and cardcages are available to support multiboard systems.

System Bus—Multimaster Capabilities

For those applications requiring additional processing capacity and the benefits of multiprocessing (i.e., several CPUs and/or controllers logically sharing system tasks through communication over the system bus), the iSBC 386/20P board provides full system bus arbitration control logic. This control logic allows up to four bus masters to share the system bus using a serial (daisy chain) priority scheme. By using an external parallel priority decoder, this may be extended to 16 bus masters. In addition to multiprocessing, the multimaster capability also provides a very efficient mechanism for all forms of DMA (Direct Memory Access) transfers.

iSBX™ Bus MULTIMODULE® On-Board Expansion

One 8-, 16-bit iSBX MULTIMODULE connector is provided on the iSBC 386/20P microcomputer board. Through this connector, additional on-board I/O functions may be added. The iSBX MULTIMODULE boards optimally support functions provided by VLSI peripheral components such as additional parallel and serial I/O, analog I/O, small mass storage device controllers (e.g., floppy disks), BITBUS™ Control, and other custom interfaces to meet specific needs. By mounting directly on the single board computer, less interface logic, less power, simpler packaging, higher performance, and lower cost result when compared to other alternatives such as MULTIBUS form factor compatible boards. The iSBX interface connector on the iSBC 386/20P board provides all the signals necessary to interface to the local on-board bus, including 16 data lines. The iSBX MULTIMODULE boards designed with 8-bit data paths and using the 8-bit iSBX connector are also supported on the iSBC 386/20P microcomputer board. A broad range of iSBX MULTIMODULE options are available from Intel. Custom iSBX modules may also be designed. An iSBX bus interface specification is available from Intel.

SOFTWARE SUPPORT

Operating Systems

The iRMX 286/386 ES software (available in the iRMX-based starter kit), together with the iRMX 286 Release 1 Operating System, currently provides operating system support for the iSBC 386/20P board.

The production iSBC 386/20 board will be supported both by the iRMX 286 Release 2 operating system and the System V/386™ UNIX*-based operating system.

The iRMX 286 Release 2 operating system is a real-time multi-tasking and multi-programming software system capable of executing all the configurable layers of the iRMX 286 operating system on the 80386 microprocessor and the iSBC 386/20 single board computer. The operating system is designed to support time-critical applications such as factory automation, industrial control, and communications networks.

For multiple user, interactive systems, Intel will offer the System V/386 operating system, which is designed to support a broad range of applications in business, science, and engineering. Typical applications include distributed data processing, business data and word processing, software development, scientific and engineering applications, and graphics.

*UNIX is a trademark of Bell Labs

LANGUAGES AND TOOLS

Intel will be offering several languages supported by the iRMX and System V/386 operating systems. For the iRMX 286/386 Software System and the iRMX 286 Release 2 operating system, this includes ASM 286, Pascal 286, PL/M 286, C 286, and FORTRAN 286. For the System V/386 Operating System, languages will include ASM 386, C 386, PL/M 386, and FORTRAN 386. Software development tools will include PSCOPE Monitor 386, and an ICE™ 386 in-circuit emulator.

System Compatibility

The iSBC 386/20P Single Board Computer is complemented by a wide range of MULTIBUS hardware and software products from over 200 manufacturers worldwide. This enables the designer to easily and quickly incorporate the iSBC 386/20P board into his system design to satisfy a wide range of high performance applications.

Applications that use other 16-bit MULTIBUS single board computers (such as Intel's iSBC 286/10A and iSBC 286/12 8 MHz, 80286 based single board computers) can be easily upgraded to use the iSBC 386/20P board. Only minor changes to hardware and systems software (for speed and I/O configuration dependent code) may be required.

BOARD SPECIFICATIONS

Word Size

Instruction—8, 16, 24, 32 or 40 bits
Data—8, 16, 32 bits

System Clock

CPU—16 MHz
Numeric Processor—80287 module—8 MHz

Cycle Time

Basic Instruction—16 MHz—125 ns (assumes instruction in queue)

NOTE:
Basic instruction cycle is defined as the fastest instruction time (i.e. two clock cycles)

Dual-Port Memory

Capacity—One memory board
Maximum Physical Memory—
  4 Megabytes (protected mode)
  1 Megabyte (real mode)
Compatible DRAM Memory—
  iSBC 402P 2MB or
  iSBC 404P 4MB parity memory board (supplied with starter kit)

Local Memory

Number of sockets—Two 28-pin JEDEC Sites
Maximum size—128KB with 27512 EPROMS

I/O Capability

Serial Channel
Type—One RS232C DTE Asynchronous channel using an 8251A device.
Max speed—19.2 kilobaud
Leads supports—TD, RD, RTS, CTS, DSR, RI, CD, SG
Connector Type—10 pin ribbon
Expansion—One 8/16-bit iSBX interface connector for single or double wide iSBX MULTIMODULE board.

Interrupt Capacity

Potential Interrupt Sources—20 (2 fixed, 18 jumper selectable)
Interrupt Levels—16 using two 8259A devices and 80386 microprocessors NMI line.

Timers

Quantity—Two programmable timers using one 8274 device.
Input Frequency—1.23 MHz ±0.1%

Interfaces

MULTIBUS Bus—All signals TTL compatible
iSBX Bus—All signals TTL compatible
Serial I/O—RS232C, DTE
Timer—All signals TTL compatible
Interrupt Requests—All TTL compatible

MEMORY MAP (DEFAULT CONFIGURATION)

MEMORY TYPE	PVAM ADDRESS
LOCAL EPROM (EPROM IN U32/U33) 27256 EPROMs	FFFFFFFFH (64K BYTES) FFFF0000H
UNUSED MEMORY	FFFEFFFFH 01000000H
MULTIBUS MEMORY	00FFFFFFH (14M BYTES) 00200000H
DUAL-PORT DRAM	001FFFFFH (2M BYTES) 00000000H

MEMORY TYPE	REAL MODE ADDRESS
LOCAL EPROM (EPROM IN U32/U33) 27256 EPROMs	FFFFFH (64K BYTES) F0000H
MULTIBUS MEMORY	EFFFFH (64K BYTES) E0000H
DUAL-PORT DRAM	DFFFFH (896K BYTES) 00000H

Memory as seen from the on-board 80386

MEMORY TYPE	MULTIBUS® ADDRESS
DUAL-PORT DRAM	1FFFFFH (2M BYTES) 000000H

MEMORY TYPE	MULTIBUS® ADDRESS
DUAL-PORT DRAM	DFFFFH (896K BYTES) 00000H

Memory as seen from the MULTIBUS® Interface

Note:
The iSBC 386/20P board is default configured for PVAM operation. To operate the board in real mode, the dual-port DRAM ending address must be set to DFFFFH, as shown.

OUTPUT FREQUENCIES/TIMING INTERVALS

Function	Single Counter	
	Min	Max
Real-time interrupt	667 ns	53.3 ms
Programmable one-shot	667 ns	53.3 ms
Rate generator	18.8 Hz	1.50 MHz
Square-wave rate generator	18.8 Hz	1.50 MHz
Software triggered strobe	667 ns	53.3 ms
Hardware triggered strobe	667 ns	53.3 ms
Event counter	—	8.0 MHz

MULTIBUS® DRIVERS

Function	Type	Sink Current (ma)
Data	Tri-State	64
Address	Tri-State	24
Commands	Tri-State	32
Bus Control	Open Collector	16/32

Physical Characteristics

DIMENSIONS:

iSBC 386/20P CPU Board—
Width—12.00 in. (30.48 cm)
Height—8.75 in. (22.22 cm)

iSBC 402P/404P Memory Board—
Width—12.00 in. (30.48 cm)
Height—6.75 in. (17.15 cm)

RECOMMENDED MINIMUM CARDCAGE SLOT SPACING:

iSBC 386/20P CPU Board—1.2 in. (3.0 cm) (with or without iSBX MULTIMODULE)
iSBC 402P/404P Memory Board — 0.8 in. (2.0 cm)

Mating Connectors

Function	# of Pins	Centers (in)	Connector Type	Vendor*	Vendor Part* Vendor* Number
iSBX Bus Connector	44	0.1	Soldered	Viking	000293-0001
Serial RS232C Connector	10	0.1	Flat Crimp	3M	3399-6010
Front Panel Connector	14	0.5	Flat Crimp	3M	3385-6014
P2 Interface Edge Connector	60	0.1	Flat Crimp T&B Ansley	KEL-AM	RF30-2803-5 A3020

* Or equivalent

APPROXIMATE WEIGHT:

iSBC 386/20P CPU Board—26 oz. (731 gm)
iSBC 402P/404P Memory Board—18 oz. (510 gm)

Starter Kit System Requirements

iRMX®-BASED KIT

Intellec Series III/IV Development System (host)
Intel 286/310 System (target)
Models Sys 310-17, -17A, -40, -40A, -41, or -41A

PMON-BASED KIT

XENIX 286/310 System (host)
Models Sys 310-40, -40A, -41, -41A, or -APXX.

NOTE:
System must be configured with XENIX Release 3, Update 3 (or higher) and a minimum of 2 MB of DRAM memory.

DC POWER REQUIREMENTS

Board	Voltage	Current (Approx.)
iSBC 386/20P CPU Board*	+5V	11A(max) 9A (typ)
	±12V	35mA (max) 20mA (typ)
iSBC 402P/404P Memory Board	+5	5.5A (max) 3.9A (typ)

***Notes:**
1. Includes power for local EPROM Memory
2. Does not include power for iSBX MULTIMODULE

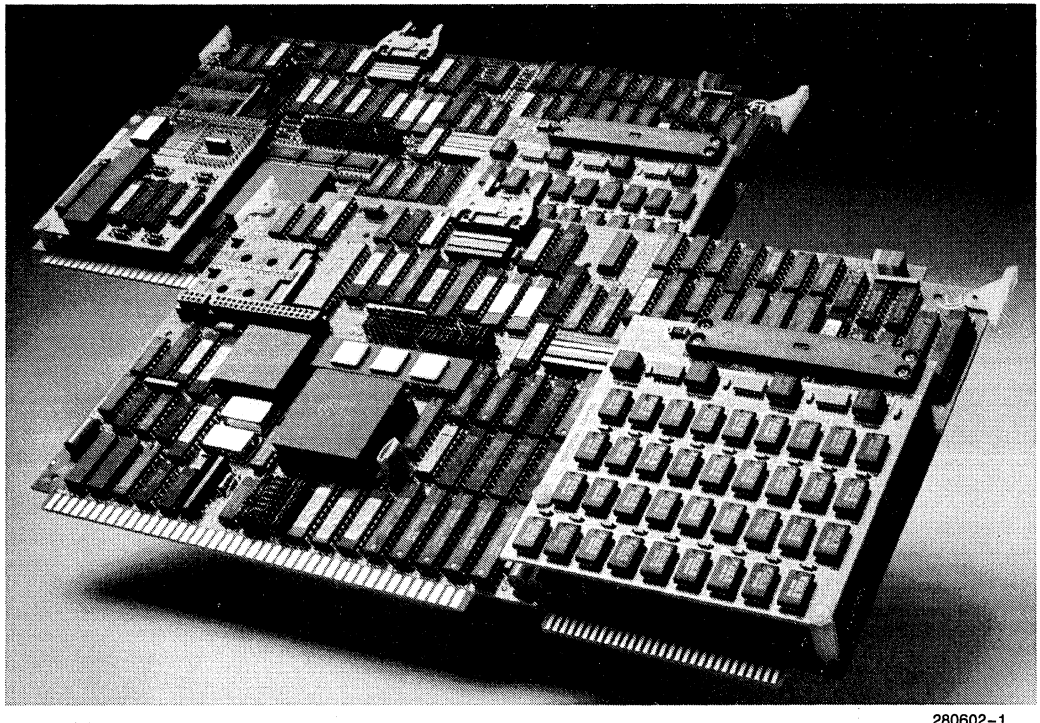
ORDERING INFORMATION

Part Number	Description
SBC38620SPKGR	iRMX 286/386 ES-Based iSBC 386/20 Starter Kit. Supplied: iSBC 386/20P CPU board; iSBC 402P 2MB memory board; one set of CPU/memory ribbon cable assemblies; four serial cables for connection to Intellec Series III/IV system or console terminal; two 27256 EPROMs; 8" ISIS media and 5-¼" iRMX media host/target diskettes; user documentation.
SBC38620SPKG2R	Same as above except with iSBC 404P 4MB memory board.
SBC38620SPKG	P-MON386ES-Based iSBC 386/20 Starter Kit. Supplied: iSBC 386/20P CPU board; iSBC 402P 2MB memory board; one set of CPU/memory ribbon cable assemblies; two serial cables for connection to DCE or DTE RS232C host interface; two 27512 EPROMS; 5-¼" host diskettes; user documentation.
SBC38620SPKG2	Same as above except with iSBC 404P 4MB memory board.

iSBC® 386/21/22/24/28 AND 386/31/32/34/38 SINGLE BOARD COMPUTERS

- **Choice of 16 MHz or 20 MHz 80386 Microprocessor**
- **Available with 1, 2, 4, or 8 Megabytes of On-Board 32-Bit Memory, expandable to 16 Megabytes**
- **High Speed 80387 Floating Point Math Coprocessor**
- **Uses iRMX® or XENIX* Operating Systems**
- **Complete Starter Kits to Speed Development**
- **Two 32-Bit JEDEC Sites for up to 512 Kilobytes of EPROM Memory**
- **RS232C Interface for Local/Remote Control and Diagnostics**
- **iSBX® Interface for Low Cost I/O Expansion**
- **16 Levels of Direct Vectored Interrupt Control**
- **64 Kilobyte 0 Wait-State Cache Memory**

The iSBC® 386/2x and 3x series boards (iSBC 386/21/22/24/28 and iSBC 386/31/32/34/38) are Intel's highest performance MULTIBUS® I CPU boards. These boards feature either a 16 MHz or 20 MHz 80386 CPU, an 80387 math coprocessor, a 64k byte, 0 wait-state cache memory to support the CPU, and a 32-bit interface to 1, 2, 4, or 8 megabytes of dual-port parity DRAM memory. An additional 1, 2, 4, or 8 MB iSBC MM0x series memory module may be installed to provide up to 16 MB of on-board DRAM memory. The iSBC 386/2x and 3x boards also feature an 8/16-bit iSBX MULTIMODULE interface for low-cost I/O expansion, an asynchronous RS232C interface to support a local terminal or modem, two 16-bit programmable timer/counters, a 16-level direct-vectored interrupt controller, two 32-pin JEDEC sites for up to 512 kb of EPROM memory, and multimaster MULTIBUS arbitration logic. The iSBC 386/2x and 3x boards are ideal for applications needing 32-bit performance together with full MULTIBUS I compatibility.



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*XENIX is a trademark of Microsoft Corp.
**UNIX is a trademark of AT&T Bell Labs.

August 1987
Order Number: 280602-001

OVERVIEW—iSBC 386/2x AND 3x SERIES CPU BOARDS

The iSBC 386/21/22/24/28 and iSBC 386/31/32/34/38 boards (iSBC 386/2x and 3x series) are Intel's first 32-bit MULTIBUS I single board computers using the 80386 microprocessor. The boards employ a dual-bus structure, a 32-bit CPU bus for data transfers between the CPU and memory, and a 16-bit bus for data transfers over the MULTIBUS interface, iSBX interface, EPROM local memory, and I/O interfaces. In this manner, the boards take advantage of the 80386 CPU's 32-bit performance while maintaining full compatibility with the MULTIBUS I interface and iSBX MULTIMODULE boards.

The DRAM memory, which is on a module that is secured to the baseboard, may be expanded by installing a second 1, 2, 4, or 8M byte memory module. A block diagram of the board is shown in Figure 1.

The iSBC 386/2x and 3x series boards can be used in many applications originally designed for Intel's other 8- and 16-bit microcomputer based, single board computers. In this way, performance can be upgraded without requiring major hardware or software changes.

16 MHz or 20 MHz Central Processor Unit

The heart of the iSBC 386/2x and 3x CPU board is the 80386 microprocessor. The complete series includes two lines, with a choice of CPU speed. The iSBC 386/21/22/24/28 boards use the 16 MHz 80386 microprocessor and the iSBC 386/31/32/34/38 boards use the 20 MHz 80386 microprocessor. The 80386 utilizes address pipelining, a high speed execution unit, and on-chip memory management/protection to provide the highest level of system performance. The 80386 microprocessor also features an Address Translation Unit that supports up to 64 terabytes of virtual memory.

The 80386 CPU is upward compatible from Intel's 8088, 8086, 80186, and 80286 CPUs. Application software written for these other 8- and 16-bit microprocessor families can be easily recompiled to run on the 80386 microprocessor. Some changes to the software such as adjustment of software timing loops and changing I/O address references may be required. The 80386 microprocessor resides on the 32-bit wide CPU bus which interconnects the CPU with the math coprocessor and dual-port memory.

Instruction Set

The 80386 instruction set includes: variable length instruction format (including double operand instruc-

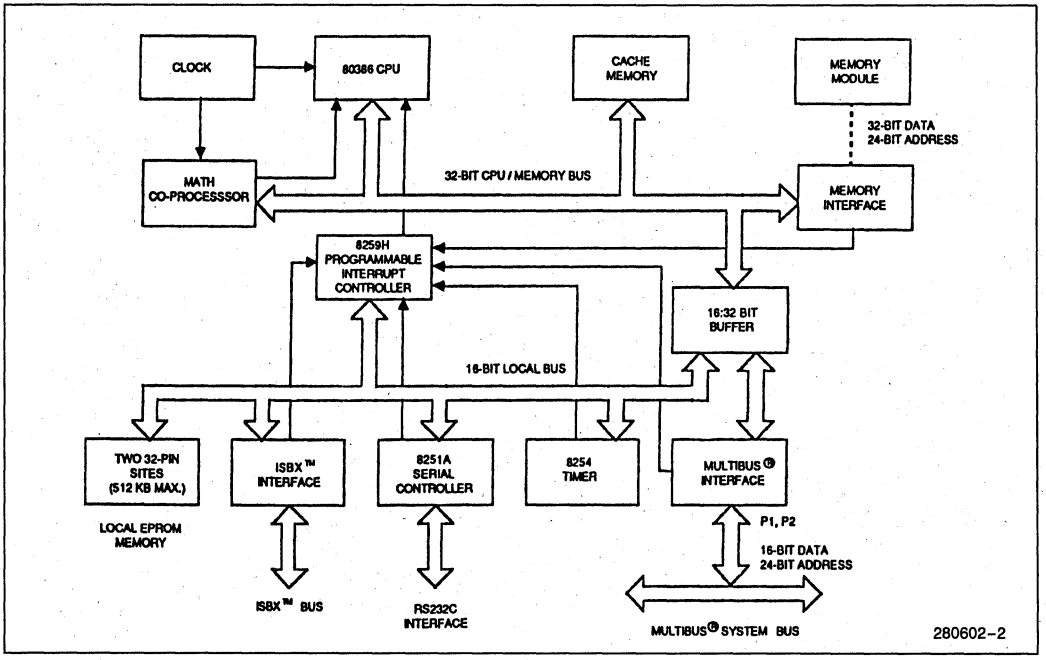

Figure 1. iSBC® 386/2x and 3x CPU Board Block Diagram

tions; 8-, 16-, and 32-bit signed and unsigned arithmetic operators for binary, BCD and unpacked ASCII data; and iterative word and byte string manipulation functions. All existing instructions have been extended to support 32-bit addresses and operands. New bit manipulation and other instructions have been added for extra flexibility in designing complex software.

Numeric Data Processor

For enhanced numerics processing compatibility, the iSBC 386/2x board includes an 80287-based math module on the iSBC 386/2x board. Over 60 numeric instructions offer arithmetic, trigonometric, transcendental, logarithmic and exponential instructions. Supported data types include 16-, 32-, and 64-bit integer, 32- and 64-bit floating point, 18-digit packed BCD and 80-bit temporary. The numeric data processor meets the IEEE P754 (Draft 7) standard for numeric data processing and maintains compatibility with 8087-based systems. Data transfers to and from the on-board CPU bus are 16-bits wide. The iSBC 386/3x boards and future iSBC 386/2x boards will use an 80387 numeric coprocessor in place of the math module. Boards that use an 80287-based math module may be easily upgraded by removing the module and installing an 80387 device. The 80387 provides higher performance through a 32-bit data path to the CPU bus, added numeric instructions, and a faster clock.

Architectural Features

The 8086, 8088, 80188, 80286, and 80386 microprocessor family contain the same basic sets of registers, instructions, and addressing modes. The 80386 processor is upward compatible with the 8086, 8088, 80186, 80188, and 80286 CPU's.

Architectural Features

The 80386 operates in two modes: protected virtual address mode; and 8086 real address mode. In protected virtual address mode (also called protected mode), programs use virtual addresses. In this mode, the 80386 CPU automatically translates logical addresses to physical addresses. This mode also provides memory protection to isolate the operating system and ensure privacy of each task's programs and data. In 8086 real address mode, programs use real addresses with up to one megabyte of address space. Both modes provide the same base instruction set and registers.

Interrupt Control

Incoming interrupts are handled by two cascaded on-board 8259A programmable interrupt controllers and by the 80386's NMI line. Twenty interrupt sources are routed to the programmable controllers and the interrupt jumper matrix. Using this jumper matrix, the user can connect the desired interrupt sources to specific interrupt levels. The interrupt controllers prioritize interrupts originating from up to 15 sources and send them to the CPU. The user can connect a sixteenth interrupt to the 80386 NMI line. Table 1 includes a list of devices and functions suported by interrupts. Bus vectored interrupts are not supported.

Table 1. Interrupt Request Sources

Source	Function	Number of Interrupts
MULTIBUS® Interface	Requests from MULTIBUS® resident peripherals or other CPU baords	8
8251A Serial Controller	Indicates status of transmit and receive buffers and RI lead of the RS232C interface	3
8254 Timers	Timer 0, 1 outputs; function determined by timer mode (hardwired to interrupt controller)	2
iSBX™ Connector	Function determined by iSBX™ MULTIMODULE™ board	4
Bus Timeout	Indicates addressed MULTIBUS® or iSBX™ resident device has not responded to a command within 10 ms	1
Power Fail Interrupt	Indicates AC power is not within tolerance (signal generated by system power supply)	1
Parity Interrupt	Indicates on-board parity error	1
Programmable Register	Generate interrupt under program control	1

Memory Capabilities

The iSBC 386/2x and 3x boards support both EPROM local memory and dynamic RAM (DRAM), which is located on-board. The DRAM is supported by a high speed on-board cache memory.

DRAM Memory

The iSBC 386/2x and 3x series CPU boards come with 1, 2, 4, or 8M bytes of DRAM memory. This memory is on a low profile module that is installed on the baseboard. The module measures approximately 4" x 4" and uses surface mount DRAM devices. The DRAM memory supports byte-parity error detection and has a 32-bit wide data path to the 80386 CPU and 16-bit wide data path to the MULTIBUS interface.

The memory may be expanded by installing an additional iSBC MM0x series memory module, which is available in 1, 2, 4, or 8M byte sizes. All mounting hardware is included. Maximum DRAM memory is 16M bytes using an iSBC 386/28 or 386/38 CPU board and an 8M byte iSBC MM08 memory module. This combination requires only 1.8 inches of card-cage space.

Cache Memory

A 64K byte cache memory on the iSBC 386/2x and 3x boards supports the 80386 and provides 0 wait-state reads for data and program code resident in the cache memory. The cache memory is updated whenever data is written into the dual-port memory or when the CPU executes a read cycle and the data or program code is not present in cache memory. This process is controlled by the cache replacement algorithm. Cache "misses" require additional wait-states to retrieve data from the DRAM memory. If the processor is in pipelined mode, 2 wait-states (4 clock cycles) are required to retrieve data. If the processor is in non-pipelined mode, 3 wait-states are required. All writes to DRAM memory require 2 (pipelined) or 3 (non-pipelined) wait-states.

The cache memory supports 16K entries, with each entry comprised of a 32-bit data field and an 8-bit tag field. The tag field is used to determine which actual memory word currently resides in a cache entry. The cache memory size and effective replacement algorithm are designed to optimize both the probability of cache "hits" and local bus utilization.

EPROM Memory

The EPROM memory consists of two 32-pin JEDEC sites that are intended for boot-up and system diagnostic/monitor routines, application code, and ROM-able operating system software. Maximum local memory capacity is 512K bytes using Intel 27020 (256k x 8) 2 megabit EPROM devices. The EPROM memory resides at the upper end of the 80386 device's memory space for both real address mode and PVAM operation.

Memory Map

In real address mode, the maximum amount of addressable physical memory is 1 Mbyte. In protected virtual address mode (PVAM), the maximum amount of addressable physical memory is 16 Mbytes. The system designer can easily change the CPU memory map to adapt the CPU board to the required overall system memory map. Reconfiguration is usually necessary for multiple processor-based systems with more than two CPU boards and/or intelligent I/O boards. By changing PAL devices and/or by moving jumpers, the designer can set:

- EPROM memory space
- Starting address of DRAM memory
- Amount of DRAM memory that is dual-ported to the CPU and MULTIBUS interface or single-ported to the CPU
- Access to off-board MULTIBUS address space

EPROM Memory

The EPROM memory space is set using four jumpers to accommodate 27256 (256 kb), 27512 (512 kb), 27010 (1 Mb), or 27020 (2 Mb) byte-wide devices. Smaller EPROM devices may be used, however the EPROM will appear more than once within the EPROM address space. Using a pair of 27020 EPROMs will provide 512k bytes of memory. The iSBC 386/2x and 3x series boards are designed to accommodate EPROM devices with access times ranging from 130 ns–320 ns. In real address mode, the ending address of EPROM memory is always 1M byte (FFFFFH). In PVAM, the ending address of EPROM memory is always 4G bytes (FFFF FFFFH), which is the top of the 80386 address space.

DRAM Memory Size/Location

The iSBC 386/2x and 3x boards allow the user to control the location and size of the DRAM memory (on the iSBC 386/2x and 3x boards) available for use by the CPU and other boards in the system. In PVAM, the starting address of DRAM can be set to start on any 1M byte boundary up through 15M bytes by setting jumpers and by installing a custom-programmed PAL device. In real address mode, the DRAM memory always starts at 0H (hex).

The ending address can be set on 64k byte boundaries using jumpers in both PVAM and real address mode. Setting the ending address at lower than the actual amount of installed memory effectively deselects a portion of DRAM and creates additional MULTIBUS address space.

MULTIBUS Address Space

Any address space not set aside as EPROM or DRAM memory automatically becomes address space the CPU can use to access other boards in the system. For example, Figure 2A shows a real address mode CPU memory map for a 1M byte iSBC 386/21 board. With the DRAM ending address set at 512k bytes and 128k bytes of installed EPROM, 384k bytes of MULTIBUS address space is accessable by the CPU. Figure 2B shows a typical PVAM configuration where the 4 Mbytes of DRAM has been set to start at 1M byte and end at 4.5M bytes. The address space from 0 to 1M byte and 4.5 to 16M bytes is the MULTIBUS address space accessable by the CPU.

Figure 2C illustrates another way the board can establish additional MULTIBUS address space. If the DRAM memory starts at 0, a jumper on the board can be used to create additional MULTIBUS address space between 512k bytes and 1M byte. This feature is available both in real address mode and PVAM.

Dual-Port/Local Memory

A portion or all of the DRAM memory can be selected to be dual-port (shared) memory. Both the starting and ending addresses are set on 256k byte boundaries using jumpers on the board. Any DRAM memory that is not configured as dual-port memory is local (single-port) memory available only to the CPU.

Programmable Timer

Three 16-bit, programmable interval timer/counters are provided using an 8254 device, with one timer dedicated to the serial port for use as a baud rate generator. The other two timers can be used to generate accurate time intervals under software control. The timers are not cascadable. Four timer/counter modes are available as listed in Table 2. Each counter is capable of operating in either BCD or binary modes. The contents of each counter may be read at any time during system operation.

Table 2. Programmable Timer Functions

Function	Operation
Interrupt on terminal count	When terminal count is reached, an interrupt request is generated. This function is extremely useful for generation of real-time clocks.
Rate generator	Divide by N counter. The output will go low for one input clock cycle, and the period from one low going pulse to the next is N times the input clock period.
Square-wave rate generator	Output will remain high until one-half the count has been completed, and go low for the other half of the count.
Software triggered strobe	Output remains high until software loads count (N). N counts after count is loaded, output goes low for one input clock period.

Serial I/O

The iSBC 386/2x and 3x boards include one RS232C serial channel, which is configured as an

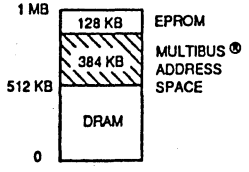

Figure 2A. Real Address Mode iSBC® 386/21 Board Memory Map

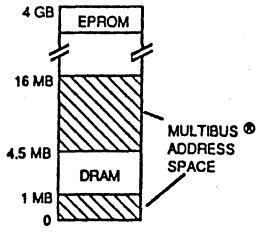

Figure 2B. PVAM iSBC® 386/24 Board Memory Map

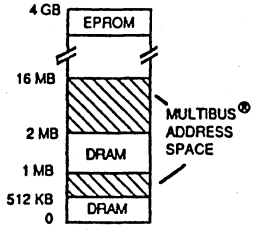

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Figure 2C. PVAM iSBC® 386/22 Board Memory Map

asynchronous, DTE interface. Data rates up to 19.2k baud may be selected. The serial channel can connect either to a host system for software development or to a stand alone terminal for field diagnostic support. For stand alone use, unhosted monitor software needs to be programmed by the user into the local EPROM memory. The serial channel may also be connected to a modem to provide remote diagnostic support or to download program codes. The physical interface is a 10-pin ribbon-style connector located on the front edge of the board.

iSBX™ Interface

For iSBX MULTIMODULE support, the iSBC 386/2x and 3x CPU boards provide an 8/16-bit iSBX connector that may be configured for use with either 8- or 16-bit, single or double-wide iSBX MULTIMODULE boards. Using the iSBX interface, a wide variety of specialized I/O functions can be added easily and inexpensively to the iSBC 386/2x and 3x boards.

Reset Functions

The iSBC 386/2x and 3x boards are designed to accept an Auxilliary Reset signal via the boards' P2 interface. In this way, system designs that require front panel reset switches are supported. The iSBC 386/2x and 3x boards use the AUX reset signal to reset all on-board logic (excluding DRAM refresh circuitry) and other boards in the MULTIBUS system. The iSBC 386/2x and 3x boards will also respond to an INIT reset signal generated by another board in the system.

LED Status Indicators

Mounted on the front edge of the iSBC 386/2x and 3x boards are four LED indicators that indicate the operating status of the board and system. One LED is used to show that an on-board parity error or a MULTIBUS bus parity error has occurred. A second LED indicates that a MULTIBUS or iSBX bus access timeout has occurred. The third LED is triggered by the start of an 80386 bus cycle and will turn off if the 80386 CPU stops executing bus cycles. The fourth LED will light under software control if the program writes to a specific I/O location.

MULTIBUS® SYSTEM ARCHITECTURE

Overview

The MULTIBUS system architecture includes three bus structures: the MULTIBUS system bus, the iLBX local bus extension and the iSBX MULTIMODULE expansion bus. Each bus structure is optimized to satisfy particular system requirements. The system bus provides a basis for general system design including memory and I/O expansion as well as multiprocessing support. The iLBX bus, which is usually used for memory expansion, is not supported by the iSBC 386/2x and 3x boards since all DRAM memory is located on-board. The iSBX bus povides a low cost way to add I/O to the board.

System Bus—IEEE 796

The MULTIBUS system bus is Intel's industry standard, IEEE 796, microcomputer bus structure. Both 8- and 16-bit single board computers are supported on the IEEE 796 structure with 24 address and 16 data lines. In its simplest application, the system bus allows expansion of functions already contained on a single board computer (e.g., memory and digital I/O). However, the IEEE 796 bus also allows very powerful distributed processing configurations using multiple processors, I/O boards, and peripheral boards. The MULTIBUS system bus is supported with a broad array of board level products, VLSI interface components, detailed published specifications and application notes.

System Bus—Expansion Capabilities

The user can easily expand or add features to his system by adding various MULTIBUS boards to his system. Products available from Intel and others include: video controllers; D/A and A/D converter boards; peripheral controller cards for floppy disk, hard disk, and optical disk drives; communications/networking boards; voice synthesis and recognition boards; and EPROM/bubble memory expansion boards.

System Bus—Multimaster Capabilities

For those applications requiring additional processing capacity and the benefits of multiprocessing (i.e., several CPUs and/or controllers sharing system tasks through communication over the system bus), the iSBC 386/2x and 3x boards provide full system bus arbitration control logic. This control logic allows up to four bus masters to share the system bus using a serial (daisy chain) priority scheme. By using an external parallel priority decoder, this may be extended to 16 bus masters. In addition to multiprocessing, the multimaster capability also provides a very efficient mechanism for all forms of DMA (Direct Memory Access) transfers.

iSBX™ Bus MULTIMODULE™ On-Board Expansion

One 8-/16-bit iSBX MULTIMODULE interface is provided on the iSBC 386/2x and 3x microcomputer boards. Through this interface, additional on-board I/O functions may be added, such as parallel and serial I/O, analog I/O, small mass storage device controllers (e.g., floppy disks), BITBUS Control, and other custom interfaces to meet specific needs. Compared to other alternatives such as MULTIBUS I boards, iSBX modules need less interface logic and power, and offer simpler packaging and lower cost. The iSBX interface connector on the iSBC 386/2x and 3x boards provides all the signals necessary to interface to the local on-board bus, and is compatible with both 8-bit and 16-bit MULTIMODULES. A broad range of iSBX MULTIMODULE options are available from Intel. Custom iSBX modules may also be designed using Intel's "MULTIBUS I Architecture Reference Book" (order no. 210883) as a guide.

SOFTWARE SUPPORT

Operating Systems

The iSBC 386/2x and 3x boards are supported by a variety of operating systems, including the iRMX 86 Release 8, iRMX 286 Release 2, and XENIX Release 3.4.2 operating systems from Intel, and System V/386 operating systems from third party vendors.

The iRMX 286 Release 2 operating system is a real-time multi-tasking and multi-programming software system capable of executing all the configurable layers of the iRMX 286 operating system on the 80386 microprocessor and the iSBC 386/2x and 3x single board computers. Up to 16 MB of physical system memory is supported. The iRMX 286 Operating System also allows the user to take advantage of the hardware traps built into the 80386 processor that provide expanded debug capabilities and increased code reliability.

The iRMX 286 Release 2 operating system is designed to support time-critical applications requiring real time performance in the industrial automation, financial; medical, communications, and data acquisition and control (including simulation) marketplaces.

Application code written under the iRMX 86 operating system can also run on the iSBC 386/2x and 3x boards. The code may either be run directly on the iRMX 86 operating system, or may be recompiled using Intel's 286 compilers and then run under iRMX 286 release 2 software. Application code will require only minor changes and may then take advantage of the added memory addressability, code reliability, and debug capability of the iRMX 286 operating system.

Applications software written for Release 1 of the iRMX 286 Operating Systems is upward compatible with iRMX 286 Release 2 software.

The XENIX operating system is a very high performance, UNIX operating system. This industry standard multi-user, multitasking operating system, provides a broad range of programming languages, system software, and application software for the system and application designer.

For customers preferring the UNIX operating system, third party software vendors offer UNIX System V.3.

Languages and Tools

A wide variety of languages is available for the iRMX, XENIX and System V/386 operating systems. For the iRMX 286 Release 2 operating system, Intel offers ASM 286, PASCAL 286, PL/M 286, C 286, and FORTRAN 286. For the XENIX operating system Intel offers ASM 386, PL/M 386, C 386, and PASCAL 386. For the System V/386 Operating System several different software vendors provide selections of languages, including ASM, C, PASCAL, FORTRAN, COBOL, RPG, PL1, BASIC, and Artificial Intelligence programming languages LISP and Arity/Prolog. Software development tools include PSCOPE Monitor 386 (PMON 386 and DMON 386), Softscope 286 (for iRMX 286 Release 2), and an ICE 386 in-circuit-emulator.

Starter Kits

The iSBC 386/2x and 3x Starter Kits are a set of hardware, software and support products designed to allow the user to easily evaluate the iSBC 386/2x and 3x boards and 80386 microprocessor, and to begin system design and software development for their iSBC 386/2x and 3x applications. The kits include an iSBC 386/2x or 3x board (with memory module), choice of iRMX 286 release 2 software or of the DMON 386/020 Debug Monitor, free admission to one Customer Training Workshop, valuable discounts on development tools, and complete documentation. Each kit includes all items at one low price. The kits come in two major types, either the iRMX Starter Kits or the DMON-based Starter Kits. Each of these types are described below.

iRMX® 286 Release 2-Based iSBC® 386/2x Starter Kits

The iRMX Starter Kits are designed to provide a complete development solution for new iRMX-based applications and enable an existing iRMX 286 Release 1 application to run on the iSBC 386/2x and 3x boards. The starter kits include the complete iRMX 286 Release 2 operating system with single user license and include a 16-bit debug monitor that supports 16-bit application software development either in an on-target development environment using an Intel 286/310 system or in a host-target development environment using a Series III/IV system. These two development environments are shown in Figure 3.

The starter kit contains diskettes, two 27256 EPROMs, 10 foot serial cables for connection to the host Series III/IV development system or separate console terminal, and installation/operating instructions.

The diskettes provide the iRMX 286 Release 2 Operating System, ported to run on the iSBC 386/2x and 3x boards, and 16-bit monitor software. Both 8" ISIS format and 5¼" iRMX format diskette media are provided. The EPROMs, which the user installs on the iSBC 386/2x and 3x boards, contain the bootloader, device initialization code, and the debug monitor. The iRMX 286/310 system or Intellec® Series III/IV development system are user provided.

The monitor allows the designer to debug both real mode and protected mode applications that run on the iSBC 386/2x and 3x boards.

The monitor provides commands that perform the following functions:

- Bootstrap load the program of your choice
- Examine and modify the contents of the 80386 registers and board memory
- Display the contents of memory and descriptor tables
- Load and execute relocatable and absolute object files
- Move blocks of memory from one location to another
- Perform I/O to a specified port
- Disassemble and execute instructions
- Single-step execution of instructions
- Define and examine symbols in a program

Using the starter kit, designers can generate and debug 16-bit application software either on the host Intellec system or on the iSBC 386/2x and 3x based system.

The iRMX 286 Operating System together with the monitor support the use of iRMX 286 16-bit lan-

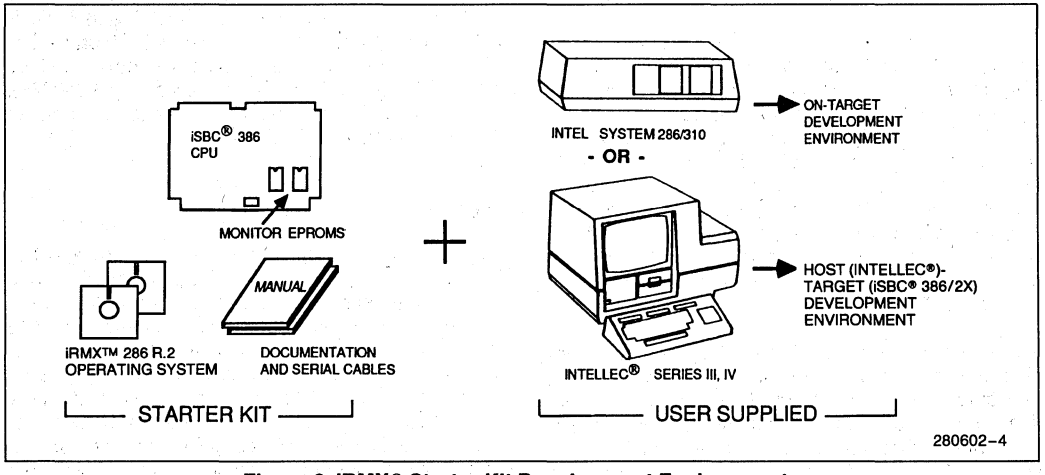


Figure 3. iRMX® Starter Kit Development Environments

guages and tools including ASM 86, ASM 286, PL/M 286, BIND 286, BUILD 286, and AEDIT text editor. Thirty-two-bit languages are not supported.

The starter kit also allows designers to download all or part of an existing iRMX 286-based application to the iSBC 386/2x and 3x boards for execution. In some cases, software timing loops may need to be readjusted to compensate for the increased clock rate of the 80386 microprocessor. Furthermore, I/O address references may also need changing to match the I/O map of the iSBC 386/2x and 3x boards.

iRMX 86-based 8086 applications will also run on the iSBC 386/2x and 3x boards under the iRMX 86 operating system or under the iRMX 286 operating system included in the starter kit. To run them under the iRMX 286 operating system, the code is first recompiled using 286 compilers. The code is then downloaded to the iSBC 386/2x and 3x boards using the monitor software. As with other code, the iRMX 86 application code may have to be modified to adjust software timing loops and I/O address references.

Configuring the On-Target Development Environment

If the designer chooses to configure an on-target development environment using an Intel 286/310 system, either a standard SYS 310-40(A), -41(A), or -17(A) system may be used.

In addition to the iSBC 386/2x and 3x boards and memory, other boards that the iRMX 286 software supports may be installed in the system. These boards include the iSBC 214/215G/217/218A series of disk controller boards, the iSBC 188/48 and iSBC 544A 8- and 4-channel communications boards, the iSBC 350 line printer board, the iSBX 351 2-channel communications MULTIMODULE™ and a RAM (disk) driver, and many more.

On-Target Debug with the DMON 386020-Based iSBC 386/2x and 3x Starter Kits

The DMON 386-Based starter kits use the unhosted DMON 386020 Debug Monitor, which is intended for debugging embedded, 32-bit code. Once the user has either downloaded their code (using their own bootstrap loader) to the iSBC 386/2x and 3x board's DRAM memory, or programmed their code in EPROMs and plugged them in the iSBC 386/2x's and 3x's sockets, DMON may be used to fully debug the code, including any code using the 80386's 32-bit OMF (object module format).

The DMON 386020 portion of the DMON-based starter kits provides DMON in two 27512 EPROMs, ready for use immediately in an iSBC 386/2x and 3x board, and in a 5¼" diskette, for integration with other, user-supplied code. Complete documentation is also included.

The DMON 386020 monitor provides the following debug capabilities:

- Examine/modify memory, I/O ports, processor registers, descriptor tables, and the task state segment
- Evaluate expression
- Control execution both in real and protected mode
- Set software breakpoints on execution addresses
- Set hardware breakpoints on execution and data addresses
- Disassemble instructions

The DMON 386020 based starter kit does not provide operating system (O.S.) support. If the application software uses an O.S. interface, the O.S. must be ported to run with the 80386 microprocessor, the 8251A Serial Controller, and the 80387 math coprocessor (if used).

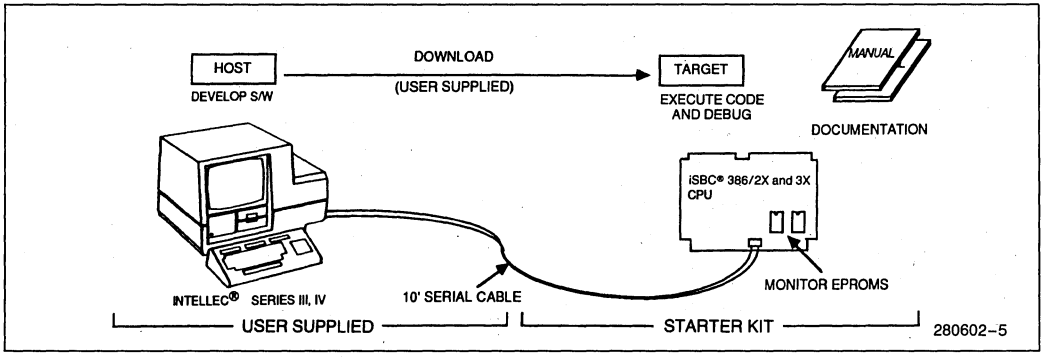


Figure 4. D-MON386ES Target Development Environment

System Compatibility

The iSBC 386/2x and 3x Single Board Computers are complemented by a wide range of MULTIBUS hardware and software products from over 200 manufacturers worldwide. This product support enables the designer to easily and quickly incorporate the iSBC 386/2x boards into his system design to satisfy a wide range of high performance applications.

Applications that use other 8- and 16-bit MULTIBUS single board computers (such as Intel's iSBC 286/10A and iSBC 286/12 8 MHz, 80286 based single board computers) can be upgraded to use the iSBC 386/2x and 3x boards. Changes to hardware and systems software (for speed and I/O configuration dependent code) may be required.

BOARD SPECIFICATIONS

Word Size

Instruction—8, 16, 24, 32 or 40 bits
Data—8, 16, 32 bits

System Clock

80386 CPU—16 MHz or 20 MHz
Numeric Processor—80387 module—16 MHz or 20 MHz

Cycle Time

Basic Instruction: iSBC 386/21/22/24/28, 16 MHz—125 ns
iSBC 386/31/32/34/38, 20 MHz—100 ns (assumes instruction in queue)

NOTE:
Basic instruction cycle is defined as the fastest instruction time (i.e. two clock cycles)

DRAM Memory

On-board parity memory
- iSBC 386/21/31 board—1M byte
- iSBC 386/22/32 board—2M bytes
- iSBC 386/24/34 board—4M bytes
- iSBC 386/28/38 board—8M bytes

Memory expansion—One additonal plug-in module:
- iSBC MM01—1M byte
- iSBC MM02—2M bytes
- iSBC MM04—4M bytes
- iSBC MM08—8M bytes

Maximum Addressable Physical Memory—16 Megabytes (protected virtual address mode) 1 Megabyte (real address mode)

EPROM Memory

Number of sockets—Two 32-pin JEDEC Sites (compatible with 28-pin and 32-pin devices)

Sizes accommodated—64 kb (8k x 8), 128 kb (16k x 8), 256 kb (32k x 8), 512 kb (64k x 8), 1 Mb (128k x 8), 2 Mb (256k x 8)

Device access speeds—130 ns to 320 ns
Maximum memory—512k bytes with 27020 (2M bit) EPROMs

I/O Capability

Serial Channel

Type—One RS232C DTE asynchronous channel using an 8251A device

Data Characteristics—5-8 bit characters; break character generation; 1, 1½, or 2 stop bits; false start bit detection; automatic break detect and handling; even/odd parity error generation and detection

Speed—110, 150, 300, 600, 1.2 kb, 2.4 kb, 4.8 kb, 9.6 kb, 19.2 kb

Leads supported—TD, RD, RTS, CTS DSR, RI, CD, SG

Connector Type—10 pin ribbon

Expansion—One 8/16-bit iSBX interface connector for single or double wide iSBX MULTIMODULE board.

Interrupt Capacity

Potential Interrupt Sources—21 (2 fixed, 19 jumper selectable)

Interrupt Levels—16 using two 8259A devices and the 80386 NMI line

Timers

Quality—Two programmable timers using one 8274 device

Input Frequency—1.23 MHz ± 0.1%

Output Frequencies/Timing Intervals

Function	Single Counter	
	Min	Max
Real-time interrupt	1.63 μs	53.3 ms
Rate Generator	18.8 Hz	615 kHz
Square-wave rate generator	18.8 Hz	615 kHz
Software triggered strobe	1.63 μs	53.3 ms

Interfaces

MULTIBUS Bus—All signals TTL compatible
iSBX Bus—All signals TTL compatible
Serial I/O—RS 232C, DTE

MULTIBUS® DRIVERS

Function	Type	Sink Current (mA)
Data	Tri-State	64
Address	Tri-State	24
Commands	Tri-State	32
Bus Control	Open Collector	16/32

Power Requirements

iSBC 386/2x and 3x boards
Maximum: +5V, 12.5A
±12V, 35 mA
Typical: +5V, 9A
±12V, 20 mA

NOTE:
Does not include power for iSBX module, EPROM memory, or added iSBCMM0x memory modules.

Add the following power when adding iSBC MM0X memory modules:

iSBC MM01 +5V, 0.71A
MM02 +5V, 0.96A
MM04 +5V, 0.71A
MM08 +5V, 0.96A

Environmental Requirements

Operating Temperature—0°C to 60°C at 300 LFM
Relative Humidity—0% to 85% noncondensing
Storage Temperature—−40°C to +70°C

Physical Characteristics

Dimensions
Width—12.00 in. (30.48 cm)
Height—7.05 in. (17.91 cm)
Depth—0.86 in. (2.18 cm), 1.62 in. (4.11 cm) with added memory module

Recommended Minimum Cardcage Slot Spacing
1.2 in. (3.0 cm), with or without iSBX MULTIMODULE
1.8 in. (4.6 cm), with addded iSBC MM0x memory module

Approximate Weight
26 oz. (738 gm)
29 oz. (823 gm), with added iSBC MM0x memory module

Reference Manual

149094—iSBC 386/21/22/24/28 Hardware Reference Manual (order separately)

Ordering Information

Part Number	Description
CPU Boards	
SBC38621	16 MHz 80386 MULTIBUS I CPU Board with 1 MB DRAM Memory
SBC38622	16 MHz 80386 MULTIBUS I CPU Board with 2 MB DRAM Memory
SBC38624	16 MHz 80386 MULTIBUS I CPU Board with 4 MB DRAM Memory
SBC38628	16 MHz 80386 MULTIBUS I CPU Board with 8 MB DRAM Memory
SBC38631	20 MHz 80386 MULTIBUS I CPU Board with 1 MB DRAM Memory
SBC38632	20 MHz 80386 MULTIBUS I CPU Board with 2 MB DRAM Memory
SBC38634	20 MHz 80386 MULTIBUS I CPU Board with 4 MB DRAM Memory
SBC38638	20 MHz 80386 MULTIBUS I CPU Board with 8 MB DRAM Memory
Memory Modules	
SBCMM01	1 MB Parity DRAM Memory Expansion Module
SBCMM02	2 MB Parity DRAM Memory Expansion Module
SBCMM04	4 MB Parity DRAM Memory Expansion Module
SBCMM08	8 MB Parity DRAM Memory Expansion Module

Starter Kits

SBC38621SPKG	SBC38621 plus DMON386020 Debug Monitor, Training, Documentation, and Discount on tools.
SBC38621SPKGR2	SBC38621 plus iRMX 286 R.2. O.S., Monitor, Training, Documentation, and Discount on tools.
SBC38622SPKG	SBC38622 plus DMON386020 Debug Monitor, Training, Documentation, and Discount on tools.
SBC38622SPKGR2	SBC38622 plus iRMX 286 R.2. O.S., Monitor, Training, Documentation, and Discount on tools.
SBC38624SPKG	SBC38624 plus DMON386020 Debug Monitor, Training, Documentation, and Discount on tools.
SBC38624SPKGR2	SBC38624 plus iRMX 286 R.2. O.S., Monitor, Training, Documentation, and Discount on tools.
SBC38628SPKG	SBC38628 plus DMON386020 Debug Monitor, Training, Documentation, and Discount on tools.
DMON386020	Debug Monitor provided in two media, both in EPROMs for immediate use in the iSBC 386/2x board, and in a 5¼" diskette. Also includes documentation.
SBC38628SPKR2	SBC38628 plus iRMX 286 R.2. O.S. Monitor, Training, Documentation and Discount on tools.

Starter Kits

SBC38631SPKG	SBC38631 plus DMON386020 Debug Monitor, Training, Documentation, and Discount on tools.
SBC38631SPKGR2	SBC38631 plus iRMX 286 R.2. O.S., Monitor, Training, Documentation, and Discount on tools.
SBC38632SPKG	SBC38632 plus DMON386020 Debug Monitor, Training, Documentation, and Discount on tools.
SBC38632SPKGR2	SBC38632 plus iRMX 286 R.2. O.S., Monitor, Training, Documentation, and Discount on tools.
SBC38634SPKG	SBC38634 plus DMON386020 Debug Monitor, Training, Documentation, and Discount on tools.
SBC38634SPKGR2	SBC38634 plus iRMX 286 R.2. O.S., Monitor, Training, Documentation, and Discount on tools.
SBC38638SPKG	SBC38638 plus DMON386020 Debug Monitor, Training, Documentation, and Discount on tools.
SBC38638SPKR2	SBC38638 plus iRMX 286 R.2. O.S. Monitor, Training, Documentation and Discount on tools.

Mating Connectors

Function	No. of Pins	Centers (in)	Connector Type	Vendor	Vendor Part Number
iSBX Bus Connector	44	0.1	Soldered	Viking	000293-0001
Serial RS232C Connector	10	0.1	Flat Crimp	3M	3399-6010
P2 Interface Edge Connector	60	0.1	Flat Crimp	Kel-AM T&B Ansley	RF30-2803-5 A3020

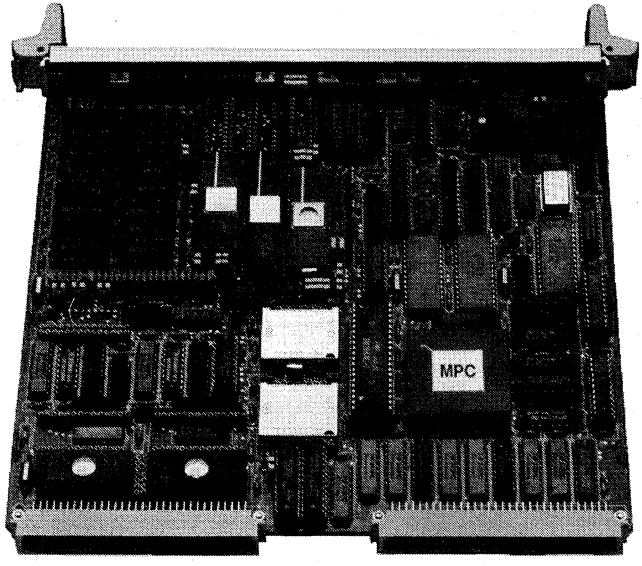
MULTIBUS® II Single Board Computers

4

iSBC® 186/100 MULTIBUS® II SINGLE BOARD COMPUTER

- **8.0 MHz 80186 Microprocessor with Optional High Speed 8087-1 Numeric Data Coprocessor**
- **Optional 82258 Advanced DMA Controller Providing Four Additional High Peformance DMA Channels**
- **On-Board 512K Bytes DRAM Configurable as Dual Port Memory**
- **MPC (Message Passing Coprocessor) Single Chip Interface to the Parallel System Bus with Full Message Passing Capability**
- **Four (Expandable to Eight) 28-Pin JEDEC Sites for PROM, EPROM, or EEPROM**
- **24 Programmable I/O Lines Configurable as SCSI Interface, Centronics Interface, or General Purpose I/O**
- **Two Programmable Serial Interfaces, One RS 232C and the Other RS 422A with Multidrop Capabilities**
- **Resident Firmware Supporting a Reset Operating Ssytem, a Program Table, and Build-In-Self-Test (BIST) Diagnostics Including Initialization and Power-Up Tests**
- **8- or 16-bit iSBX™ IEEE P959 Interface Connector with DMA Support for I/O Expansion**

The iSBC 186/100 Single Board Computer is a member of Intel's family of microcomputer modules that utilizes the advanced features of the MULTIBUS® II system architecture. The 80186-based CPU board takes advantage of VLSI technology to provide economical, off-the-shelf, computer based solutions for OEM applications. All features of the iSBC 186/100 board, including the single chip bus interface (message passing coprocessor), reside on a 220mm x 233mm (8.7 inches x 9.2 inches) Eurocard printed circuit board and provide a complete microcomputer system. The iSBC 186/100 board takes full advantage of the MULTIBUS II bus architecture and can provide a high performance single CPU system or a powerful element for a highly integrated multi-processing application.



280263-1

*IBM is a registered trademark of International Business Machines

September 1986
Order Number: 280263-001

FUNCTIONAL DESCRIPTION

Overview

The iSBC 186/100 MULTIBUS II Single Board Computer utilizes the 8 MHz 80186 microprocessor to provide a range of solutions for various low cost OEM and end-user applications. Intel's commitment to offering high performance at a cost effective level are evident in the design of the iSBC 186/100 Single Board Computer. The integration of the functions of a general purpose system (CPU, memory, I/O and peripheral control) into a single board computer imply that the total system's board count, power and space requirements, and costs are reduced. Combining these cost advantages with the advanced features of the MULTIBUS II system architecture, the iSBC 1286/100 board is ideal for price sensitive MULTIBUS II multi-processing or single CPU applications. Some of the advanced featues of the MULTIBUS II architecture embodied in the iSBC 186/100 board are distributed arbitration, virtual interrupt capabilities, message passing, iPSB bus parity, and software configurability and diagnostics using interconnect address space.

Architecture

The iSBC 186/100 CPU board supports the iPSB bus features of interconnect address space, Built-In-Self-Test (BIST) diagnostics, solicited and unsolicited message passing, and memory and I/O references. In addition to supporting the iPSB bus architecture, other functions traditionally found on Intel single board computers are included in the iSBC 186/100 board. These traditional capabilities include iSBX bus expansion, high speed 8087-1 numeric coprocessor, advanced DMA control, JEDEC memory site expansion, SCSI, Centronics, or general purpose configurable parallel I/O interface, serial I/O, and programmable timers on the 808186 microprocessor. Figure 1 shows the iSBC 186/100 board block diagram.

Central Processing Unit and DMA

The 80186 is an 8.0 MHz 16-bit microprocessor combining several common system components onto a single chip (i.e., two Direct Memory Access lines, three Interval Timers, Clock Generator, and Programmable Interrupt Controller). The 80186 instruction set is a superset of the 8086 and maintains object code compatiblity while adding additional instructions.

In the basic configuration, Direct Memory Access (DMA) requests are available between the local memory and the bus interface (see Table 1). With the addition of an Advanced DMA (ADMA) 82258 controller, ADMA requests may be generated by either the iSBX interface, the SCSI interface, the bus interface controller, or the serial interface (see Table 2). The addition of the ADMA controller also allows the serial ports to be used in a full-or half-duplex multidrop application.

An additional high performance 8087-1 Numeric Data Coprocessor may be installed by the user to significantly improve the iSBC 186/100 board's numerical processing power. Depending on the application, the high speed 8087-1 will increase the performance of floating point calculations by 50 to 100 times.

Table 1. Basic DMA Configuration

80186	Local Bus
DMA Channel 0	Output DMA iPSB Bus Interface
DMA Channel 1	Input DMA iPSB Bus Interface

Memory Subsystem

The 1M byte memory space of the 80186 is divided into three main sections. The first section is the 512K bytes of installed DRAM, the second section is the window into the global 4G bytes memory space of the iPSB bus (iPSV memory window address space) which starts at 512K bytes and goes up to either 640K bytes or 768K bytes, and the third section is designated for local ROM going from the ending address of the iPSB memory window address space up to, if desired, 1M byte (see Figure 2).

The iSBC 186/100 board comes with 512K bytes of DRAM installed on the board. This memory can be used as either on-board RAM or Dual Port RAM by loading the start and end addresses into the appropriate interconnect registers. The lower boundary address to the iPSB memory window may begin at any 64K byte boundary and the upper boundary address may end at any 64K byte boundary. Refer to the iSBC 186/100 Single Board Computer User's Guide for specific information on programming address spaces into interconnect registers.

The memory subsystem supports 128K bytes or 256K bytes access to the iPSB memory address space. The iPSB memory window base address is fixed at address 512K. The position of the window in the iPSB memory address space is programmable and thus allows the CPU to access the complete 4G byte memory address space of the MULTIBUS II iPSB bus.

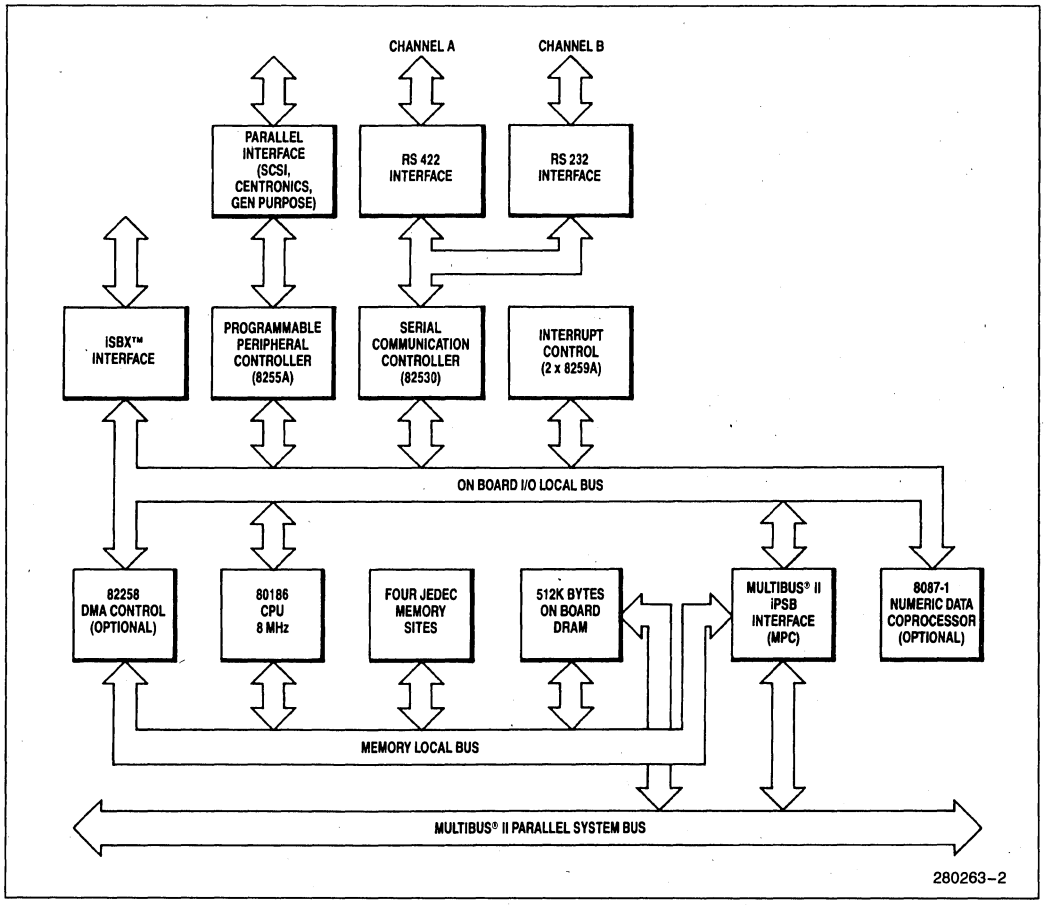


Figure 1. iSBC® 186/100 CPU Board Block Diagram

The ROM space consists of four 28-pin JEDEC sockets which take EPROMs, EEPROMs, or ROMs with 28-pin packages. An iSBC 341 28-pin MULTIMODULE™ EPROM board can be plugged into 2 of the JEDEC sockets and provide up to 512K bytes of ROM memory. Device capacities, which are jumper selectable, are supported from 8K x 8 up to 64K x 8. Once the device capacity is selected, the capacity is uniform for all sockets.

I/O access from the iSBC 186/100 CPU board across the iPSB bus is accomplished by mapping 64K bytes of local I/O access one to one to the iPSB I/O address space. However, only the upper 32K bytes are available to access the iPSB I/O address space because the lower 32K bytes on the iSBC 186/100 board are reserved for local on-board I/O.

On-Board Local Functions

PROGRAMMABLE TIMERS AND INTERRUPT CONTROL

The 80186 microprocessor on the iSBC 186/100 board provides three independent, fully programmable 16-bit interval timers/event counters. In conjunction, two 8259A Programmable Interrupt Controllers (PIC) on the iSBC 186/100 board are used in a master/slave configuration for processing on-board interrupts. At shipment, the 80186 interrupt controller and one PIC are connected as slaves to the master PIC. The first timer on the 80186 microprocessor is routed to the master Programmable Interrupt Controller and the second CPU timer is routed to the slave PIC. This architecture thus supports software

Table 2. DMA Configuration with ADMA Option

80186	Local Bus
DMA Channel 0	Serial Channel B DMA
DMA Channel 1	Serial Channel B DMA or Parallel Port
ADMA 82258	
DMA Channel 0	Input DMA Bus Interface
DMA Channel 1	Output DMA Bus Interface
DMA Channel 2	Half-duplex Fast Serial Interconnect 1 Channel A or Interrupt 1 from iSBX Bus if Used with an iSBC 341 EPROM MULTIMODULE Board
DMA Channel 3	Full-duplex Fast Serial Interconnect 1 Channel A or iSBX Bus DMA Channel if Used with an iSBC 341 EPROM MULTIMODULE board.

NOTE:
When a MULTIMODULE™ expansion board is installed and DMA support is required, then an ADMA controller must also be installed. For additional optional configurations see the *iSBC 186/100 Single Board Computer User's Guide.*

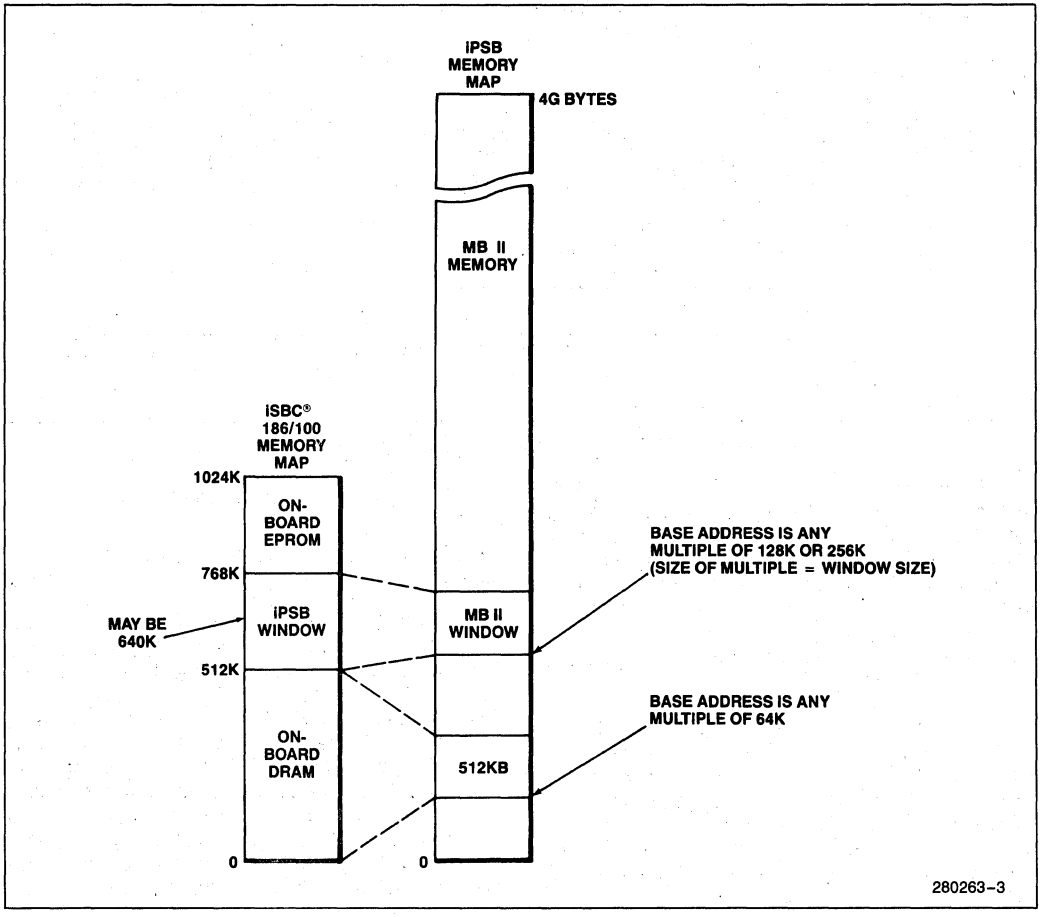


Figure 2. Memory Mapping Diagram

programmable timer interrupts. In addition, direct-vectored interrupt capability of the serial communication controller (SCC) may be used. Figure 3 depicts the interrupts in terms of their priorities.

Interrupt Services	Interrupt Priority
80186 Timer 0	Master Level 0
8087-1 Error Interrupt	1
Message Interrupt	2
iPSB Bus Error Interrupt	3
82530 SCC Interrupt	4
82258 ADMA Interrupt	5
80186 Slave PIC Interrupt	6
8259 Slave PIC Interrupt	7
PPI 0 Interrupt	Slave 0
iSBX Bus Interrupt 0	1
iSBX Bus Interrupt 1	2
Interconnect Space Interrupt	3
80186 Timer 1 Interrupt	4
PPI 1 Interrupt	5
Ground	6 & 7

Figure 3. iSBC® 186/10 Interrupt Priority Scheme

PARALLEL/SCSI PERIPHERAL INTERFACE

The iSBC 186/100 board includes an 8255A parallel peripheral interface that consists of three 8-bit parallel ports. As shipped, these ports are configured for general purpose I/O. Programmed PAL devices (Programmable Array Logic) and the bi-directional octal transceiver 74LS245 are provided to make it easy to reconfigure the parallel interface to be compatible with the SCSI (Small Computer System Interconnect) peripheral interface. Alternatively, the iSBC 186/100 board provides the jumper configuration facilities for operating the parallel interface as an interrupt driven interface for a Centronics compatible line printer by adding one PAL and reconfiguring jumpers. Both interfaces may use the 82258 DMA controller for data transfers if desired.

The SCSI interface allows multiple mass storage peripherals such as Winchester disk drives, floppy disk drives, and tape drives to be connected directly to the iSBC 186/100 board. A sample SCSI application is shown in Figure 4. The SCSI interface is compatible with SCSI controllers such as Adaptek 4500, DTC 1410, Iomega Alpha 10, Shugart 1601 and 1610, Vermont Research 8403, and Xebec 1410.

The Centronics interface requires very little software overhead since a user supplied PAL device is used to provide necessary handshake timing. Interrupts are generated for printer fault conditions and a DMA request is issued for every character.

SERIAL I/O LINES

The iSBC 186/100 board has one 82530 Serial Communciations Controller (SCC) to provide 2 channels of serial I/O. The SCC generates all baudrate clocks and provides loopback capability on both channels. Channel A is configured for RS 422A multidrop DTE application. Channel B is RS 232C only and is configured as DTE.

The multidrop configuration may either full-or half-duplex. A full-duplex multidrop configuration with a single master driving the output lines allow a slave to monitor the data line and to perform tasks in parallel with tasks performed on another slave. However, only the selected slave may transmit to the master. A half-duplex multidrop configuration is more strict in its protocol. Two data lines and a ground line are required between a master and all slaves in the system and although all units may listen to whomever is using the data line, the system software protocol must be designed to allow only one unit to transmit at any given instant.

BUILT-IN-SELF-TEST DIAGNOSTICS

On-board built-in-self-test (BIST) diagnostics are implemented using the 8751 microcontroller and the 80186 microprocessor. On-board tests include initialization tests on DRAM, EPROM, the 80186 microcontroller, and power-up tests. Additional activities performed include a Reset Operating System initialization at power-up and a program table check, a feature allowing users to add custom code in EPROM while still maintaining full use of the factory supplied BISTs.

Immediately after power-up and the 8751 microcontroller is intialized, the 80186 microprocessor begins its own initialization and on-board diagnostics. Upon successful completion of these activities, the Reset Operation System invokes the user-defined program table. A check is made of the program table and the custom programs that the user has defined for his application will then execute sequentially.

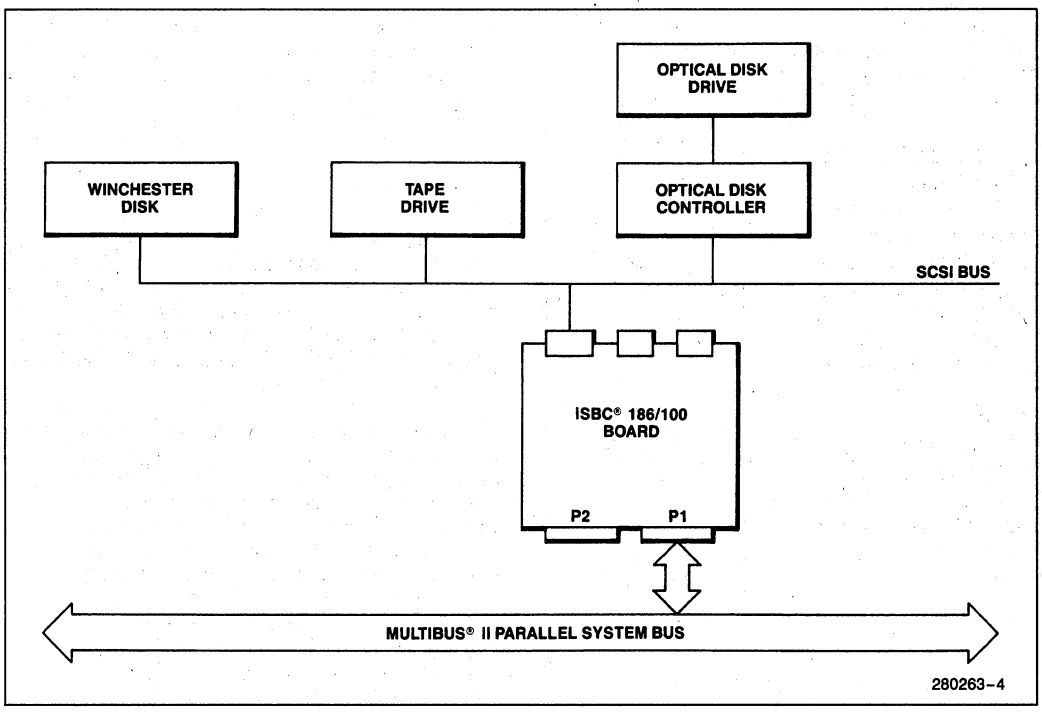


Figure 4. SCSI Application

BISTs improve the reliability, error reporting, and recovery capability of MULTIBUS II boards. In addition, these test and diagnostics reduce manufacturing and maintenance costs for the user. A yellow LED (labeled 'BIST') on the front panel indicates the status of the initialization checks and the power-up tests. It is illuminated if any of the initialization checks fail and remains off if the board successfully completes its tests. The LED also illuminates when the BIST tests start and stays on until the test complete successfully. The results of the BIST diagnostics are stored in the last 6 registers of the Header Record in Interconnect space.

iSBX™ BUS MULTIMODULE™ EXPANSION

One 8-or 16-bit iSBX bus MULTIMODULE connector is provided for I/O expansion. The iSBC 186/100 board supports both 8-bit and 16-bit iSBX modules through this connector. DMA is also supported to the iSBX connector and can be configured by programming the DMA multiplexor attached to the 82258 DMA component. The iSBX connector on the iSBC 186/100 board supports a wide variety of standard MULTIMODULE boards available from Intel and independent hardware vendors. Custom iSBX bus MULTIMODULE boards designed for MULTIBUS or proprietary bus systems are also supported as long as the IEEE P959 iSBX bus specification is followed.

iPSB BUS INTERFACE SILICON

The MPC (message passing coprocessor) provides all necessary iPSB bus interface logic on a single chip. Services provided by the MPC include memory and I/O access to the iPSB by the 80186 processor, bus arbitration, exception cycle protocols, and transfers as well as full message passing support. Dual port architecture may be implemented using the message passing coprocessor.

Interconnect Subsystem

The interconnect subsystem is one of the four MULTIBUS II address spaces, the other three being memory space, I/O space, and message space. The purpose of interconnect space is to allow software to initialize, identify, configure, and diagnose the boards in a MULTIBUS II system. All Intel MULTIBUS II boards support interconnect space.

The interconnect space is organized into a group of 8-bit registers called a template. The interconnect registers are organized into functional groups called records. Each register belongs to only one record, and there are three basic types of interconnect records: a header record, a function record, and an End of Template (EOT) record. The 80186 on the iSBC 186/100 board accesses its own template via the interconnect address space on the iPSB bus.

The header record provides board and vendor ID information, general status and control information, and diagnostic status and control information. The function record contains parameters needed to perform specific functions for the board. For example, an iPSB memory record contains registers that define the start and end address of memory for access across the iPSB bus. The number of function records in a template is determined by the manufacturer. The EOT record simply indicates the end of the interconnect template.

There are two types of registers in the MULTIBUS II interconnect space, read-only and software configurable registers. Read-only registers are used to hold information such as board type, vendor, firmware level, etc. Software configurable registers allow read and write operations under software control and are used for auto-software configurability and remote/local diagnostics and testing. A software monitor can be used to dynamically change bus memory sizes, disable or enable on-board resources such as PROM or JEDEC sites, read if the iSBX bus or PROM are installed as well as access the results of Built-In-Self-Tests or user installed diagnostics. Many of the interconnect registers on the iSBC 186/100 board perform functions traditionally done by jumper stakes. Interconnect space support is implemented with the 8751 microcontroller and iPSB bus interface logic.

SPECIFICATIONS

Word Size

INSTRUCTION: 8-, 16-, 24-, 32-, or 40-bits

DATA: 8-or 16-bits

System Clock

CPU: 8.0 MHz

NUMERIC COPROCESSOR: 8.0 MHz (part number 8087-1)

Cycle Time

BASIC INSTRUCTION: 8.0 MHz - 500 ns for minimum code read

Memory Capacity

LOCAL MEMORY

NUMBER OF SOCKETS: four 28-pin JEDEC sites

	Memory Capacity	Chip Example
EPROM	8K × 8	2764
EPROM	16K × 8	27128
EPROM	32K × 8	27256
EPROM	64K × 8	27512

ON-BOARD RAM

512K bytes 64K × 4 bit Dynamic RAM

I/O Capability

Serial:

— Two programmable channels using one 82530 Serial Communications Controller

— 19.2K baud rate maximum in full duplex in asynchronous mode or 1 megabit per second in full duplex in synchronous mode

— Channel A: RS 422A with DTE multidrop capability

— Channel B: RS 232C compatible, configured as DTE

— Parallel: SCSI, Centronics, or general purpose I/O

— Expansion: One 8-or 16-bit IEEE P959 iSBX MULTIMODULE board connector supporting DMA

Serial Communications Characteristics

ASYNCHRONOUS MODES:

- 19.2K baud rate maximum in full duplex
- 5-8-bit character; odd, even, or parity; 1, 1.5, or 2 stops bits
- Independent transmit and receive clocks, 1X, 16X, 32X, or 64X programmable sampling rate
- Error detection: Framing, Overrun, and Parity
- Break detection and generation

BIT SYNCHRONOUS MODES:

- 1 megabit per second maximum in full duplex
- SDLC/HDLC flag generation and recognition
- Automatic zero bit insertion and detection
- Automatic CRC generation and detection (CRC 16 or CCITT)
- Abort generation and detection
- I-field residue handling
- SDLC loop mode operation
- CCITT X.25 compatible

BYTE SYNCHRONOUS MODES:

- Internal or external character synchronization (1 or 2 characters)
- Automatic CRC generation and checking (CRC 16 or CCITT)
- IBM Bisync compatible

Timers

Three programmable timers on the 80186 microprocessor

INPUT FREQUENCIES:

Frequencies supplied by the internal 80186 16 MHz crystal

Serial chips: crystal driver at 9.8304 MHz divide by two

iSBX connector: 9.8304 crystal driven an 9.8304 MHz

Interrupt Capacity

POTENTIAL INTERRUPT SOURCES:

255 individual and 1 broadcast

INTERRUPT LEVELS:

12 vectored requests using two 8259As, 3 grounded inputs, and 1 input to the master PIC from the slave PIC

INTERRUPT REQUESTS:

All signals TTL compatible **INTERFACES**

IPSB BUS:

As per MULTIBUS II bus architecture specification

iSBX BUS:

As per IEEE P959 specification

CONNECTORS

Location	Function	Part #
P1	iPSB Bus	603-2-IEC-C096-F

Physical Dimensions

The iSBC 186/100 board meets all MULTIBUS II mechanical specifications as presented in the MULTIBUS II specification (#146077)

DOUBLE-HIGH EUROCARD FORM FACTOR:

Depth: 220 mm (8.7 in.)
Height: 233 mm (9.2 in.)
Front Panel Width: 20 mm (0.784 in.)
Weight: 743 g (26 oz.)

Environmental Requirements

Temperature: Inlet air at 200 LFM airflow over all boards
Non-operating: −40° to +70°C
Operating: 0° to +55°C

Humidity: Non-operating: 95% RH @55°C, non-condensing
Operating: 90% RH @ 55°C, non-condensing

Electrical Characteristics

The maximum power required per voltage is shown below. These numbers do not include the power required by the optional memory devices, SCSI PALs, or expansion modules.

Voltage (Volts)	Max Current (Amps)	Max Power (Watts)
+5	6.5 mA	34.13W
+12	50 mA	0.06W
−12	50 mA	0.06W

Reference Manuals

iSBC 186/100 Single Board Computer User's Guide (#148732-001)

Intel MULTIBUS II Bus Architecture Specification (#146077)

Manuals may be ordered from any Sales Representative, Distribution Office, or from the Intel Literature Department, 3065 Bowers Avenue, Santa Clara, CA, 95051.

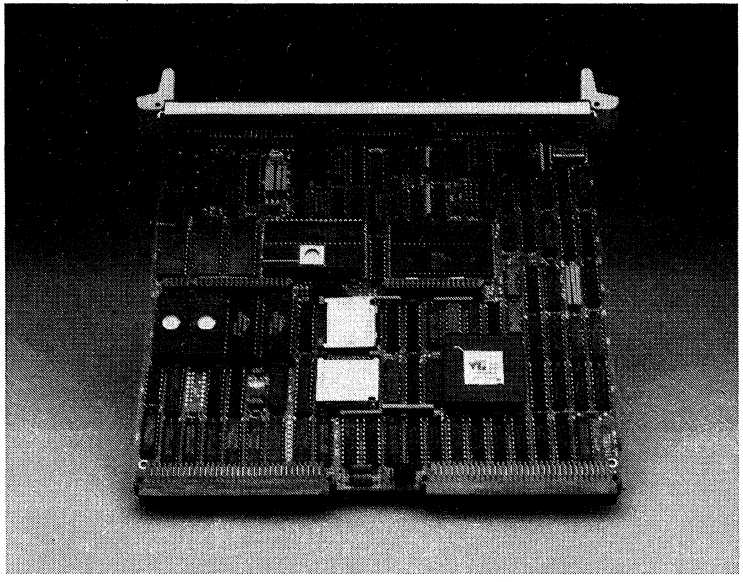
ORDERING INFORMATION

Part Number	Description
SBC186100	MULTIBUS II 80186-based Single Board Computer

iSBC® 286/100A MULTIBUS®II SINGLE BOARD COMPUTER

- 8 MHz 80286 Microprocessor with Optional 80287 Numeric Data Co-Processor
- MULTIBUS® II iPSB (Parallel System Bus) Interface with Full Message Passing Capabilities and up to 4 Gigabytes of Memory Addressability on the Bus
- High-Speed Memory Expansion with MULTIBUS II iLBX II (Local Bus Extension) Interface Addresses up to 16 MBytes of Local and/or Dual Port Memory
- Two iSBX Bus Interface Connectors for I/O Expansion Bus
- Four DMA Channels Supplied by the 82258 Advanced DMA Controller with 8 MBytes/sec Transfer Rate
- MULTIBUS® II Interconnect Space for Software Configurability and Self-Test Diagnostics
- Resident Firmware Supports Self-Test Power-Up Diagnostics and On-Command Extended Self-Test Diagnostics
- Two Programmable Serial Interfaces, one RS232C (DCE or DTE), the other RS232C or RE422A/RS449 Compatible
- Two 28-pin JEDEC Sites for up to 128 KBytes of Local Memory Using SRAM, NVRAM, EEPROM, and EPROM
- 24 Programmable I/O Lines Configurable as SCSI Interface, Centronics Interface, or General Purpose I/O

The iSBC 286/100A Single Board Computer is part of Intel's family of MULTIBUS II CPU boards that utilizes the advanced features of the MULTIBUS II System Architecture. It is ideally suited for a wide range of OEM applications. The combination of the 80286 CPU, the Message Passing Coprocessor (MPC), the MULTIBUS II Parallel System Bus (iPSB bus), and the Local Bus Extension (iLBX II bus) makes the iSBC 286/100A board suited for high performance, multiprocessing system applications in a multimaster environment. The board is a complete microcomputer system on a 220mm x 233mm (8.7 x 9.2 inch) Eurocard form factor with pin and socket DIN connectors.



280076-1

March 1987
Order Number: 280076-004

Overview

The iSBC 286/100A Single Board Computer combines the 80286 microprocessor with the Message Passing Component (MPC) on a single board within the MULTIBUS II system architecture. This offers a message passing based high performance multiprocessing solution for system integrators and designers. Figure 1 shows a typical MULTIBUS II multiprocessing system configuration. Overall system performance is enhanced by the Local Bus Extension (iLBX II) which allows 0 wait state high speed memory execution.

Architecture

All features of the MULTIBUS II architecture are fully supported by the iSBC 286/100A board including the Parallel System Bus (iPSB), interconnect space, Built-In-Self-Tests (BIST) diagnostics, and full message passing. These features are described in the following sections. In addition to taking advantage of the MULTIBUS II system architecture, the iSBC 286/100A board has complete single board computer capability including two iSBX bus expansion connectors, 80287 numeric data coprocessor option, advanced DMA control, JEDEC memory sites, SCSI configurable parallel interface, serial I/O, and programmable timers. Figure 2 shows the iSBC 286/100A board block diagram.

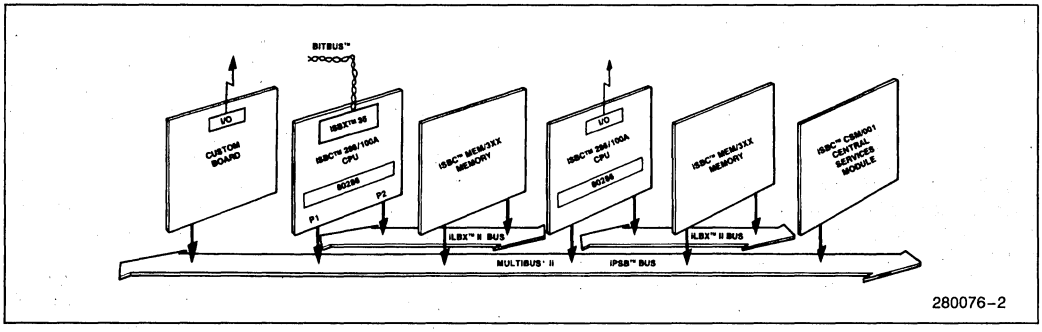


Figure 1. Typical MULTIBUS®II Multiprocessing System Configuration

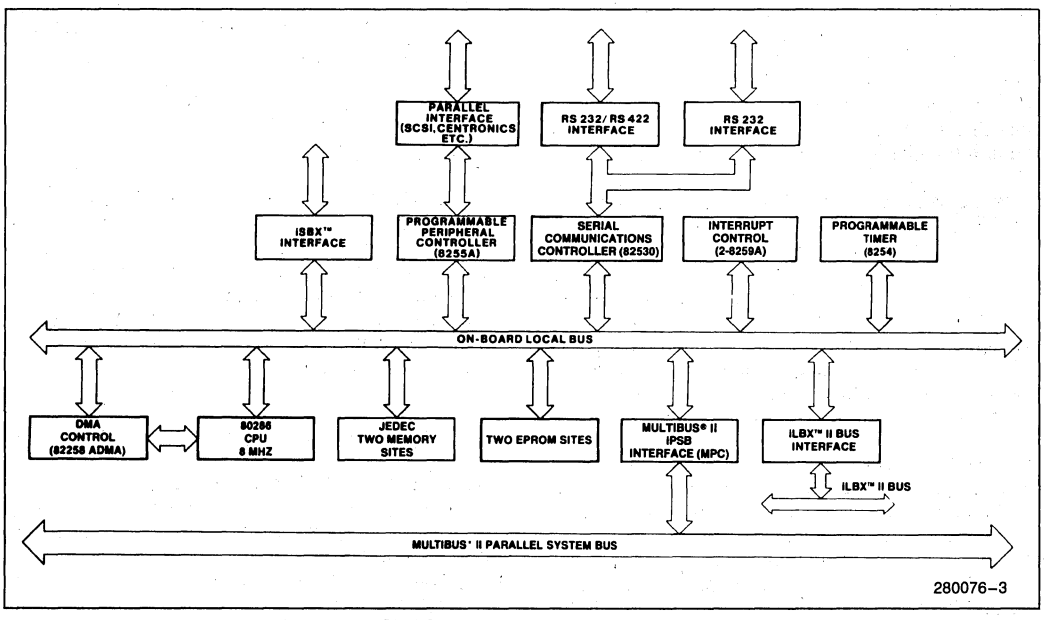


Figure 2. iSBC® 286/100A Board Block Diagram

Central Processing Unit

The central processing unit for the iSBC 286/100A board is the 80286 microprocessor operating at 8.0 MHz clock rate. The 80286 runs 8086 and 80186 code at substantially higher speeds (due to a parallel chip architecture) while maintaining software compatibility with Intel's 8086 and 80186 microprocessors. Numeric processing power may be enhanced with the 80287 numeric data coprocessor. The 80286 CPU operates in two modes: real address mode and protected virtual address mode. In real address mode, programs use real addressing with up to one megabyte of address space. In protected virtual address mode, the 80286 CPU automatically maps 1 gigabyte of virtual address per task into a 16 megabyte real address space. This mode also provides the hardware memory protection for the operating system. The operating mode is selected via CPU instructions.

iPSB Bus Interface

The iSBC 286/100A board has a Message Passing Coprocessor (MPC) component on the base board that contains most of the logic required to operate the Parallel System Bus (iPSB bus) interface. Some of the key functions provided by the MPC include bus arbitration, transfer control, parity generation and checking, and error detection and reporting.

Data transfers between processors via the iPSB bus is defined in the MULTIBUS II architecture through a transfer protocol, a reserved address space, and an information/data block. This interprocessor communication convention is known as message passing. Operations occurring within the reserved address space are called message space operations.

Message passing allows iPSB bus agents to transfer variable amounts of data at rates approaching the maximum bandwidth of the bus. Message passing permits a sustained transfer rate of 2.2 Mbytes per second, and a single message may transfer up to 16 Mbytes from one agent to another. The MPC fully supports message space operations, executes iPSB bus arbitration and executes the message passing protocol independent of the host CPU, leaving the host free to process other tasks.

The MPC supports both solicited and unsolicited message passing capability across the iPSB. An unsolicited message can be thought of as an intelligent interrupt from the perspective of the receiving agent because the arrival of an unsolicited message is unpredictable. Attached to an unsolicited message is one of 255 possible source addresses along with 28 bytes of data attached to the message data field. A solicited message moves large blocks of data between agents on the iPSB bus. The arrival of a solicited message is negotiated between the sending and receiving agents. Data is sent in "packets" with each packet containing four bytes of control information and up to 28 bytes of data. There is no specific limit to the number of packets that may be sent in a single message, but the total message may not transfer more than 16 Mbytes.

The iSBC 286/100A also includes a feature called the iPSB window register that allows the user to selectively access under software control any 256K byte block of memory within the 4 Gigabytes of memory space on the iPSB bus interface.

INTERCONNECT SPACE SUPPORT

Interconnect space is one of four MULTIBUS II address spaces, the other three being memory space, I/O space, and message space. Interconnect space allows software to initialize, identify, configure, and diagnose the boards in a MULTIBUS II system. The Interconnect template consists of 8-bit registers, organized into functional groups called records. There are three types of records, the header record, the function record, and the End of Template record.

The header record provides board and vendor ID information, general status and control information, and diagnostic control. The function record allows the user to configure and/or read the iSBC 286/100A board's hardware configuration via software. The End of Template record identifies the end of the interconnect template.

BUILT IN SELF TEST (BIST) DIAGNOSTICS

MULTIBUS II's Built in Self Test (BIST) diagnostics improve the reliability and error reporting and recovery capability of MULTIBUS II boards. These confidence tests and diagnostics not only improve reliability but also reduce manufacturing and maintenance costs for the OEM user. A yellow LED (LED 1) on the front panel provides a visual indication of the power-up diagnostics status.

Error Reporting and Recovery

The MULTIBUS II Parallel System Bus and the iLBX II bus provides bus transmission and bus parity error detection signals. Error information is logged in the MPC and a bus error interrupt is generated. Information on the error source for reporting or recovery purposes is available to software through the iSBC 286/100A board interconnect space registers.

INTERRUPT CONTROL

In a MULTIBUS II system, external interrupts (interrupts originating off the CPU board) are messages over the bus rather than signals on individual lines. Message based interrupts are handled by the MPC. Two on-board 8259A Programmable Interrupt Controllers (PICs) are used for processing on-board interrupts. One is used as the master and the other as the slave. Table 1 includes a list of devices and functions supported by interrupts.

iSBX® BUS MULTIMODULE™ ON-BOARD EXPANSION

Two iSBX bus MULTIMODULE connectors are provided, one 16- or 8-bit and the other 8-bit. Through these connectors additional on-board I/O functions may be added. The iSBX bus MULTIMODULE boards optimally support functions provided by VLSI peripheral components such as additional parallel and serial I/O, analog I/O, and graphics control. The iSBX bus connectors on the iSBC 286/100A board provides all signals necessary to interface to the local on-board bus including 16 data lines and DMA for maximum data transfer rates. MULTIMODULE boards designed with 8-bit data paths and using the 8-bit iSBX bus connectors are also supported. A broad range of iSBX bus MULTIMODULE options are available from Intel. Custom iSBX bus MULTIMODULE boards designed for MULTIBUS or proprietary bus systems are also supported provided the IEEE P959 iSBX bus specification is followed.

NUMERIC DATA CO-PROCESSOR

The 80287 Numeric Data Co-Processor can be installed on the iSBC 286/100A board by the user. The 80287 Numeric Data Co-Processor is connected to dedicated processor signal lines which are pulled to their inactive state when the 80287 Numeric Data Co-Processor is not installed. This enables the user to detect via software that the 80287 socket is occupied. The 80287 Numeric Data Co-Processor runs asynchronously to the 80286 clock. The 80287 Numeric Data Co-Processor operates at 8 MHz and is driven by the 8284A clock generator.

Table 1. Interrupt Devices and Functions

Device	Function	Number of Interrupts
MULTIBUS® II Interface	Message-based Interrupt Request from the iPSB Bus via 84120 Message Interrupt Controller	1 Interrupt from up to 256 sources
8751 Interconnect Controller	BIST Control Functions	1
82530 Serial Controller	Transmit Buffer Empty, Receive Buffer Full and Channel Errors	1 Interrupt from 10 Sources
8254 Timers	Timers 0, 1, 2 Outputs; Function Determined by Timer Mode	3
8255A Parallel I/O	Parallel Port Control	2
iLBX II Bus Interface	Indicates iLBX™ II Bus Error Condition	3
iPSB Bus Interface	Indicates Transmission Error on iPSB Bus	1
iSBX Bus Connector	Function Determined by iSBX Bus MULTIMODULE Board	2
Edge Sense Out	Converts Edge Triggered Interrupt to a Level	1
Bus Error	Indicates Last iPSB Bus Operation Encountered an Error	1
Power-Fail	External/Power-Fail Interrupts	1

DMA CONTROL

Four DMA (Direct Memory Access) channels are supplied on the iSBC 286/100A board by the 82258. The 82258 is an advanced DMA controller designed especially for the 16-bit 80286 microprocessor. It has four DMA channels which can transfer data at rates up to 8 Megabytes per second (8 MHz clock) in an 80286 system. The large bandwidth allows the user to handle very fast data transfer or a large number of concurrent peripherals.

MEMORY CAPABILITIES

The local memory of the iSBC 286/100A board consists of two groups of byte-wide sites. The first group of two sites are reserved for EPROM or ROM and are used for the BIST power-up diagnostic firmware. The second group of two sites support JEDEC standard 28-pin devices.

PARALLEL PERIPHERAL INTERFACE

The iSBC 286/100A board includes a parallel peripheral interface that consists of three 8-bit parallel ports. As shipped, these ports are configured for general purpose I/O. Programmed PAL (Programmable Array Logic) devices and the octal transceiver 74LS640-1 are provided to make it easy to reconfigure the parallel interface to be compatible with the SCSI (Small Computer System Interconnect) peripheral interface. Alternatively, the parallel interface may be reconfigured as a Centronics compatible line printer by adding one PAL and reconfiguring jumpers. Both interfaces may use the 82258 DMA controllers for data transfers.

The SCSI interface allows multiple mass storage peripherals such as Winchester disk drives, floppy disk drives, and tape drives to be connected directly to the iSBC 286/100A board. A sample SCSI application is shown in Figure 3. The SCSI interface is compatible with SCSI controllers such as the Adaptek 4500, DTC 1410, Iomga Alpha 10, Shugart 1601 and 1610, Vermont Research 8403, and Xebec 1410.

The Centronics interface requires very little software overhead since a user-supplied PAL device is used to provide necessary handshake timing. Interrupts are generated for printer fault conditions and a DMA request is issued for every character.

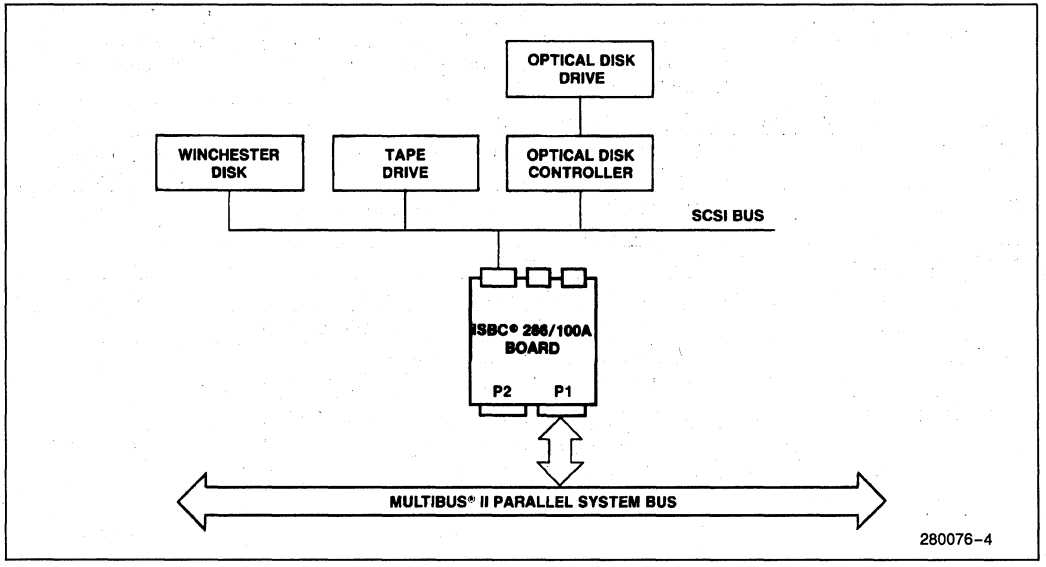


Figure 3. Sample SCSI Applications

SERIAL I/O

The 82530 Serial Communications Controller (SCC) is used to provide two channels of serial I/O. The SCC generates all baudrate clocks and provides loopback capability on both channels. Channel B is RS232C only and is configured as a DCE. Channel A is factory-default configured for DCE RS232C operation. Channel A may be reconfigured by the user for DTE or RS422 operation.

The 82258 ADMA can be programmed to support both channels A and B to perform movement of large bit streams or blocks of data.

PROGRAMMABLE TIMERS

The iSBC 286/100A board provides three independent, fully programmable 16-bit interval timers/event counters utilizing the Intel 8254 Programmable Interval Timer. Each counter is capable of operating in either BCD or binary modes. Three of these timers/counters are available to the system designer to generate accurate time intervals under software control. The outputs may be independently routed to the 8259A Programmable Interrupt Controller to count external events. The system software configures each timer independently to select the desired function. Seven functions are available as shown in Table 2. The contents of each counter may be read at any time during system operation.

SOFTWARE SUPPORT

The iRMX 86 Release 7 Operating System software provides the ability to execute all configurable layers of the iRMX 86 software in the MULTIBUS II environment. Applications in Real Address Mode are supported for the iSBC 286/100A board, including support for the SCSI peripheral interface and all iSBX bus boards. The iRMX 86 Release 7 Operating System also supports all 80286 component applications.

For on-target MULTIBUS II development, use the iSBX 218A or a SCSI controller and a floppy or Winchester drive, or port iRMX application software developed on the System 310, Series II/III, IV to MULTIBUS II hardware.

Language support for the iSBC 286/100A boards real address mode includes Intel's ASM 86, PL/M 86, PASCAL and FORTRAN as well as many third party 8086 languages. Language support for virtual address mode operation includes ASM 286, PL/M 286, PASCAL and C. Programs developed in these languages can be down-loaded from the Intel Series III or Series IV Development System to the iSBC 286/100A board via the iSDM 286 System Debug Monitor Release 2. The iSBX 218A can be used to load iRMX software developed on a System 310. The iSDM 286 monitor also provides on-target program debugging support including breakpoint and memory examination features.

Table 2. Programmable Time Functions

Function	Operation
Interrupt on Terminal Count	When terminal count is reached, an interrupt request is generated. This function is extremely useful for generation of real-time clocks.
Programmable One-Shot	Output goes low upon request of an external trigger edge or software command and returns high when terminal count is reached. This function is retriggerable.
Rate Generator	Divide by N counter. The output will go low for one input clock cycle, and the period from one low going pulse to the next is N times the input clock period.
Square-Wave Rate Generator	Output will remain high until one-half the count has been completed, and go low for the other half of the count.
Software Triggered Strobe	Output remains high until software loads count (N). N counts after count is loaded, output goes low for one input clock period.
Hardware Triggered Strobe	Output goes low for one clock period N counts after rising edge counter trigger input. The counter is retriggerable.
Event Counter	On a jumper selectable basis, the clock input becomes an input from the external system. CPU may read the number of events occurring after the counter "window" has been enabled or an interrupt may be generated after N events occur in the system.

The MULTIBUS II Interconnect Space Registers allow the software to configure boards eliminating much of the need for jumpers and wire wraps. The iSDM 286 Monitor can initialize these registers at configuration time using user-defined variables. The monitor can also automatically configure memory boards, defining the addresses for each board sequentially in relation to the board's physical placement in the card cage. This feature allows for swapping, adding, and deleting of memory boards on a dynamic basis.

SPECIFICATIONS

WORD SIZE

Instruction— 8-, 16-, 24-, 32-, or 40-bits

Data — 8- or 16-bits

SYSTEM CLOCK

CPU — 8.0 MHz

Numeric Co-Processor— 8.0 MHz

CYCLE TIME

Basic Instruction: 8.0 MHz-375 ns; 250 ns (assumes instruction in queue)

NOTE:
Basic instruction cycle is defined as the fastest instruction time (i.e., two clock cycles)

Memory Capacity (Maximum)

EPROM: 2732, 8K bytes; 2764, 16K bytes; 27128, 32K bytes; 27256, 64K bytes; 27512, 128K bytes

EEPROM: 2817A, 4K bytes

iRAM: 2186, 16K bytes

NOTE:
Two local sites must contain BIST or user-supplied boot-up EPROM.

I/O CAPABILITY

Parallel: SCSI, Centronics, or general purpose I/O

Serial: Two programmable channels using one 82530 Serial Communications Controller

Timers: Three programmable timers using one 8254 Programmable Interrupt Controller

Expansion: One 8/16-bit iSBX MULTIMODULE connector and one 8-bit iSBX MULTIMODULE connector

INTERRUPT CAPABILITY

Potential Interrupt Sources— 255 individual and 1 broadcast

Interrupt Levels — 16 vectored requests using two 8259As and the 80286 NMI line

Serial Communications Characteristics

Asynchronous Modes:

— 5–8-bit character; odd, even, or parity; 1, 1.5, or 2 stop bits

— Independent transmit and receive clocks, 1X, 16X, 32X, or 64X programmable sampling rate

— Error Detection: Framing, Overrun and Parity

— Break detection and generation

Bit Synchronous Modes:

— SDLC/HDLC flag generation and recognition

— Automatic zero bit insertion bit and detection

— Automatic CRC generation and detection (CRC 16 or CCITT)

— Abort generation and detection

— I-field residue handling

— SDLC loop mode operation

— CCITT X.25 compatible

Byte Synchronous Modes:

— Internal or external character synchronization (1 or 2 characters)

— Automatic CRC generation and checking (CRC 16 or CCITT)

— IBM Bisync compatible

Common Baud Rates

Baud Rate	Synchronous (x1 Clock)	Asynchronous (x16 Clock)
	Time Constant	Time Constant
64 K	36	—
48 K	49	—
19.2 K	126	6
9600	254	14
4800	510	30
2400	1022	62
1800	1363	83
1200	2046	126
300	8190	510
110	—	1394

Timers

Input Frequencies: 1.23 MHz ±0.1% or 4 MHz ±0.1% (Jumper Selectable)

Output Frequencies/Timing Intervals

	Single Timer/Counter		Dual Timer/Counter (two timers cascaded)	
	Min	Max	Min	Max
Real-Time Interrupt	500 ns	53.1 ms	1.00 ms	57.9 min
Programmable One-Shot	500 ns	53.1 ms	1.00 ms	57.9 min
Rate Generator	18.8 Hz	2 MHz	0.000290 Hz	1 MHz
Square-Wave Rate Generator	18.8 Hz	2 MHz	0.000290 Hz	1 MHz
Software Triggered Strobe	500 ns	53.1 ms	1.00 ms	57.9 min
Hardware Triggered Strobe	500 ns	53.1 ms	1.00 ms	57.9 min
Event Counter	—	5.0 MHz	—	—

INTERFACES

iPSB Bus: All signals TTL compatible

iLBX II Bus: All signals TTL compatible

iSBX Bus: All signals TTL compatible

SERIAL I/O

Channel A: RS232C/RS422 compatible, configurable as a data set or data terminal

Channel B: RS232C compatible, configured as a data set

Timer: All signals TTl compatible

Interrupt Requests: All signals TTL compatible

CONNECTORS

Location	Function	Part #
P1	iPSB Bus	603-2-IEC-C096-F
P2	iLBX™ II Bus	603-2-IEC-C096-F

PHYSICAL DIMENSIONS

The iSBC 286/100A board meets all MULTIBUS II mechanical specifications as represented in the MULTIBUS II specification (part number 146077).

Double-High Eurocard Form Factor:

Depth:	220 mm (8.7 in.)
Height:	233 mm (9.2 in.)
Front Panel Width:	20 mm (0.784 in.)
Weight:	653 g (1 lb. 7 oz.)

ENVIRONMENTAL REQUIREMENTS

Temperature: (Inlet air) at 200 LFM airflow over boards

Non-operating—−40°C to +70°C

Operating—0 to +55°C

Humidity: Non-operating—95% RH @ 55°C

Operating—90% RH @ 55°C

ELECTRICAL CHARACTERISTICS

The maximum power required per voltage is shown below. These numbers do not include the power required by the optional memory devices, SCSI PALs, or expansion modules.

Voltage (volts)	Max/Typical Current (amps)	Max Power (watts)	BTU	Gram-Calorie
+5	10.31/8.25A	54.39W	3.13	774.2
+12	50/40 mA	630 mW	0.04	9.0
−12	46/37 mA	580 mW	0.03	8.3

REFERENCE MANUALS

ISBC 286/100A Single Board Manual Computer User's Guide (#149093-001)

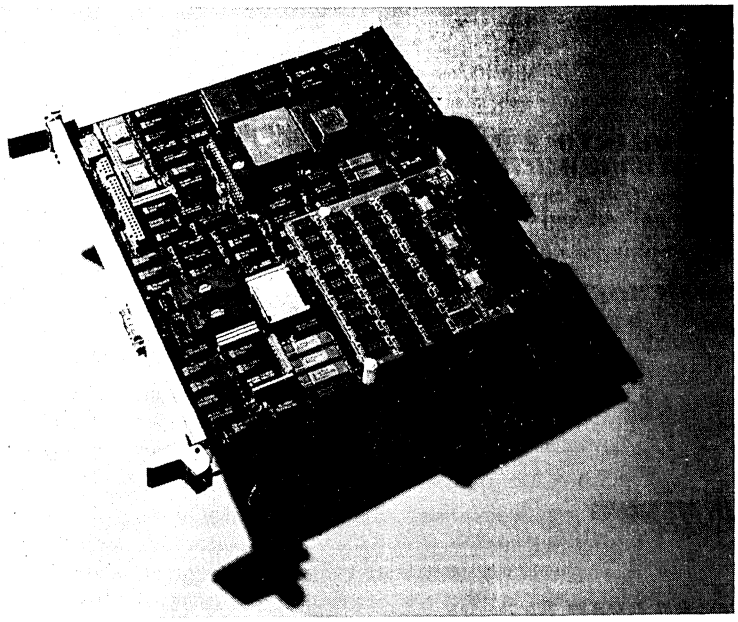
Intel MULTIBUS II Bus Architecture Specification (#146077)

Manual may be ordered from any Sales Representative, Distribution Office, or from the Intel Literature Department, 3065 Bowers Ave., Santa Clara, CA 95051

ORDERING INFORMATION

Part Number	Description
SBC 286/100A	MULTIBUS II 80286 based Single Board Computer

MULTIBUS® II 386 CPU BOARDS



32-BIT PERFORMANCE WITH MULTIBUS® II CAPABILITY

These 32-bit MULTIBUS® II boards provide the system architect the power of the 80386 in a fully tested, industry standard form. Off-the-shelf boards are available in 16 MHz and 20 MHz versions configured with one to sixteen megabytes of on-board memory. Performance is further enhanced by the MULTIBUS II architecture's support for multi-processing. Additional benefit comes from simplified configuration and maintenance through software controlled registers. Maintenance is further reduced by a very reliable parity error detection protocol and with pin-and-socket connectors. Broad, multi-vendor support is assured by rigid bus conformance implemented by a standard single chip bus interface.

FEATURES:

- 80386 32-bit CPU operating at 16 or 20 MHz
- 80387 Numeric Coprocessor operating at 16 or 20 MHz
- Full 32-bit MULTIBUS II Parallel System Bus (PSB, IEEE 1296) interface
- Eurocard form factor (8.7 by 9.2 inches) with 96-pin DIN pin-and-socket connectors
- 82258 ADMA operating at 8 or 10 MHz with special 32-bit "fly-by" mode
- 64 K byte static RAM cache memory for 0 wait states
- 1 M, 2 M, 4 M or 8 M byte on-board dynamic RAM, expandable to 16 M byte
- Parity error detection and dual-port access capability for on-board DRAM
- One SBX (IEEE P959) 8/16-bit interface
- 15 levels of programmable interrupt control
- 3 programmable interval timers
- Built-in self-test (BIST) provided in 256 K bytes of EPROM
- Software configuration via interconnect space
- One RS-232-C serial I/O port
- Software supported by the UNIX* V.3 operating system, the iRMX® 286 real-time operating system, the iRMK 386 real-time kernel, and the PMON 386 debug monitor

*UNIX is a trademark of AT&T.

intel

June, 1987
Order Number: 280620-001

SPECIFICATIONS

386 AND 387 CLOCK RATES/BASIC CYCLE TIME*

iSBC 386/116:	16 MHz/125 ns
iSBC 386/120:	20 MHz/100 ns

*assumes instruction in queue or cache memory.

82258 ADMA CLOCK RATES/ MAXIMUM BANDWIDTH**

iSBC 386/116:	8 MHz/10.7 MB per second
iSBC 386/120:	10 MHz/13.3 MB per second

**assumes move between local DRAM and MPC.

EPROM MEMORY

Devices	Capacity
2764	16 K byte
27128	32 K byte
27256	64 K byte
27512	128 K byte (supplied)
27010	256 K byte
27020	512 K byte

CACHE MEMORY

Capacity:	64 K byte
Speed:	0 wait state on cache hit

ON-BOARD DRAM MEMORY

Model #	Supplied
iSBC 386/116 M01	1 MB
iSBC 386/116 M02	2 MB
iSBC 386/116 M04	4 MB
iSBC 386/116 M08	8 MB
iSBC 386/120 M01	1 MB
iSBC 386/120 M02	2 MB
iSBC 386/120 M04	4 MB
iSBC 386/120 M08	8 MB

- Maximum on-board memory capacity = 16 MB
- Single-bit parity error detection per 8-bits
- 1 wait state on write, 2 wait states on read cache miss

iSBX BUS INTERFACE

- Compliance Level: D16/16 DMA

PROGRAMMABLE INTERNAL TIMERS

- Three event counters/timers
- 16-bit programmable count
- Interval range from 1.6 μs to 52.4 ms

SERIAL I/O PORT

- RS-232-C (subset) interface (DTE)
- 9-pin D-shell shielded connector
- Configurable baud rates: 300, 600, 1200, 2400, 4800, and 9600

PHYSICAL DIMENSIONS

Height:	233 mm (9.18 inches)
Depth:	220 mm (8.65 inches)
Width:	19.2 mm (0.80 inches)

USERS GUIDE

iSBC 386/116 and 386/120 Single Board Computer User's Guide

ORDER INFORMATION

Order code	Description
SBC 386 116 M01	16 MHz 386-based MULTIBUS II CPU board with 1 M byte DRAM
SBC 386 116 M02	16 MHz 386-based MULTIBUS II CPU board with 2 M byte DRAM
SBC 386 116 M04	16 MHz 386-based MULTIBUS II CPU board with 4 M byte DRAM
SBC 386 116 M08	16 MHz 386-based MULTIBUS II CPU board with 8 M byte DRAM
SBC 386 120 M01	20 MHz 386-based MULTIBUS II CPU board with 1 M byte DRAM
SBC 386 120 M02	20 MHz 386-based MULTIBUS II CPU board with 2 M byte DRAM
SBC 386 120 M04	20 MHz 386-based MULTIBUS II CPU board with 4 M byte DRAM
SBC 386 120 M08	20 MHz 386-based MULTIBUS II CPU board with 8 M byte DRAM
SBC MM01	1 M byte expansion memory module
SBC MM02	2 M byte expansion memory module
SBC MM04	4 M byte expansion memory module
SBC MM08	8 M byte expansion memory module

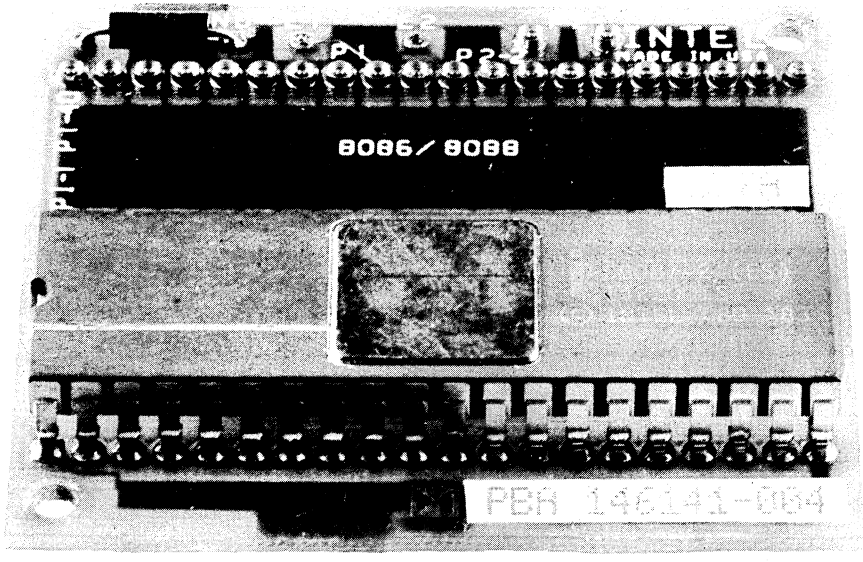
High Speed Math Boards 5

iSBC® 337A and iSBC® 337 MULTIMODULE™ NUMERIC DATA PROCESSOR

- **High speed fixed and floating point functions for 8 or 5 MHz iSBC® 86, 88, and iAPX 86, 88 systems**
- **Extends host CPU instruction set with arithmetic, logarithmic, transcendental and trigonometric instructions**
- **MULTIMODULE™ option containing 8087 Numeric Data Processor**
- **Up to 80X performance improvement in Whetstone benchmarks over 8MHz iAPX-86/10 performance**
- **Supports seven data types including single and double precision integer and floating point**
- **Software support through ASM 86/88 Assembly Language and High Level Languages**
- **Fully supported in the multi-tasking environment of the iRMX™ 86 Operating System**

The Intel iSBC® 337A/337 MULTIMODULE™ Numeric Data Processor offers high performance numerics support for iSBC 86 and iSBC 88 Single Board Computer users, for applications including simulation, instrument automation, graphics, signal processing and business systems. The coprocessor interface between the 8087 and the host CPU provides a simple means of extending the instruction set with over 60 additional numeric instructions supporting six additional data types. The MULTIMODULE implementation allows the iSBC 337A module to be used on all iSBC 86 and iAPX 88 board designs.

The coprocessor interface between the 8087 Numeric Data Processor and the host CPU provides a simple means of extending the instruction set with over 60 additional numeric instructions supporting seven data types. The MULTIMODULE implementation allows the iSBC 337A/337 module to be used on all iSBC 86/88" single board computers and can be added as an option to custom iAPX board designs.



October, 1984
ORDER NUMBER: 280077-001

OVERVIEW

The iSBC 337A/337 MULTIMODULE Numeric Data Processor (also called NDP) provides arithmetic and logical instruction extensions to the 86/88 of the iAPX 86/88 families. The instruction set consists of arithmetic, transcendental, logical, trigonometric and exponential instructions which can all operate on seven different data types. The data types are 16, 32, and 64 bit integer, 32 and 64 bit floating point, 18 digit packed BCD and 80 bit temporary.

Coprocessor Interface

The coprocessor interface between the host CPU and the iSBC 337A/337 processor provides easy to use and high performance math processing. Installation of the iSBC 337A/337 processor is simply a matter of removing the host CPU from its socket, installing the iSBC 337A/337 processor into the host's CPU socket, and reinstalling the host CPU chip into the socket provided for it on the iSBC 337A/337 processor (see Figure 1).

All synchronization and timing signals are provided via the coprocessor interface with the host CPU. The two processors also share a common address/data bus. (See Figure 2). The NDP component is capable of recognizing and executing NDP numeric instructions as they are fetched by the host CPU. This interface allows concurrent processing by the host CPU and the NDP. It also allows NDP and host CPU instructions to be intermixed in any fashion to provide the maximum overlapped operation and the highest aggregate performance.

High Performance and Accuracy

The 80-bit wide internal registers and data paths contribute significantly to high performance and minimize the execution time difference between single and double precision floating point formats. This 80-bit architecture provides very high resolution and accuracy.

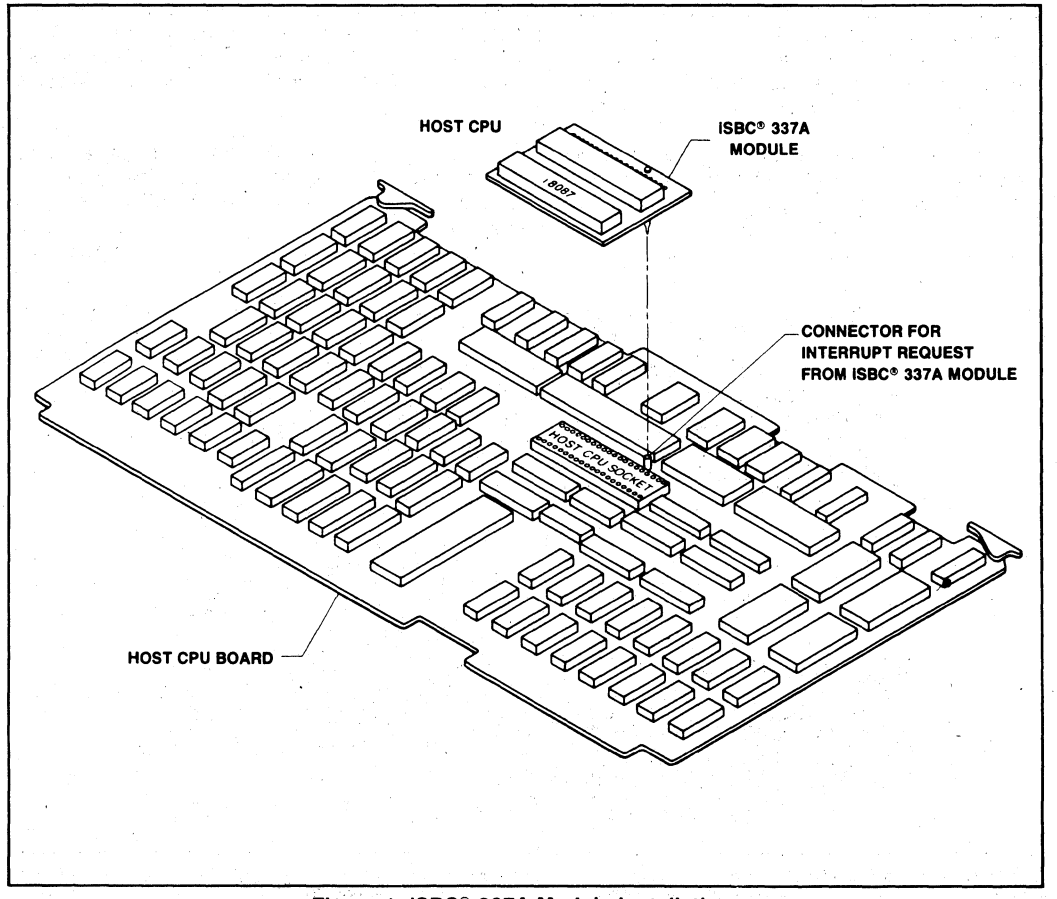


Figure 1. iSBC® 337A Module Installation

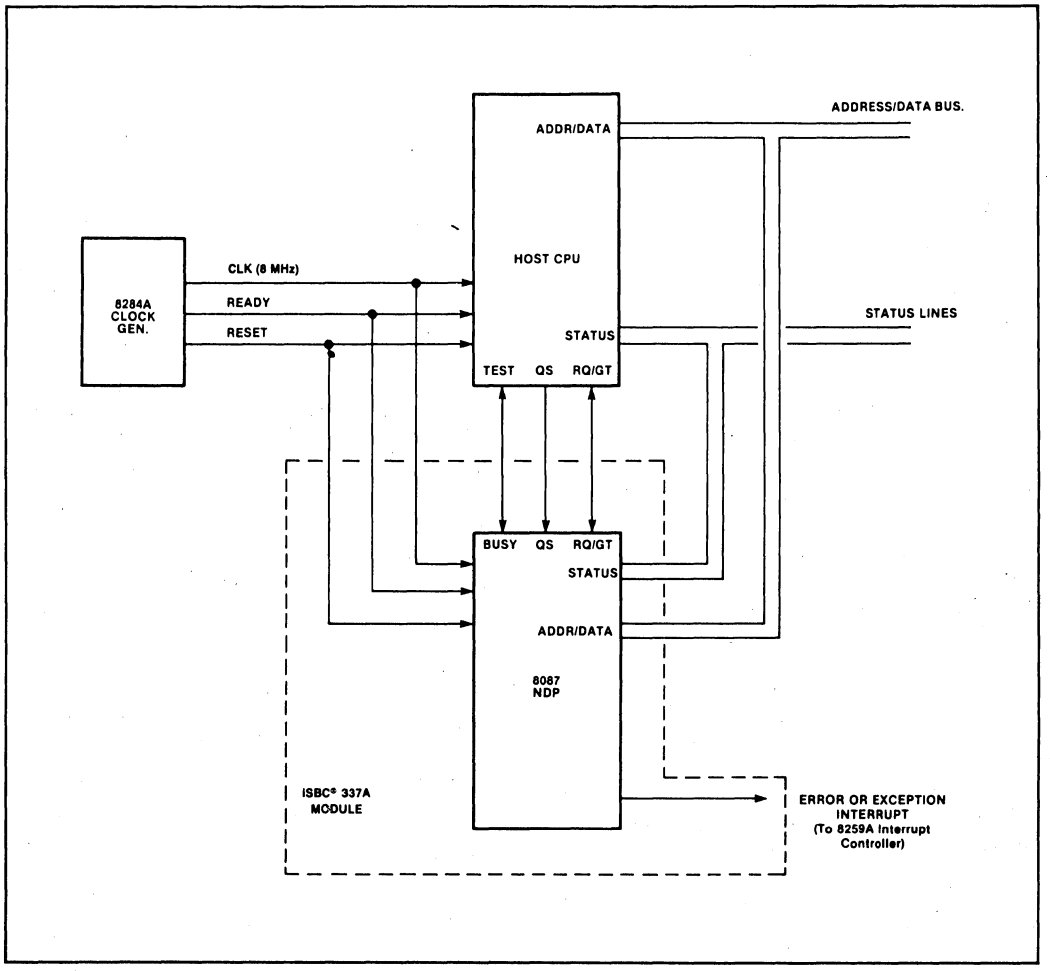


Figure 2. iSBC® 337A System Configuration

This precision is complemented by extensive exception detection and handling. Six different types of exceptions can be reported and handled by the NDP. The user also has control over internal precision, infinity control and rounding control.

SYSTEM CONFIGURATION

As a coprocessor to the Host CPU, the NDP is wired in parallel with the CPU as shown in Figure 2. The CPU's status and queue status lines enable the NDP to monitor and decode instructions in synchronization with the CPU and without any CPU overhead. Once started, the NDP can process in parallel with and independent of the host CPU. For resynchronization, the NDP's BUSY signal informs the CPU that the NDP is executing an instruction and the CPU WAIT instruction tests this signal to insure that the NDP is ready to execute subsequent instructions.

The NDP can interrupt the CPU when it detects an error or exception. The interrupt request line is routed to the CPU through an 8259A Programmable Interrupt Controller. This interrupt request signal is brought down from the iSBC 337A/337 module to the single board computer through a single pin connector (see Figure 1). The signal is then routed to the interrupt matrix for jumper connection to the 8259A Interrupt Controller. Other iAPX designs may use a similar arrangement, or by masking off the CPU "READ" pin from the iSBC 337A/337 socket, provisions are made to allow the now vacated pin of the host's CPU socket to be used to bring down the interrupt request signal for connection to the base board and then to the 8259A. Another alternative is to use a wire to establish this connection.

PROGRAMMABLE INTERFACE

Table 1 lists the seven data types the NDP supports and presents the format for each type. Internally, the NDP holds all numbers in the temporary real format. Load and store instructions automatically convert operands represented in memory as 16-, 32-, or 64-bit integers, 32- or 64-bit floating point numbers or 18-digit packed BCD numbers into temporary real format and vice versa.

Computations in the NDP use the processor's register stack. These eight 80-bit registers provide the equivalent capacity of 40 16-bit registers. The NDP register set can be accessed as a stack, with instructions operating on the top stack element, or as a fixed register set with instructions operating on explicitly designated registers.

Table 2 lists the NDP instructions by class. Assembly language programs are written in ASM 86/88, the iAPX family assembly language.

Table 3 gives the execution times of some typical numeric instructions and their equivalent time on a 8 MHz 8086-2.

FUNCTIONAL DESCRIPTION

The NDP is internally divided into two processing elements, the control unit (CU) and the numeric execution unit (NEU), providing concurrent operation of the two units. The NEU executes all numeric instructions, while the CU receives and decodes instructions, reads and writes memory operands and executes processor control instructions.

Control Unit

The CU keeps the NDP operating in synchronization with its host CPU. NDP instructions are intermixed with CPU instructions in a single instruction stream. The CPU fetches all instructions from memory; by monitoring the status signals emitted by the CPU, the NDP control unit determines when an 8086-2 instruction is being fetched. The CU taps the bus in parallel with the CPU and obtains that portion of the data stream.

After decoding the instruction, the host executes all opcodes but ESCAPE (ESC), while the NDP executes only the ESCAPE class instructions. (The first five bits of all ESCAPE instructions are identical). The CPU does provide addressing for ESC instructions, however.

Table 1. 8087 Datatypes

Data Formats	Range	Precision	Most Significant Byte (7 07 07 07 07 07 07 07 07 07 0)
Word Integer	10^4	16 Bits	I_{15} ... I_0 Two's Complement
Short Integer	10^9	32 Bits	I_{31} ... I_0 Two's Complement
Long Integer	10^{19}	64 Bits	I_{63} ... I_0 Two's Complement
Packed BCD	10^{18}	18 Digits	S — D_{17} D_{16} ... D_1 D_0
Short Real	$10^{\pm 38}$	24 Bits	S E_7 E_0 F_1 ... F_{23} F_0 Implicit
Long Real	$10^{\pm 308}$	53 Bits	S E_{10} E_0 F_1 ... F_{52} F_0 Implicit
Temporary Real	$10^{\pm 4932}$	64 Bits	S E_{14} E_0 F_0 ... F_{63}

Note:

Integer: I **Sign: S**
Fraction: F **BCD Digit (4 Bits): D**
Exponent: E

Packed BCD: $(-1)^S(D_{17} \ldots D_0)$

Real: $(-1)^S(2^{E-BIAS})(F_0F_1 \ldots)$

Bias = 127 for Short Real
1023 for Long Real
16i383 for Temp Real

Table 2. 8087 Instruction Set

Data Transfer Instructions

Real Transfers	
FLD	Load real
FST	Store real
FSTP	Store real and pop
FXCH	Exchange registers
Integer Transfers	
FILD	Integer load
FIST	Integer store
FISTP	Integer store and pop
Packed Decimal Transfers	
FBLD	Packed decimal (BCD) load
FBSTP	Packed decimal (BCD) store and pop

Comparison Instructions

FCOM	Compare real
FCOMP	Compare real and pop
FCOMPP	Compare real and pop twice
FICOM	Integer compare
FICOMP	Integer compare and pop
FTST	Test
FXAM	Examine

Transcendental Instructions

FPTAN	Partial tangent
FPATAN	Partial arctangent
F2XM1	2^X-1
FYL2X	$Y \bullet \log_2 X$
FYL2XP1	$Y \bullet \log_2 (X+1)$

Arithmetic Instructions

Addition	
FADD	Add real
FADDP	Add real and pop
FIADD	Integer add
Subtraction	
FSUB	Subtract real
FSUBP	Subtract real and pop
FISUB	Integer subtract
FSUBR	Subtract real reversed
FSUBRP	Subtract real reversed and pop
FISUBR	Integer subtract reversed
Multiplication	
FMUL	Multiply real
FMULP	Multiply real and pop
FIMUL	Integer multiply
Division	
FDIV	Divide real
FDIVP	Divide real and pop
FIDIV	Integer divide
FDIVR	Divide real reversed
FDIVRP	Divide real reversed and pop
FIDIVR	Integer divide reversed
Other Operations	
FSQRT	Square root
FSCALE	Scale
FPREM	Partial reminder
FRNDINT	Round to integer
FXTRACT	Extract exponent and significand
FABS	Absolute value
FCHS	Change sign

Processor Control Instructions

FINIT/FNINIT	Initialize processor
FDISI/FNDISI	Disable interrupts
FENI/FNENI	Enable interrupts
FLDCW	Load control word
FSTCW/FNSTCW	Store control word
FSTSW/FNSTSW	Store status word
FCLEX/FNCLEX	Clear exceptions
FSTENV/FNSTENV	Store environment
FLDENV	Load environment
FSAVE/FNSAVE	Save state
FRSTOR	Restore state
FINCSTP	Increment stack pointer
FDECSTP	Decrement stack pointer
FFREE	Free register
FNOP	No operation
FWAIT	CPU wait

Table 3. Execution Time for Selected 8087 Actual and Emulated Instructions

Floating Point Instruction	Approximate Execution Time (microseconds)		
	8087 (5 MHz Clock)	8086 Emulation	8087 (8 MHz Clock)
Add/Subtract Magnitude	14/18	1,600	9/11
Multiply (single precision)	19	1,600	12
Multiply (extended precision)	27	2,100	17
Divide	39	3,200	24
Compare	9	1,300	6
Load (double precision)	10	1,700	6
Store (double precision)	21	1,200	13
Square Root	36	19,600	23
Tangent	90	13,000	56
Exponentiation	100	17,100	63

An NDP instruction either will not reference memory, will require loading one or more operands from memory into the NDP, or will require storing one or more operands from the NDP into memory. In the first case, a non-memory reference escape is used to start NDP operation. In the last two cases, the CU makes use of a "dummy read" cycle initiated by the CPU, in which the CPU calculates the operand address and initiates a bus cycle, but does not capture the data. Instead, the CPU captures and saves the address which the CPU places on the bus. If the instruction is a load, the CU additionally captures the data word when it becomes available on the local data bus. If data required is longer than one word, the CU immediately obtains the bus from the CPU using the request/grant protocol and reads the rest of the information in consecutive bus cycles. In a store operation, the CU captures and saves the store address as in a load, and ignores the data word that follows in the "dummy read" cycle. When the NDP is ready to perform the store, the CU obtains the bus from the CPU and writes the operand starting at the specified address.

Numeric Execution Unit

The NEU executes all instructions that involve the register stack. These include arithmetic, logical, transcendental, constant and data transfer instructions. The data path in the NEU is 80 bits wide (64 fraction bits, 15 exponent bits and a sign bit) which allows internal operand transfers to be performed at very high speeds.

When the NEU begins executing an instruction, it activates the NDP BUSY signal. This signal is used in conjunction with the CPU WAIT instruction to resynchronize both processors when the NEU has completed its current instruction.

Register Set

The NDP register set is shown in Figure 3. Each of the eight data registers in the NDP's register stack is 80 bits wide and is divided into "fields" corresponding to the NDP's temporary real data type. The register set may be addressed as a push down stack, through a top of stack pointer or any register may be addressed explicitly relative to the top of stack.

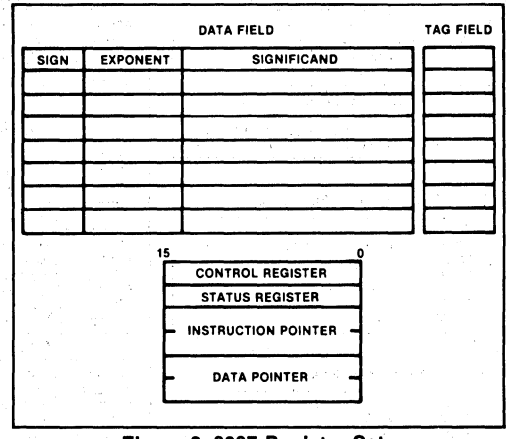


Figure 3. 8087 Register Set

Status Word

The status word shown in Figure 4 reflects the overall state of the NDP; it may be stored in memory and then inspected by CPU code. The status word is a 16-bit register divided into fields as shown in Figure 4. The busy bit (bit 15) indicates whether the NEU is executing an instruction (B = 1) or is idle (B = 0). Several

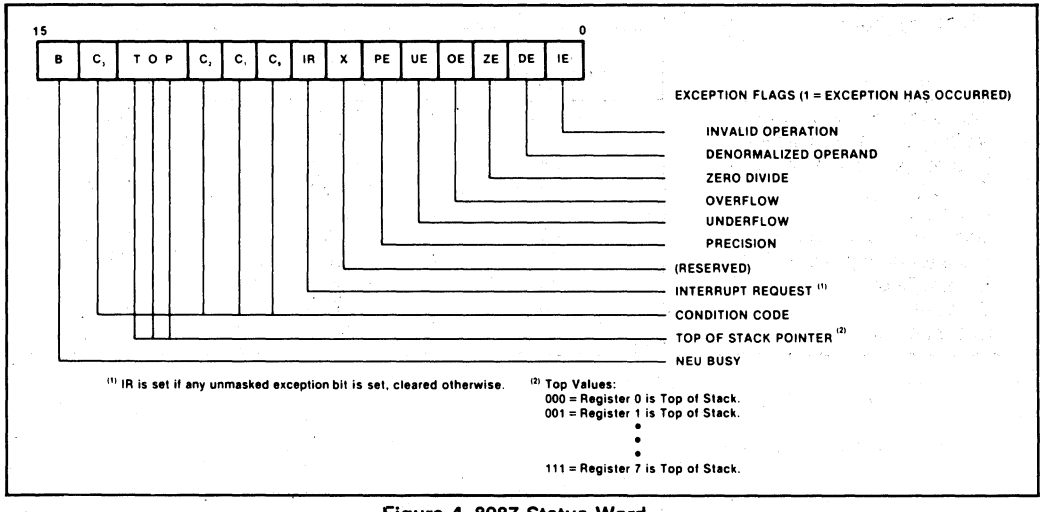


Figure 4. 8087 Status Word

instructions which store and manipulate the status word are executed exclusively by the CU, and these do not set the busy bit themselves.

The four numeric condition code bits (C_0-C_3) are similar to the flags in a CPU: various instructions update these bits to reflect the outcome of NDP operations.

Bits 13-11 of the status word point to the NDP register that is the current top-of-stack (TOP).

Bit 7 is the interrupt request bit. This bit is set if any unmasked exception bit is set and cleared otherwise.

Bits 5-0 are set to indicate that the NEU has detected an exception while executing an instruction.

Tag Word

The tag word marks the content of each register as shown in Figure 5. The principal function of the tag word is to optimize the NDP's performance. The tag word can be used, however, to interpret the contents of NDP registers.

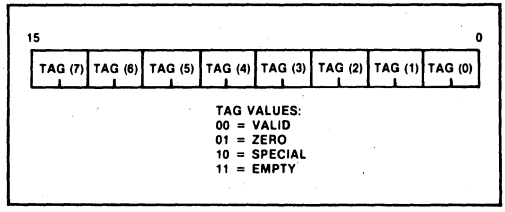


Figure 5. 8087 Tag Word

Instruction and Data Pointers

The instruction and data pointers (see Figure 6) are provided for user-written error handlers. Whenever the NDP executes an NEU instruction, the CU saves the instruction address, the operand address (if present) and the instruction opcode. The NDP can then store this data in memory.

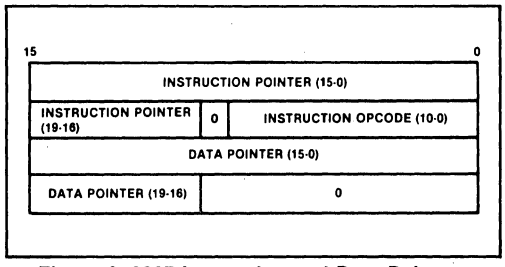


Figure 6. 8087 Instruction and Data Pointers

Control Word

The NDP provides several processing options which are selected by loading a word from memory into the control word. Figure 7 shows the format and encoding of the fields in the control word.

Exception Handling

The NDP detects six different exception conditions that can occur during instruction execution. Any or all exceptions will cause an interrupt if unmasked and interrupts are enabled.

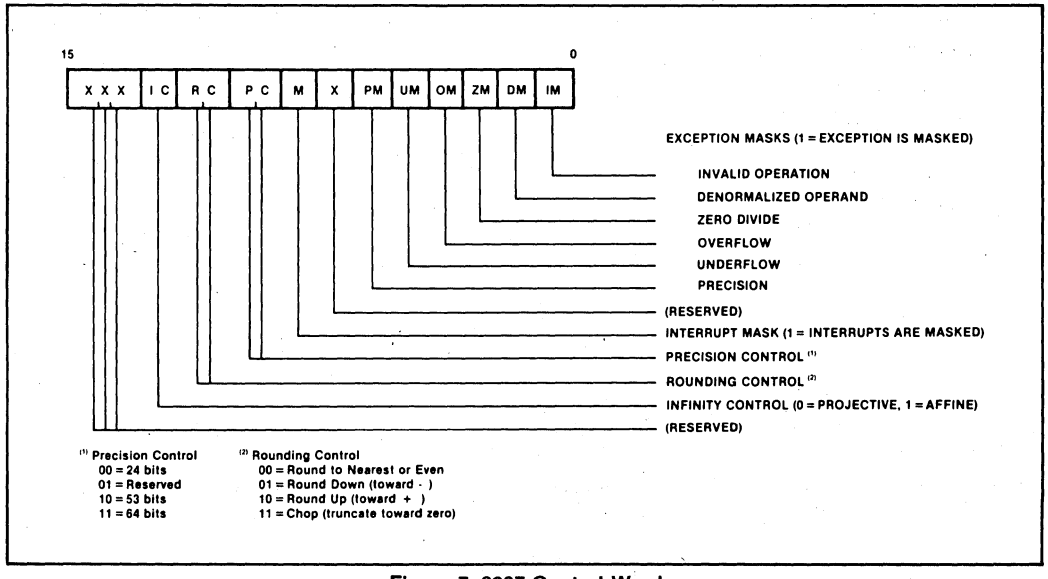


Figure 7. 8087 Control Word

If interrupts are disabled, the NDP will simply suspend execution until the host clears the exception. If a specific exception class is masked and that exception occurs however, the NDP will post the exception in the status register and perform an on-chip default exception handling procedure, thereby allowing processing to continue. The exceptions that the NDP detects are the following:

1. **INVALID OPERATION:** Stack overflow, stack underflow, indeterminate form (0/0, -, etc.) or the use of a Non-Number (NAN) as an operand. An exponent value is reserved and any bit pattern with this value in the exponent field is termed a Non-Number and causes this exception. If this exception is masked, the NDP default response is to generate a specific NAN called INDEFINITE, or to propagate already existing NANs as the calculation result.

2. **OVERFLOW:** The result is too large in magnitude to fit the specified format. The NDP will generate the code for infinity if this exception is masked.

3. **ZERO DIVISOR:** The divisor is zero while the dividend is a non-infinite, non-zero number. Again, the NDP will generate the code for infinity if this exception is masked.

4. **UNDERFLOW:** The result is non-zero but too small in magnitude to fit in the specified format. If this exception is masked the NDP will denormalize (shift right) the fraction until the exponent is in range. This process is called gradual underflow.

5. **DENORMALIZED OPERAND:** At least one of the operands or the result is denormalized; it has the smallest exponent but a non-zero significand. Normal processing continues if this exception is masked off.

6. **INEXACT RESULT:** If the true result is not exactly representable in the specified format, the result is rounded according to the rounding mode, and this flag is set. If this exception is masked, processing will simply continue.

SOFTWARE SUPPORT

The iSBC 337A/337 module is supported by the following Intel software products: iRMX™ 86 Operating System, iRMX 88 Real-time Multi-tasking Executive, ASM 86/88 Assembly language, PL/M 86/88 Systems Implementation Languages, Pascal 86/88, Fortran 86/88 along with iRMX Development Utilities Package. In addition to the instructions provided in the languages to support the additional math functions, a software emulator is also available to allow the execution of iAPX instructions without the need for the iSBC 337A/337 module. This allows for the development of software in an environment without the iAPX processor and then transporting to its final run time environment with no changes in software code or mathematical results.

SPECIFICATIONS

Physical Characteristics

Width — 5.33 cm (2.100")

Length — 5.08 cm (2.000")

Height — 1.82 cm (.718")
iSBC 337A board + host board

Weight — 17.33 grams (.576 oz.)

Electrical Characteristics

DC Power Requirements

$V_{CC} = 5V \pm 5\%$
$I_{CC} = 475$ mA max.
$I_{CC} = 350$ mA typ.

Environmental Characteristics

Operating Temperature — 0°C to 55°C with 200 linear feet/minute airflow

Relative Humidity — Up to 90% R.H. without condensation.

Reference Manual

147163-001 — iSBC 337A/337 MULTIMODULE Numeric Data Processor Hardware Reference Manual (NOT SUPPLIED WITH MULTIMODULE BOARD).

Manuals may be ordered from any Intel sales representative, distributor office, or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California, 95051.

ORDERING INFORMATION

Part Number	Description
SBC 337A	MULTIMODULE Numeric Data Processor
SBC 337	MULTIMODULE Numeric Data Processor

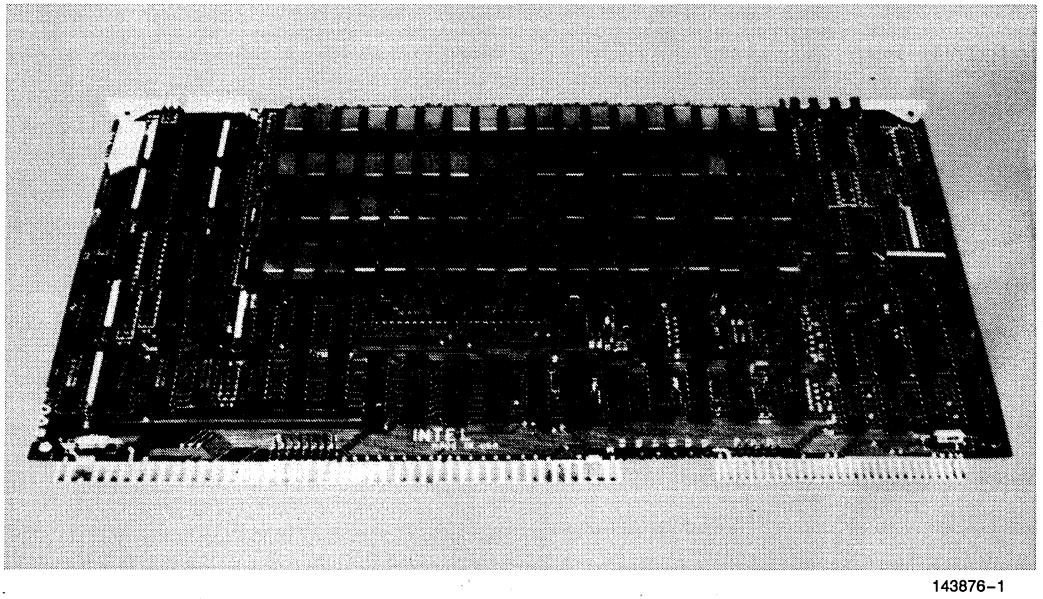
Memory Expansion Boards 6

iSBC® 012B
RAM MEMORY BOARDS

- **iSBC® 86, iSBC 88 and iSBC 80 Board RAM Expansion Through Direct MULTIBUS® Interface**
- **512K of Read/Write Memory**
- **On-Board Parity Generator/Checker and Error Status Register**
- **Requires a Single +5V Power Supply**
- **Assignable Anywhere Within a 16 Megabyte Address Space**
- **Jumper Selectable Base Address on any 16K Byte Boundary**
- **Auxiliary Power Bus and Memory Protect Control Logic for Battery Backup RAM Requirements**

The iSBC 012 RAM memory board is a member of Intel's complete line of iSBC memory and I/O expansion boards. The board interfaces directly to any iSBC 86, iSBC 88 or iSBC 80 Single Board Computer via the MULTIBUS interface to expand system RAM capacity. The iSBC 012B board contains 512K bytes of read/write memory implemented using dynamic RAM components. An on-board dynamic RAM controller refreshes a portion of these components every 16 microseconds. Each refresh cycle utilizes memory for 550 nanoseconds (maximum).

The iSBC 012B board generates byte oriented parity during all write operations and performs parity checking during all read operations. When a parity error is detected, the board can generate an interrupt on the MULTIBUS interface. In addition, the row and bank of the RAM array containing the error are stored in a Parity Flag Register. This register is accessible as a MULTIBUS I/O port. An on-board LED also provides a visual indication that a parity error has occurred.



143876-1

October 1986
Order Number: 143876-001

SPECIFICATIONS

Word Size

8 bits and 16 bits

Memory Size

524,288 bytes (iSBC 012B)

Access Time

330 ns (worst case)
300 ns (typical)

Cycle Times (Worst Case)

Read: 500 ns max.
Write: 500 ns max.
Refresh: 550 ns max.

Interface

All address, data and command signals are TTL compatible.

Address Selection

Memory: Base address is jumper selectable on any 16K byte boundary in a 16 megabyte address space. On-board RAM cannot cross a 4 megabyte address boundary.

Parity Flag Register: The I/O address of the Parity Flag Register is jumper selectable to be between 00H to 0FH or 40H to 4FH.

Connector

Edge Connector: 86-pin double-sided PC edge connector with 0.156 in. contact centers.

Mating Connector: Viking 3KH43/9AMK12 or equivalent.

Auxiliary Power

An auxiliary power bus is provided to allow separate power to RAM array for systems requiring battery backup of read/write memory. Selection of this auxiliary RAM power bus is made via jumpers on the board.

Memory Protect

An active-low TTL compatible memory protect signal is brought out on the auxiliary connector which, when asserted, disables read/write access to RAM on the board. This input is provided for the protection of RAM contents during system power-down sequences.

Physical Characteristics

Width: 12.00 in. (30.48 cm)
Height: 6.75 in. (17.15 cm)
Depth: 0.50 in. (1.27 cm)
Weight: 14 oz. (397 gm)

Electrical Characteristics

D.C. POWER REQUIREMENTS

All configurations require only +5V ±5%.

Normal System Operation (max.)

4.8A (worst case)
3.46A (typical)

Auxiliary Power No RAM Access (max.)

1.35A (worst case)
0.88A (typical)

Environmental Characteristics

Operating Temperature: 0°C to +55°C
Relative Humidity: to 90% (without condensation)

Reference Manual

143865-001— iSBC 056B/012B Hardware Reference Manual (not supplied)

Manuals may be ordered from any Intel sales representative, distributor office, or from Intel Literature Dept., 3065 Bowers Avenue, Santa Clara, California 95051.

ORDERING INFORMATION

Part Number	Description
SBC 012B	512K-Byte RAM Board with Parity

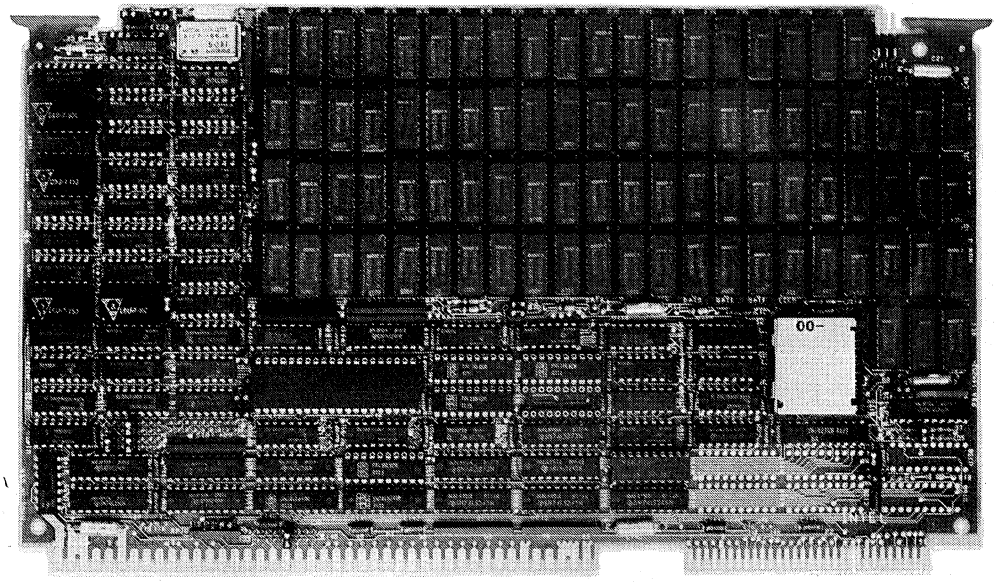
iSBC® 012C
ECC RAM BOARD

- **iSBC 86, iSBC 88 RAM Expansion Through Direct, IEEE 796, MULTIBUS® Interface**
- **512K Bytes of Read/Write Memory**
- **Single Bit Error Correction and Double Bit Error Detection Via Intel 8206 ECC Device**
- **Control Status Register Supports Multiple ECC Operating Modes**
- **Error Status Register Provides Error Logging by Host CPU Board**
- **Base Address Selectable on 16K Byte Boundaries**
- **Supports 8 or 16-Bit Transfer and 24-Bit Addressing**
- **Auxiliary Power Bus and Memory Protect Logic for Battery Back-Up RAM Requirements**

The iSBC 012C RAM board is a member of Intel's complete line of iSBC memory and I/O Expansion boards. The board interfaces directly to any iSBC 88 or iSBC 86 Single Board Computer via the IEEE P796 MULTIBUS interface to expand system RAM capacity. The iSBC 012C board contains 512K bytes of read/write memory implemented using dynamic RAM components.

Single bit error correction and double bit error detection are provided on the iSBC 012C board via the Intel 8026 Error Checking and Correction (ECC) device. Due to the on-board ECC features of the board it is ideally suited in applications where integrity of the stored data is critical, such as financial transactions, process control and medical equipment applications.

Refresh control of the RAM array is handled on-board by the RAM Array Control Logic. Therefore, no external refresh commands are necessary.



280222-1

November 1986
Order Number: 280222-001

FUNCTIONAL DESCRIPTION

General

The iSBC 012C RAM board is physically and electrically compatible with the MULTIBUS interface standard, IEEE P796, as outlined in the Intel MULTIBUS specification.

System Memory Size

Maximum system memory size with this board is 16 megabytes. On-board jumpers assign the board to one of four 4 megabyte pages. Each page is partitioned into 256 blocks of 16K bytes each. The smallest partition on the board is 16K bytes. Jumpers assign the base address (lowest 16K block) within the selected 4 megabyte page.

Error Checking and Correcting (ECC)

Error Checking and Correction is accomplished with the Intel 8206 Error Checking and Correction device. This ECC component in conjunction with the ECC check bit RAM array provides error detection and correction of single bit errors and detection only of double bit and most multiple bit errors. The ECC circuitry can be programmed to various modes to provide full diagnostic testing of both the storage and check bit RAM arrays.

ECC I/O Address Selection

The processor board communicates with the ECC circuitry via a single I/O port. This port is used for the Control Status Register (CSR) and the Error Status Register (ESR). The Control Status Register is programmed by the user to determine the mode of operation while the Error Status Register provides information about memory errors. The iSBC 012C RAM board is shipped with a Programmable Array Logic (PAL) device which allows selecting one of 9 possible addresses for the I/O port. The actual selection is done by jumper configuration. Additional unprogrammed locations are left in the PAL to allow application specific I/O addresses to be defined.

Battery Back-up/Memory Protect

An auxiliary power bus is provided to allow separate power to the RAM array for systems requiring back-up of read/write memory. An active low TTL compatible memory protect signal is brought out on the auxiliary bus connector which, when asserted, disables read/write access to the RAM board. This input is provided for the protection of RAM contents during system power-down sequences.

ERROR CHECKING AND CORRECTION

The iSBC 012C RAM board uses two special registers to pass ECC mode control and status information to and from the system master iSBC board. These registers are called the Control Status Register (CSR) and the Error Status Register (ESR).

CONTROL STATUS REGISTER

There are six ECC modes of operation on the iSBC 012C RAM board. Each mode is obtained by software programming of the CSR from the master iSBC board. The size modes are:

a. Interrupt on any error mode
b. Interrupt on non-correctable error only mode
c. Correcting mode
d. Non-correcting mode
e. Diagnostic mode
f. Examine syndrome word mode

Modes (a) and (b) can be used in conjunction with (c) and (d). The six modes are described below.

Interrupt on Any Error Mode—In this mode the RAM board will interrupt the iSBC processor only when any error (single or multiple bit) is detected by the ECC circuitry.

Interrupt on Non-Correctable Error Mode—In this mode the RAM board will interrupt the iSBC processor only when a non-correctable (multiple bit) error is detected by the ECC circuitry. A multiple bit error is not correctable by the ECC circuitry.

Correcting Mode—In this mode the RAM board corrects any correctable error (single-bit error). Errors which are not correctable are not modified. Interrupts are generated depending on the interrupt mode selected.

Non-Correcting Mode—In this mode the RAM board does not correct any error. The ECC circuitry continues to check for errors, but no corrective action is taken. Interrupts continue as described previously.

Diagnostic Mode—This mode is used for testing the on-board ECC circuitry. In this mode the write enable strobe to the ECC RAM array is continuously disable. The diagnostic mode can be used to simulate errors and in conjunction with the "Examine Syndrome Word Mode" examine the check bits generated by the ECC circuitry.

Examine Syndrome Word Mode—This mode, in conjunction with the "Diagnostic Mode", is used for testing the ECC memory. In this mode, the syndrome bits/check bits are clocked into the Error Status Register (ESR) on every memory read/write cycle, respectively. The ESR translation PROM switches to a transparent mode in the Examine Syndrome Word Mode. This allows the actual syndrome word generated by the 8206 ECC device to be examined.

ERROR STATUS REGISTER

This 8-bit register contains information about memory errors. The ESR reflects the latest error occurance. Table 1 shows the status register format. Bits 5 & 6 show the failing row while bits 0 through 4 indicate which bit (of the 16-bit data word or the 6-bit ECC syndrome word) is in error. Bit 7 is always high.

Table 1

Bit 6	Bit 5	Meaning	
0	0	Error in row	0
0	1		1
1	0		2
1	1		3

Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Meaning	
0	0	0	0	0	Error in data bit	0
0	0	0	0	1		1
0	0	0	1	0		2
0	0	0	1	1		3
0	0	1	0	0		4
0	0	1	0	1		5
0	0	1	1	0		6
0	0	1	1	1		7
0	1	0	0	0		8
0	1	0	0	1		9
0	1	0	1	0		10
0	1	0	1	1		11
0	1	1	0	0		12
0	1	1	0	1		13
0	1	1	1	0		14
0	1	1	1	1		15
1	0	0	0	0	Error in check bit	0
1	0	0	0	0		1
1	0	0	1	0		2
1	0	0	1	1		3
1	0	1	0	0		4
0	0	1	0	1		5
1	1	1	1	0	No Error	
1	1	1	1	1	Non-correctable (multiple-bit error)	

NOTE:
Bit 7 is always high

SPECIFICATIONS

Word Size Supported

8 or 16-bits

Memory Size

524,288 Bytes (iSBC 012C)

Access Times (All Densities)

Read/Full Write: 350 ns (max)
Write Byte: 530 ns (max)

Cycle Times (All Densities)

Read/Full Write: 460 ns (max)
Write Byte: 885 ns (max)

NOTE:
If an error is detected, read access time and cycle times are extended by 255 ns.

Refresh Times

Refresh Cycle Time: 15.6 μs
Refresh Delay Time: 760 ns

Memory Partitioning

Maximum System RAM size is 16M Bytes

PAGE ADDRESS (4M BYTES)

1 of 4 megabyte pages as follows: 0–4 megabytes; 4–8 megabytes; 8–12 megabytes; 12–16 megabytes

BLOCK ADDRESS (16K BYTES)

iSBC 012C RAM board—32 continguous 16K Byte Blocks (512K Bytes)

NOTE:
Blocks cannot cross 4K Byte Boundary.

BASE ADDRESS

Any 16K Byte Boundary

Power Requirements

Voltage: $5V_{DC} \pm 5\%$
Current: iSBC 012C 6.8A max
Standby: iSBC 012C 2.5A max

Environmental Requirements

Operating Temperature: 0°C to 55°C
Operating Humidity: To 90% without condensation

Physical Dimensions

Width: 12 inches (30.48 cm)
Height: 6.75 inches (17.15 cm)
Thickness: 0.50 inches (1.27 cm)
Weight: 23.5 ounces (6589 gm)

Reference Manuals

145183-001—iSBC 028C/iSBC 056C/iSBC 012C Hardware Reference Manual

Manuals may be ordered from any Intel Sales Representative, Distributor Office, or from the Intel Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051.

ORDERING INFORMATION

Part Number	Description
SBC 012C	512K Byte RAM board with ECC

iSBC® 012CX, 010CX, AND 020CX iLBX™ RAM BOARDS

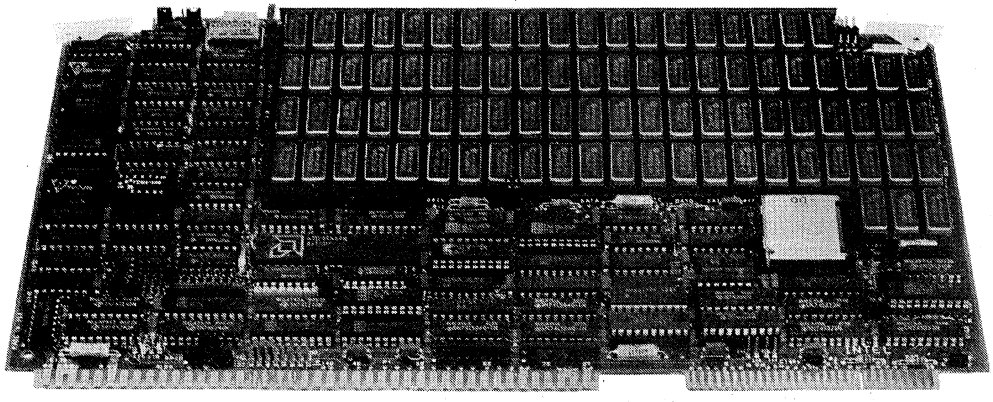
- **Dual Port Capability via MULTIBUS® and iLBX Interfaces**
- **Single Bit Error Correction and Double Bit Error Detection Utilizing Intel 8206 ECC Device**
- **512K Byte, 1024K Byte, and 2048K Byte Versions Available**
- **Control Status Register Supports Multiple ECC Operating Modes**
- **Error Status Register Provides Error Logging by Host CPU Board**
- **16 Megabyte Addressing Capability**
- **Supports 8- or 16-bit Data Transfer and 24-bit Addressing**
- **Auxiliary Power Bus and Memory Protect Logic for Battery Back-Up RAM Requirements**

The iSBC 012CX, iSBC 010CX and iSBC 020CX RAM memory boards are members of Intel's complete line of iSBC memory and I/O expansion boards. Each board interfaces directly to any iSBC 80, iSBC 86, iSBC 186, and iSBC 286 Single Board Computers. The dual port feature of the CX series of RAM-boards allow access to the memory of both the MULTIBUS and iLBX bus interfaces.

In addition to the dual port features the "CX" series of RAM-boards provide Error Checking and Corrections Circuitry (ECC) which can detect and correct single bit errors and detect, but not correct, double and most multiple bit errors.

The iSBC 012CX board contains 512K bytes of read/write memory using 64K dynamic RAM components. The iSBC 010 CX and iSBC 020 CX boards contain 1024K and 2048K bytes of read/write memory using 256K dynamic RAM components.

Due to the iLBX dual port capability and on-board ECC features of the boards they are ideally suited in applications where memory performance and integrity is critical, such as financial transactions, process control and medical equipment applications.



231023-1

October 1986
Order Number: 231023-002

FUNCTIONAL DESCRIPTION

General

The iSBC 012CX, 010CX, and 020CX RAM boards are physically and electrically compatible with the MULTIBUS interface standard, IEEE-796, as outlined in the Intel MULTIBUS specification. In addition the CX series of RAM-boards are physically and electrically compatible with the iLBX bus (Local Bus Extension) interface as outlined in the Intel iLBX Specification (see Figure 1).

Dual Port Capabilities

The "CX" series of RAM-boards can be accessed by either the MULTIBUS interface or the iLBX interface (see Figure 2). Intel's iLBX interface is an unarbitrated bus architecture which allows direct transfer of data between the CPU and the memory boards

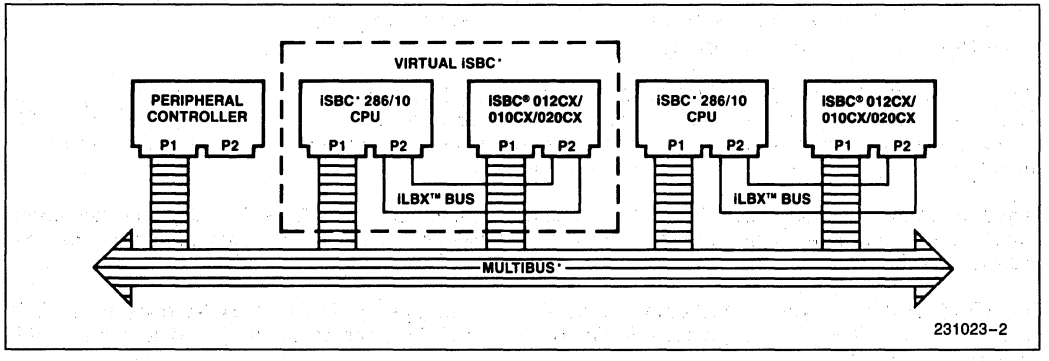


Figure 1. Typical iLBX™ System Configuration

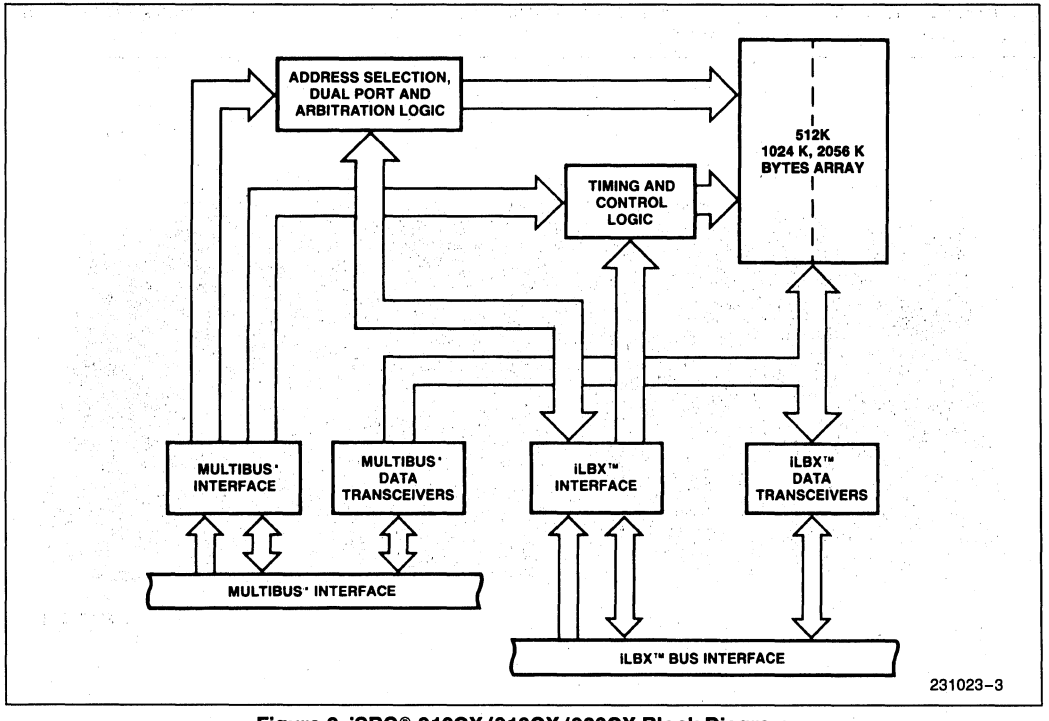


Figure 2. iSBC® 012CX/010CX/020CX Block Diagram

without accessing the MULTIBUS bus. Due to the unarbitrated nature of the iLBX interface significant improvements in memory access times result, typically a 2-6 Wait State improvement over MULTIBUS memory access.

System Memory Size

Maximum system memory size with this series of boards is 16 megabytes. Memory partitioning is independent for the MULTIBUS interface and the iLBX interface.

For MULTIBUS operations, on-board jumpers assign the board to one of four 4-megabyte pages. Each page is partitioned into 256 blocks of 16K bytes each. The smallest partition on any board in this series is 8K bytes. Jumpers assign the base address (lowest 16K block) within the selected 4-megabyte page.

The iLBX bus memory partitioning differs from the MULTIBUS bus partitioning in that the iLBX bus address space consists of 256 contiguous blocks of 64K bytes totaling 16 megabytes. As with the MULTIBUS bus partitioning, the base addresses are set with on-board jumpers.

Error Checking and Correcting (ECC)

Error checking and correction is accomplished with the Intel 8206 Error Checking and Correcting device. This ECC component, in conjunction with the ECC check bit RAM array, provides error detection and correction of single bit errors and detection only of double bit and most multiple bit errors. The ECC circuitry can be programmed via the Control Status Register (CSR) to various modes while error logging is supported by the Error Status Register (ESR). Both CSR and ESR communicate with the master CPU board through a single I/O port.

ECC I/O Address Selection

The processor board communicates with the ECC circuitry via a single I/O port. This port is used for the Control Status Register (CSR) and the Error Status Register (ESR). The CSR is programmed by the user to determine the mode of operation while the ESR provides information about memory errors.

The iSBC 012CX, iSBC 010CX, and iSBC 020CX RAM boards are shipped with a Programmed Array Logic (PAL) device which allows selecting one of 9 possible addresses for the I/O port. The actual selection is done by jumper configuration. Additional unprogrammed locations are left in the PAL to allow application specific I/O addresses to be defined.

CONTROL STATUS REGISTER

There are six ECC modes of operation in the "CX" family of RAM boards. Each mode is obtained by software programming of the CSR from the master iSBC board. The six modes are:

a. Interrupt on any error mode
b. Interrupt on non-correctable error only mode
c. Correcting mode
d. Non-correcting mode
e. Diagnostic mode
f. Examine syndrome word mode

Modes (a) and (b) can be used in conjunction with (c) and (d). The six modes are described below.

Interrupt on Any Error Mode—In this mode the RAM board will interrupt the iSBC processor board when any error (single bit or multiple bit) is detected by the ECC circuitry.

Interrupt on Non-Correctable Error Mode—In this mode the RAM board will interrupt the iSBC processor board only when a non-correctable (multiple bit) error is detected by the ECC circuitry. A multiple bit error is not correctable by the ECC circuitry.

Correcting Mode—In this mode the RAM board corrects any correctable error (single bit error). Errors which are not correctable are not modified. Interrupts are generated depending on the interrupt mode selected.

Non-Correcting Mode—In this mode the RAM board does not correct any error. The ECC circuitry continues to check for errors, but no corrective action is taken. Interrupts continue as described previously.

Diagnostic Mode—This mode is used for testing the on-board ECC circuitry. In this mode the write enable strobe to the ECC RAM array is continuously disabled. The diagnostic mode can be used to simulate errors and in conjunction with the "Examine Syndrome Word Mode" examine the check bits generated by the ECC circuitry.

Examine Syndrome Word Mode—This mode, in conjunction with the diagnostic mode, is used for testing the ECC memory. In this mode, the syndrome bits/check bits are clocked into the ESR on every memory read/write cycle, respectively. The ESR translation PROM switches to a transparent mode in the examine syndrome word mode. This allows the actual syndrome word generated by the 8206 ECC device to be examined.

Table 1. Error Status Register Format

Bit 6	Bit 5	Meaning
0	0	Error in row 0
0	1	Error in row 1
1	0	Error in row 2
1	1	Error in row 3

Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Meaning	
0	0	0	0	0	Error in data bit	0
0	0	0	0	1		1
0	0	0	1	0		2
0	0	0	1	1		3
0	0	1	0	0		4
0	0	1	0	1		5
0	0	1	1	0		6
0	0	1	1	1		7
0	1	0	0	0		8
0	1	0	0	1		9
0	1	0	1	0	Error in data bit	10
0	1	0	1	1		11
0	1	1	0	0		12
0	1	1	0	1		13
0	1	1	1	0		14
0	1	1	1	1		15
1	0	0	0	0	Error in check bit	0
1	0	0	0	1		1
1	0	0	1	0		2
1	0	0	1	1		3
1	0	1	0	0		4
1	0	1	0	1		5
1	1	1	1	0	No Error	
1	1	1	1	1	Non-correctable (multiple-bit error)	

ERROR STATUS REGISTER

The 8-bit register contains information about memory errors. The ESR reflects the latest error occurrence. Table 1 shows the status register format. Bits 5 and 6 show the failing row while bits 0 through 4 indicate which bit (of the 16-bit data word or the 6-bit ECC syndrome) is in error. Bit 7 is always high.

Battery Back-Up/Memory Protect

An auxiliary power bus is provided to allow separate power to the RAM array for systems requiring back-up of read/write memory. An active low TTL compatible memory protect signal is brought out on the auxiliary bus connector which, when asserted, disables read/write access to the RAM board. This input is provided for the protection of RAM contents during system power-down sequences.

SPECIFICATIONS

Word Size Supported

8- or 16-bits

Memory Size

524,288 bytes (iSBC 012CX board)
1,048,576 bytes (iSBC 010CX board)
2,097,152 bytes (iSBC 020CX board)

Access Times (All densities)

MULTIBUS® System Bus

Read/Full Write— 380 ns (max)
Write Byte — 530 ns (max)

iLBX™ Local Bus

Read/Full Write— 340 ns (max)
Write Byte — 440 ns (max)

Cycle Times (All densities)

MULTIBUS® System Bus

Read/Full Write— 490 ns (max)
Write Byte — 885 ns (max)

iLBX™ Local Bus

Read/Full Write— 375 ns
Write Byte — 740 ns

NOTE:
If an error is detected, read access time and cycle times are extended to 255 ns (max)

Memory Partitioning

Maximum System memory size is 16M Bytes for both MULTIBUS and iLBX BUS. MULTIBUS partitioning is by Page, Block and Base, while the iLBX BUS is by Block and Base only.

Page Address

MULTIBUS®— 0–4 megabytes; 4–8 megabytes, 8–12 megabytes; 12–16 megabytes

iLBX™ BUS — N/A

Base Address

MULTIBUS® System Bus— Any 16K byte boundary within the 4M-byte page.

iLBX™ Local Bus — Any 64K byte boundary selectable on board boundaries to 8M-bytes and some 64K-byte boundaries in the first megabyte. Others available if PAL programming is changed.

Power Requirements

Voltage—5 VDC ±5%

Product	Current	Standby (Battery Back-Up)
iSBC® 012CX Board	4.4A (typ.) 6.8A (max.)	2.2A (typ.) 2.4A (max.)
iSBC® 010CX Board	4.8A (typ.) 7.0A (max.)	2.1A (typ.) 2.3A (max.)
iSBC® 020CX Board	5.3A (typ.) 7.5A (max.)	2.2A (typ.) 2.4A (max.)

Environmental Requirements

Operating Temperature: 0°C to 55°C airflow of 200 linear feet per minute

Operating Humidity: To 90% without condensation

Physical Dimensions

Width: 30.48 cm (12 inches)

Height: 17.15 cm (6.75 inches)

Thickness: 1.27 cm (0.50 inches)

Weight: iSBC 012CX board: 6589 gm (23.5 ounces); iSBC 010CX board: 5329 gm (19.0 ounces); iSBC 020CX board: 6589 gm (23.5 ounces)

Reference Manuals

145158-003—iSBC® 028CX/iSBC® 056CX/iSBC® 012CX Hardware Reference Manual

144456-001—Intel iLBX™ 010CX, 020CX Specification

9800683-03—Intel MULTIBUS® Specification

Manuals may be ordered from any Intel Sales Representative, Distributor Office or from the Intel Literature Department, 3065 Bowers Avenue, Santa Clara, CA. 95051

ORDERING INFORMATION

Part Number	Description
iSBC 012CX	512K byte RAM board with ECC and iLBX Connectors
iSBC 010CX	1M byte RAM board with ECC and iLBX Connectors
iSBC 020CX	2M byte RAM board with ECC and iLBX Connectors

iSBC® 012EX, 010EX, 020EX, and 040EX HIGH PERFORMANCE RAM BOARDS

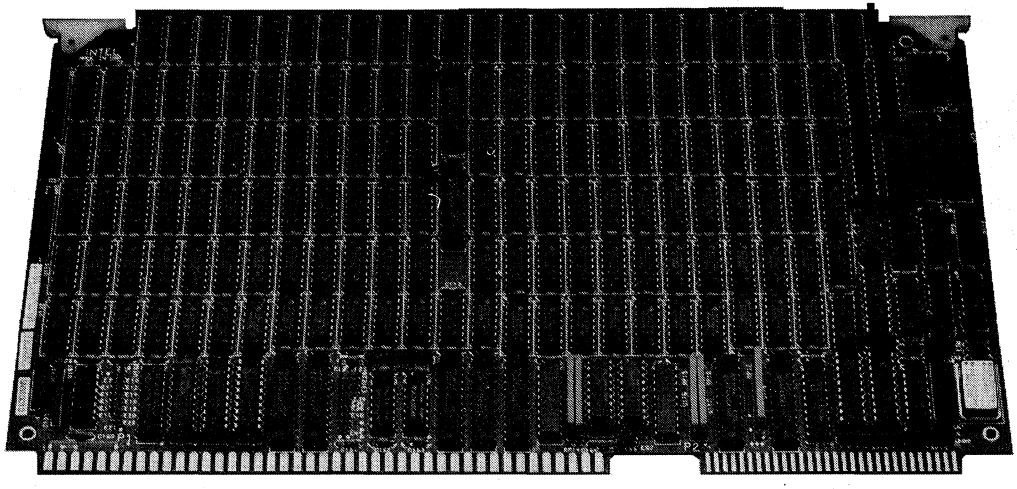
- **0 Wait States at 8 MHz Performance with the iSBC® 286/10A, iSBC 286/12 Board**
- **Dual Port Capability Via MULTIBUS® and High Speed Synchronous Interface**
- **Configurable to Function Over iLBX™ Bus**
- **On-Board Parity Generator/Checker**
- **Independently Selectable Starting and Ending Addresses**
- **16 Megabyte Addressing Capability**
- **512K Byte, 1024K Byte, 2048K Byte, and 4096K Byte Densities Available**

The iSBC 012EX, iSBC 010EX, iSBC 020EX, and iSBC 040EX RAM memory boards are members of Intel's complete line of iSBC memory and I/O expansion boards. The EX boards are dual ported between the MULTIBUS interface and one of two types of dedicated memory buses. The dedicated buses are the iLBX bus and a high speed interface. The EX series of RAM-boards can be configured to be accessed over the iLBX bus, as well as MULTIBUS bus, to provide memory support for the iSBC 286/10 board, performing at 6 MHz and the iSBC 186/03A board, performing at 8 MHz. The EX boards are default configured to run over the MULTIBUS interface and the high speed interface. This provides 0 wait state 8 MHz memory support for the iSBC 286/10A and iSBC 286/12 boards.

The EX RAM-boards generate byte oriented parity during all write operations and perform parity checking during all read operations. An on-board LED provides a visual indication that a parity error has occurred.

The iSBC 012EX, iSBC 010EX, iSBC 020EX, and iSBC 040EX boards contain 512K bytes, 1M byte, 2M bytes, and 4M bytes of read/write memory using 256K dynamic RAM components.

Due to the high speed synchronous interface capability of the boards, they are ideally suited in applications where memory performance is critical.



280142-1

October 1986
Order Number: 280142-001

FUNCTIONAL DESCRIPTION

General

The iSBC 012EX, 010EX, 020EX, and 040EX RAM boards are physically and electrically compatible with the MULTIBUS interface standard, IEEE-796, as outlined in the Intel MULTIBUS architecture specification.

Dual Port Capabilities

The "EX" series of RAM-Boards can be accessed by the MULTIBUS interface, and either the iLBX Bus, or the high speed synchronous interface (see Figures 1 and 2). The EX series require jumper and PAL configuration to be accessed over iLBX Bus.

Intel's iLBX interface is an unarbitrated bus architecture which allows direct transfer of data between the CPU and the memory boards without accessing the MULTIBUS bus. Due to the unarbitrated nature of the iLBX interface, significant improvements in memory access times compared to the MULTIBUS bus accesses result. The EX Boards provide 1 wait state performance at 6 MHz and 2 wait states at 8 MHz over the iLBX board. The EX Memory Board Hardware Reference Manual should be consulted for details.

The high speed synchronous interface, like the iLBX Bus, is a bus architecture which allows direct transfer of data between the CPU and the memory boards without accessing the MULTIBUS bus. This high speed interface runs synchronously with the iSBC 286/10A and iSBC 286/12 to provide 0 wait state performance at 8 MHz.

System Memory Size

Maximum system memory size with this series of boards is 16 megabytes. Memory partitioning is independent for the MULTIBUS interface and the iLBX interface.

Address Selection/Memory

SELECTABLE STARTING ADDRESS

A 256K boundary select is implemented on the iSBC 012EX board. A 512K boundary select is implemented on the iSBC 010EX board. A 1M boundary is implemented on the iSBC 020EX and iSBC 040EX boards.

SELECTABLE ENDING ADDRESS

The ending address is selectable as memory size minus select options of 0, 128K, 256K, or 512K on all of the EX boards.

PARITY INTERRUPT CLEAR

The I/O address of the Parity Interrupt Clear circuitry is jumperable to any one of 256 addresses.

SPECIFICATIONS

Word Size Supported

8- or 16-bits.

Memory Size

524,288 bytes (iSBC 012EX board)
1,048,576 bytes (iSBC 010EX board)
2,097,152 bytes (iSBC 020EX board)
4,194,304 bytes (iSBC 040EX board)

Access Times (All densities)

MULTIBUS® SYSTEM BUS

Read/Full Write— 375 ns (max)
Write Byte— 375 ns (max)

HIGH SPEED SYNCHRONOUS INTERFACE

Read/Full Write— 167 ns (max)
Write Byte— 132 ns (max)

iLBX™ BUS

Read/Full Write— 295 ns (max)
Write Byte— 116 ns (max)

Cycle Times (All densities)

MULTIBUS® SYSTEM BUS

Read/Full Write— 625 ns (max)
Write Byte— 625 ns (max)

HIGH SPEED SYNCHRONOUS INTERFACE

Read/Full Write— 250 ns (max)
Write Byte — 250 ns (max)

iLBX™ BUS

Read/Full Write— 437.5 ns (max)
Write Byte — 437.5 ns (max)

Memory Partitioning

Maximum System memory size is 16M Bytes for the MULTIBUS, iLBX bus and the high speed interface.

BASE ADDRESS

Board	Base Address
iSBC 012EX Board	any 256K boundary in first 4 megabytes
iSBC 010EX Board	any 512K boundary in first 8 megabytes
iSBC 020EX Board	any 1M boundary
iSBC 040EX Board	any 1M boundary

Power Requirements

Voltage—5 VDC ±5%

Product	Current
iSBC 012EX Board	3.2A (typ) 4.9A (max)
iSBC 010EX Board	3.4A (typ) 5.0A (max)
iSBC 020EX Board	3.7A (typ) 5.2A (max)
iSBC 040EX Board	3.9A (typ) 5.5A (max)

ENVIRONMENTAL REQUIREMENTS

Operating Temperature: 0°C to 60°C airflow of 5 cubic feet per minute

Storage Temperature: −40°C to +75°C

Operating Humidity: To 90% without condensation

PHYSICAL DIMENSIONS

Width: 12 inches (30.48 cm)
Height: 6.75 inches (17.15 cm)
Thickness: 0.50 inches (1.27 cm)
Weight: iSBC 012EX board: 6.8 ounces (1910 gm)
iSBC 010EX board: 9.0 ounces (2550 gm)
iSBC 020EX board: 13.5 ounces (3830 gm)
iSBC 040EX board: 18.0 ounces (5100 gm)

REFERENCE MANUALS

147783-001— iSBC 012EX/iSBC 010EX/iSBC 020EX/iSBC 040EX Hardware Reference Manual
9800683-03— Intel MULTIBUS Specification
144456-001— Intel iLBX Specification

Manuals may be ordered from any Intel Sales Representative, Distributor Office or from the Intel Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051.

ORDERING INFORMATION

Part Number	Description
iSBC 012EX	512K byte RAM board with parity, iLBX connectors, and high speed interface
iSBC 010EX	1M byte RAM board with parity, iLBX connectors, and high speed interface
iSBC 020EX	2M byte RAM board with parity, iLBX connectors, and high speed interface
iSBC 040EX	4M byte RAM board with parity, iLBX connectors, and high speed interface
EX ASYNCPKG	Jumper scheme and PAL's required to configure EX memory boards for iLBX function with the iSBC 186/03A and iSBC 286/10

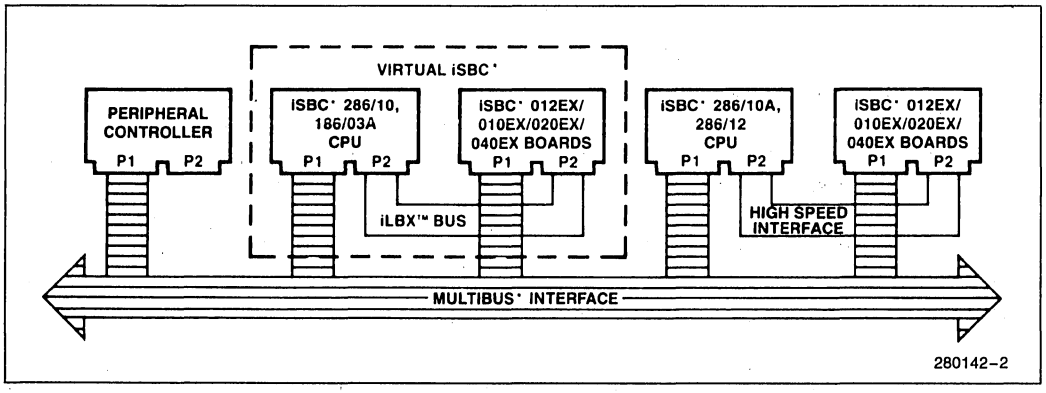


Figure 1. Typical iLBX™ System Configuration

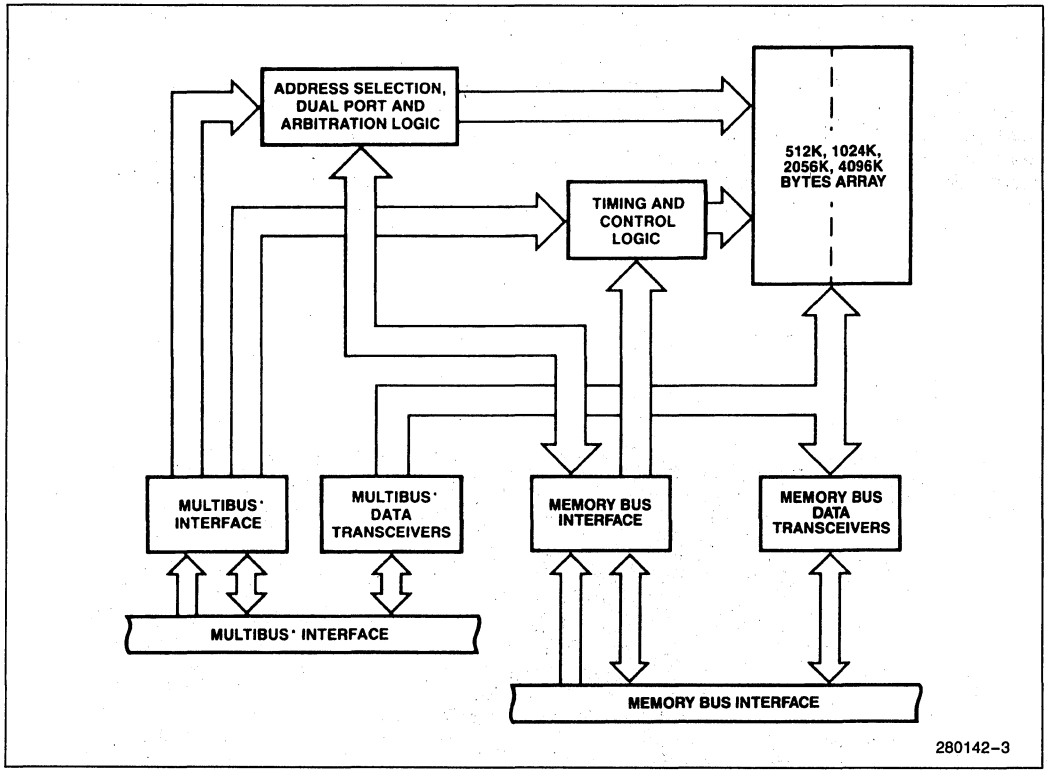


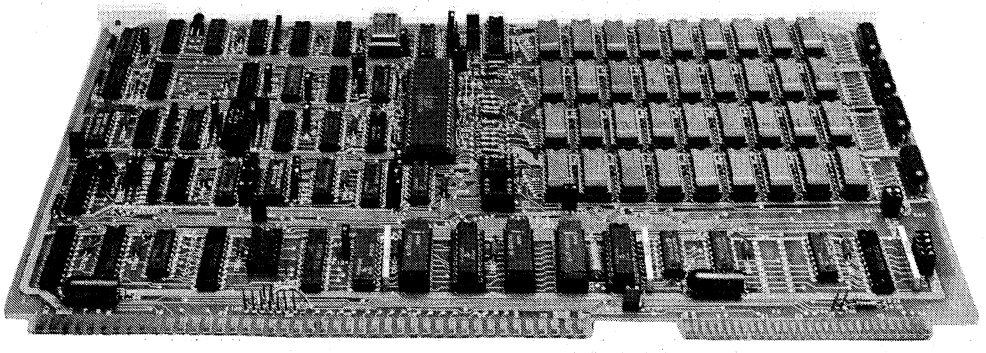
Figure 2. iSBC® EX Memory Board Block Diagram

iSBC® 028A/056A RAM MEMORY BOARDS

- **iSBC 86, iSBC 88 and iSBC 80 Board RAM Expansion through Direct MULTIBUS® Interface**
- **128K or 256K Bytes of Read/Write Memory**
- **On-Board Parity Generator/Checker and Error Status Register**
- **Requires a Single +5V Power Supply**
- **Assignable Anywhere within a 16 Megabyte Address Space**
- **Jumper Selectable Base Address on Any 4K Byte Boundary**
- **Auxiliary Power Bus and Memory Protect Control Logic for Battery Backup RAM Requirements**

The iSBC 028A and iSBC 056A RAM memory boards are members of Intel's complete line of iSBC memory and I/O expansion boards. Each board interfaces directly to any iSBC 80, iSBC 88 or iSBC 86 Single Board Computer via the MULTIBUS interface to expand system RAM capacity. The iSBC 028A and iSBC 056A boards contain 128K, or 256K bytes of read/write memory implemented using dynamic RAM components. An on-board LSI dynamic RAM controller refreshes a portion of these components every 14 microseconds. Each refresh cycle utilizes memory for 480 nanoseconds (maximum).

The iSBC 028A and iSBC 056A boards generate byte oriented parity during all write operations and perform parity checking during all read operations. When a parity error is detected, these boards can generate an interrupt on the MULTIBUS interface. In addition, the row and bank of the RAM array containing the error are stored in a Parity Flag Register (see Figure 1). This register is accessible as a MULTIBUS I/O port. An on-board LED also provides a visual indication that a parity error has occurred. To facilitate testing of these boards, parity generation and checking can be changed from even to odd under software control.



143877-1

October 1986
Order Number: 143877-002

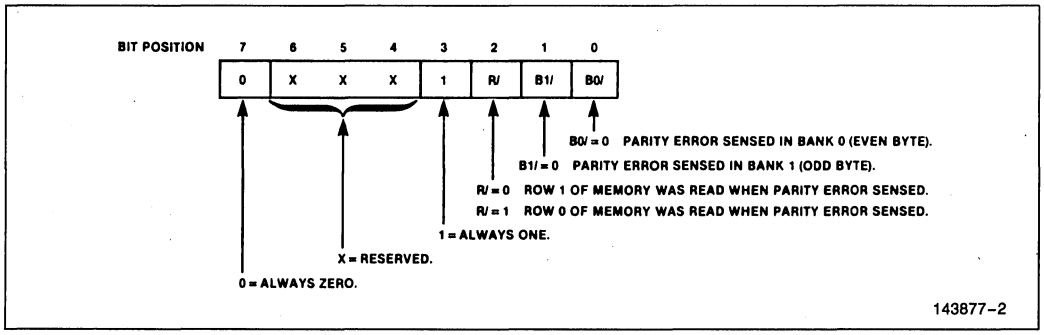


Figure 1. Parity Flag Register Format

SPECIFICATIONS

Word Size

8 bits and 16 bits

Memory Size

131,072 bytes (iSBC 028A); or 262,144 bytes (iSBC 056A)

Access Time

iSBC 028A
500 ns max. (worst case)
460 ns max. (typical)

iSBC 056A
570 ns max. (worst case)
530 ns max. (typical)

Cycle Times (Worst Case)

Read
iSBC 028A—600 ns max.
iSBC 056A—650 ns max.

Write
iSBC 028A—600 ns max.
iSBC 056A—650 ns max.

Refresh
iSBC 028A—480 ns max.
iSBC 056A—600 ns max.

Interface

All address, data and command signals are TTL compatible.

Address Selection

Memory—Base address is jumper selectable on any 4K byte boundary in a 16 megabyte address space. On-board RAM cannot cross a megabyte address boundary.

Parity Flag Register—The I/O address of the Parity Flag Register is jumper selectable to be between 00H to 0FH or 40H to 4FH.

Connector

Edge connector—86 pin double-sided PC edge connector with 0.156 in. contact centers.

Mating connector—Viking 3KH43/9AMK12 or equivalent.

Auxiliary Power

An auxiliary power bus is provided to allow separate power to RAM array for system requiring battery backup of read/write memory. Selection of this auxiliary RAM power bus is made via jumpers on the board.

Memory Protect

An active-low TTL compatible memory protect signal is brought out on the auxiliary connector which, when asserted, disables read/write access to RAM on the board. This input is provided for the protection of RAM contents during system power-down sequences.

Physical Characteristics

Width: 12.00 in. (30.48 cm)
Height: 6.75 in. (17.15 cm)
Depth: 0.50 in. (1.27 cm)
Weight: 14 oz. (397 gm)

Electrical Characteristics

D.C. POWER REQUIREMENTS

All configurations require only +5V ±5%.

Normal System Operation (max.)
iSBC 028A/056A—4.57A (worst case)
3.66A (typical)

Auxiliary Power No RAM Access (max.)
iSBC 028A/056A—0.55A (worst case)
0.45A (typical)

Environmental Characteristics

Operating Temperature: 0°C to +55°C
Relative Humidity: to 90% (without condensation)

Reference Manual

143572-001— iSBC 032A/064A/028A/056A Hardware Reference Manual (not supplied)

Manuals may be ordered from any Intel sales representative, distributor office, or from Intel Literature Dept., 3065 Bowers Avenue, Santa Clara, California 95051.

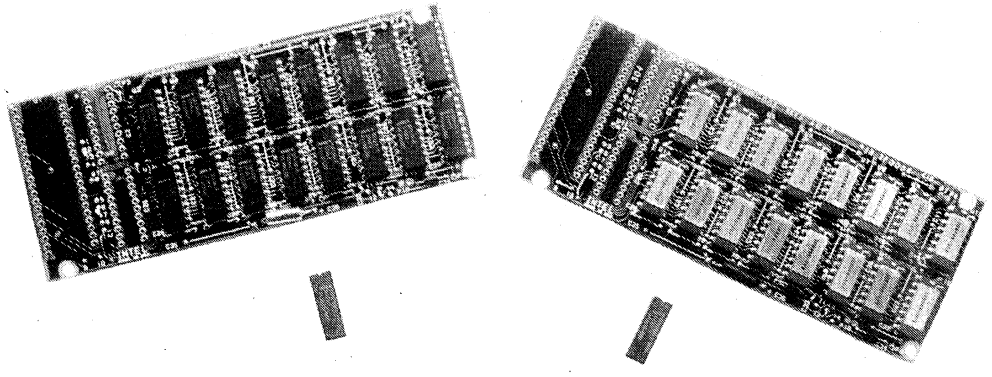
ORDERING INFORMATION

Part Number	Description
SBC 028A	128K-Byte RAM Board with Parity
SBC 056A	256K-Byte RAM Board with Parity

iSBC® 304 128K BYTE RAM MULTIMODULE™ BOARD
iSBC® 300A 32K BYTE RAM MULTIMODULE™ BOARD

- **iSBC® 304 Module Provides 128K Bytes of Dual Port RAM Expansion for the iSBC 86/30 or iSBC 86/35 Board**
- **iSBC 300A Module Provides 32K Bytes of Dual Port RAM Expansion for the iSBC 86/14 Board**
- **Simple, Reliable, Mechanical and Electrical Interconnection**
- **On-Board Memory Expansion for the iSBC 86/30, iSBC 86/14 and iSBC 86/35 Single Board Computers**
- **On-board Memory Expansion Eliminates MULTIBUS® System Bus Latency and Increases System Throughput**
- **Low Power Requirements**

The iSBC 304 and iSBC 300A RAM modules provide simple, low cost expansion of the memory compliment available on the iSBC 86/30 and iSBC 86/14 Single Board Computers, respectively. Each module doubles the on-board RAM memory capacity of the host board. Additionally, the iSBC 304 provides 128K bytes RAM expansion to the iSBC 86/35 giving a total capacity of 640K bytes RAM memory. The RAM MULTIMODULE options for the host boards offer system designers a new level of flexibility in defining and implementing Intel single board computer systems. Because they expand the memory configuration on-board, they can be accessed as quickly as the existing host board memory by eliminating the need for accessing the additional memory via the MULTIBUS system bus.



210329-1

September 1987
Order Number: 210329-002

FUNCTIONAL DESCRIPTION

Each MULTIMODULE contains dynamic RAM devices and sockets for the Intel 8203 dynamic RAM controller and memory interface latching. To install the module, the latches and controller from the host CPU board are removed and inserted into sockets on the RAM MULTIMODULE. The module is then mounted onto the host board. Pins extending from the controller and latch sockets mate with device sockets underneath (see Figure 1). Additional pins mate to supply other signals to complete the electrical interface.

The module is then secured at three additional points with nylon hardware to ensure the mechanical security of the assembly.

To complete the installation, one socketed PROM is replaced on the host CPU board with the one supplied with the MULTIMODULE kit. This is the MULTIBUS address decode PROM which allows the host board logic to recognize its expanded on-board memory compliment.

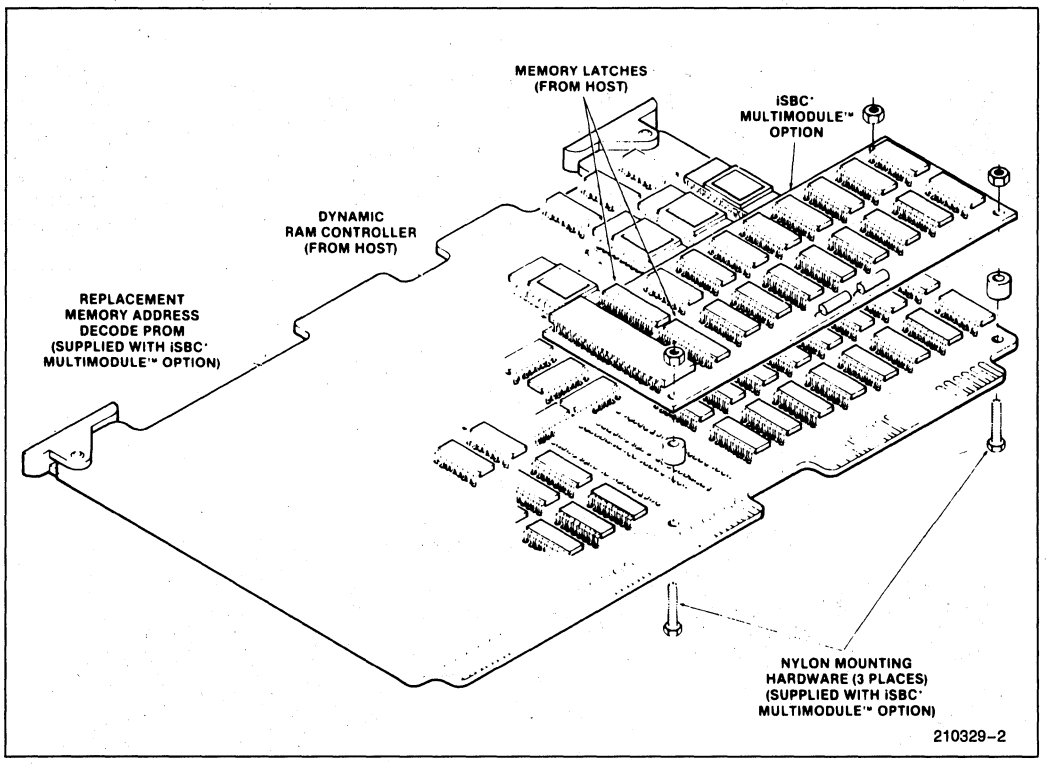


Figure 1. Installation of the MULTIMODULE™ RAM on the Host Single Board Computer

SPECIFICATIONS

Word Size

8 or 16 bits (16-bit data paths)

Memory Size

iSBC 304 Module—128K bytes RAM

iSBC 300A Module—32K bytes RAM

Cycle Time

iSBC 304—700 ns (read); 700 ns (write)

iSBC 300A—700 ns (read); 700 ns (write)

Memory Addressing

CPU ACCESS

iSBC 304 (with iSBC 86/35)—640K bytes (total capacity); 0-9FFFFH (address range)

iSBC 304 (with iSBC 86/30)—256K bytes (total capacity); 0-3FFFFH (address range)

iSBC 300A (with iSBC 86/14)—64K bytes (total capacity); 0-0FFFFH (address range)

MULTIBUS® Access

Jumper selectable for any 32K (8K) byte boundary, but not crossing a 256K (128K) byte boundary on the iSBC 86/30 (iSBC 86/14) host board.

Interface

The interfaces for the iSBC 304 and iSBC 300A module options are designed only for the iSBC 86/30 and iSBC 86/14 host boards, respectively.

Private Memory Allocation

Segments of the combined host/MULTIMODULE RAM memory may be configured as a private resource, protected from MULTIBUS system access. The amount of memory allocated as a private resource may be configured in increments of 25% of the total on-board memory ranging from 0% to 100%. The iSBC 304 module mounted on the iSBC 86/30 board, therefore, supports private allocation of 64K, 128K, 192K, or 256K bytes of RAM memory.

The iSBC 300A module mounted on the iSBC 86/14 board supports private allocation of 16K, 32K, 48K, or 64K bytes of RAM memory.

Auxiliary Power

The low power memory protection option included on the CPU host boards supports the RAM modules.

Physical Characteristics

Width: 2.4 in. (6.10 cm)

Height: 5.75 in. (14.61 cm)

Depth*: 0.72 in. (1.83 cm)

Weight: 0.13 oz. (59 g)

***NOTE:**
Combined depth including host board.

Electrical Characteristics

DC POWER REQUIREMENTS

iSBC 304: 640 mA at +15V incremental power

iSBC 300A: 256 mA at +5V incremental power

Environmental Characteristics

Operating Temperature: 0°C to 55°C

Relative Humidity: to 90% (without condensation)

Reference Manual

All necessary documentation for the iSBC 304 and iSBC 300A MULTIMODULE boards is included in the iSBC 86/14 and iSBC 86/30 Hardware Reference Manual, Order No. 144044-002 (NOT SUPPLIED).

Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051.

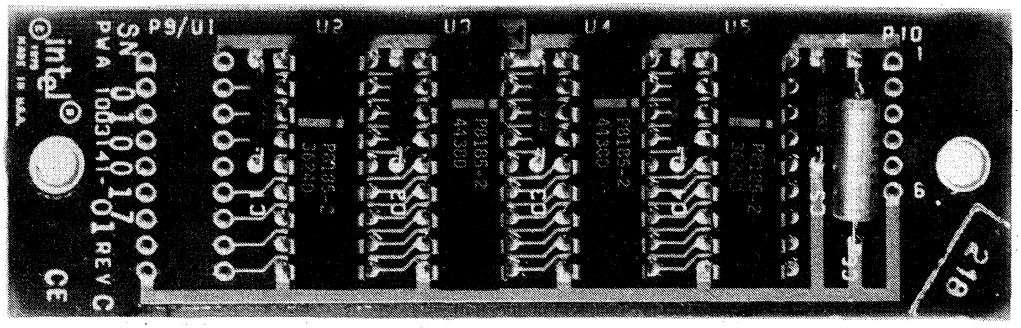
ORDERING INFORMATION

Part Number	Description
SBC 304	128K MULTIMODULE option for iSBC 86/30 or iSBC 86/35 CPU boards
SBC 300A	32K MULTIMODULE option for iSBC 86/14 board

iSBC® 301
4K-BYTE RAM
MULTIMODULE™ BOARD

- **On-Board Memory Expansion to 8K Bytes for iSBC® 88/40A Single Board Computers**
- **Provides 4K Bytes of Static RAM Directly On-Board**
- **Uses 5 MHz (8185-2) RAMs**
- **Single +5V Supply**
- **0.5 Watts Incremental Power Dissipation**
- **On-Board Memory Expansion Eliminates MULTIBUS® System Bus Latency and Increases System Throughput**
- **Reliable Mechanical and Electrical Interconnection**

The Intel iSBC 301 4K-byte RAM MULTIMODULE Board provides simple, low cost expansion to double the RAM capacity on the iSBC 88/40A Single Board Computer to 8K bytes. This offers system designers a new level of flexibility in defining and implementing system memory requirements. Because memory is configured on-board, it can be accessed as quickly as the existing iSBC 88/40A memory, eliminating the need for accessing the additional memory via the MULTIBUS system bus. As a result, the iSBC 301 board provides a high speed, cost effective solution for systems requiring incremental RAM expansion. Incremental power required by the iSBC 301 module is minimal, dissipating only 0.5 watts.



280224-1

October 1986
Order Number: 280224-001

FUNCTIONAL DESCRIPTION

The iSBC 301 Board measures 3.95″ by 1.20″ and mounts above the RAM area on the iSBC 88/40A single board computer. It expands the on-board RAM capacity from 4K bytes to 8K bytes. The iSBC 301 MULTIMODULE board contains four 1K byte static RAM devices and a socket for one of the RAM devices on the iSBC 88/40A board. To install the iSBC 301 MULTIMODULE board, one of the RAMs is removed from the host board and inserted into the socket on the iSBC 301 board. The add-on board is then mounted into the vacated RAM socket on the host board. Pins extending from the RAM socket mate with the device's socket underneath (see Figure 1). Additional pins mate to the power supply and chip select lines to complete the electrical interface. The MULTIMODULE board is then secured at two additional points with nylon hardware to insure mechanical security of the assembly. With the iSBC 88/40A board mounted in the top slot of an iSBC 604 or iSBC 614 cardcage, sufficient clearance exists for mounting the iSBC 301 option. If the iSBC 80/24 or iSBC 88/40A board is inserted into some other slot, the combination of boards will physically (but not electrically) occupy two cardcage slots.

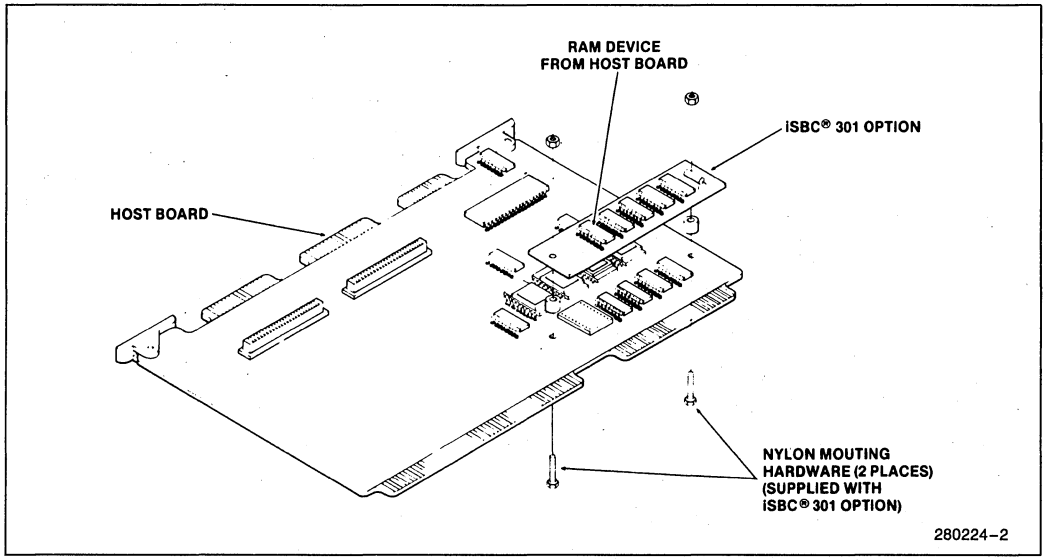


Figure 1. Installation of iSBC® 301 4K Byte RAM MULTIMODULE™ Board

SPECIFICATIONS

Word Size

8 bits

Memory Size

4096 bytes of RAM

Access Time

Read: 140 ns (from READ command)
200 ns (from ALE)
Write: 150 ns (from READ command)
190 ns (from ALE)

Memory Addressing

Memory addressing for the iSBC 301 4K-Byte-RAM MULTIMODULE Board is controlled by the host board via the address and chip select signal lines and is contiguous with the host board RAM.

iSBC 88/40A and iSBC 301 board: 00000-01FFF

Physical Characteristics

Width: 1.20 in. (3.05 cm)
Length: 3.95 in. (10.03 cm)
Height: 0.44 in. (1.12 cm) iSBC 301 Board
0.56 in. (1.42 cm)
iSBC 301 Board + host board
Weight: 0.69 oz. (19 gm)

Electrical Characteristics DC Power Requirements:

10 mA at +5 Volts incremental power

Environmental Characteristics

Operating Temperature: 0°C to +55°C
Relative Humidity: to 90% (without condensation)

Reference Manuals

All necessary documentation for the iSBC 301 MULTIMODULE board is included in the CPU board Hardware Reference Manual (NOT SUPPLIED)

iSBC 88/40A—Order No. 147049-001

Manuals may be ordered from any Intel sales representative, distributor office, or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

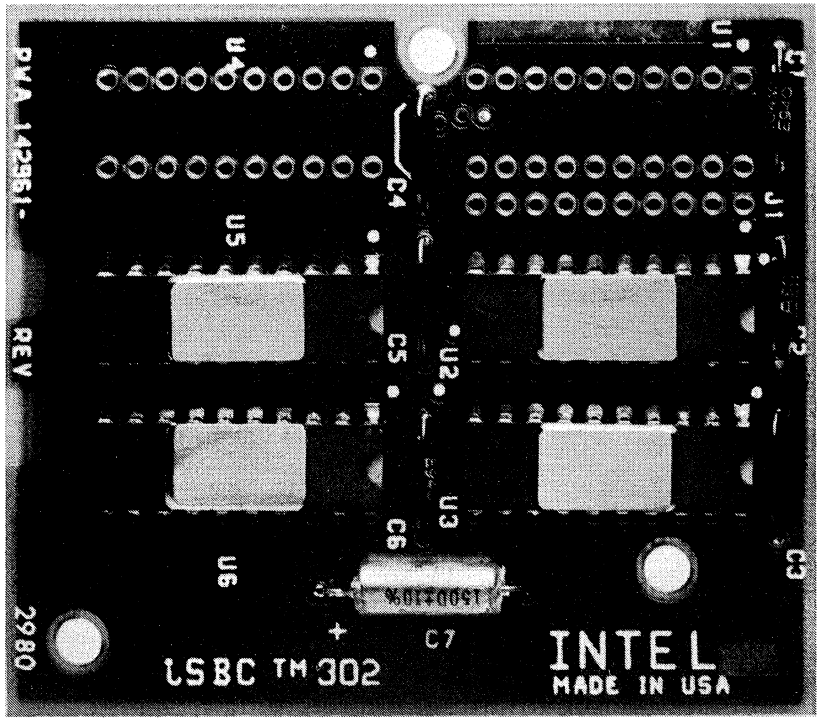
SPECIFICATIONS

Part Number	Description
SBC 301	4K Byte RAM MULTIMODULE Board

iSBC® 302
8K BYTE MULTIMODULE™ RAM

- **Expands On-Board Memory of the iSBC 86/05A and iSBC 88/25 Signal Board Computers**
- **Uses Four Intel 2168 Static RAMs**
- **Single +5V Supply**
- **On-Board Memory Expansion Eliminates System Bus Latency and Increases System Throughput**
- **Reliable Mechanical and Electrical Interconnection**

The Intel iSBC 302 8K byte MULTIMODULE RAM provides simple, low cost expansion to double the RAM capacity on the iSBC 86/05A Single Board Computer to 16K bytes or increase RAM capacity on the iSBC 88/25 Single Board Computer to 12K bytes. This offers system designers a new level of flexibility in implementing system memory. Because the MULTIMODULE memory is configured on-board, it can be accessed as quickly as the standard on-board iSBC 86/05A or iSBC 88/25 memory, eliminating the need for accessing the additional memory via the MULTIBUS system bus. As a result, the iSBC 302 board provides a high-speed, cost effective solution for systems requiring incremental RAM expansion.



280225-1

October 1986
Order Number: 280225-001

FUNCTIONAL DESCRIPTION

The iSBC 302 board measures 2.60" by 2.30" and mounts above the RAM area on the iSBC 86/05A or iSBC 88/25 Single Board Computer. The iSBC 302 MULTIMODULE board contains four 4K x 4 static RAM devices and sockets for two of the RAM devices on the iSBC 80/05A board. With the iSBC 302 module mounted on the iSBC 88/25 board, the two sockets on the iSBC module may be filled with 4K x 4 static RAMs. The two sockets on the iSBC 302 module have extended pins which mate with two sockets on the base board. Additional pins mate to the power supply and chip select lines to complete the electrical interface. The mechanical integrity of the assembly is assured with nylon hardware securing the module in two places. With the iSBC 86/05A or iSBC 88/25 board mounted in the top slot of an iSBC 604/614 cardcage, sufficient clearance exists for the mounted iSBC 302 option. If the iSBC 86/05A or iSBC 88/25 board is inserted into some other slot, the combination of the boards will physically (but not electrically) occupy two cardcage slots.

SPECIFICATIONS

Word Size

8/16 bits

Memory Size

16,384 bytes of RAM

Cycle Time

Provides "no wait state"memory operations on the iSBC 86/05A board at 5 MHz or 8 MHz or the iSBC 88/25 at 5 MHz.

5 MHz cycle time — 800 ns
8 MHz cycle time — 500 ns

Memory Addressing

Memory addressing for the iSBC 302 MULTIMODULE board is controlled by the host board via the address and chip select signal lines.

With the iSBC 86/05A board:

The 8K bytes of RAM on the iSBC 302 board occupy the 8K byte address space immediately after that of the iSBC 86/05A board's 8K RAM (i.e., default configuration —

iSBC 86/05A board's RAM — $00000-01FFF_H$

iSBC 302 board's RAM — $02000-03FFF_H$).

With the iSBC 88/25 board:

The 8K bytes of RAM on the iSBC 302 board occupy the 8K byte address space immediately after that of the iSBC 88/25 board's 4K RAM (i.e., default configuration —

iSBC 88/25 board's RAM — $0-0FFF_H$

iSBC 302 board's RAM — $01000_H-02FFF_H$).

Physical Characteristics

Width: 2.6 in. (6.60 cm)

Length: 2.3 in. (5.84 cm)

Height: 0.56 in. (1.42 cm) iSBC 302 board + iSBC 86/05A or iSC 88/25 board

Weight: 1.25 oz. (35 gm)

Electrical Characteristics

DC Power Requirements: 720 mA at +5V incremental power

Environmental Characteristics

Operating Temperature: 0°C to +55°C

Relative Humidity: to 90% (without condensation)

Reference Manuals

All necessary documentation for the iSBC 302 MULTIMODULE board is included in the CPU board Hardware Reference Manuals (NOT SUPPLIED).

iSBC 86/05A —Order No. 147162-001

iSBC 88/25 —Order No. 143825-001

Manuals may be ordered from any Intel sales representative, distributor office, or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

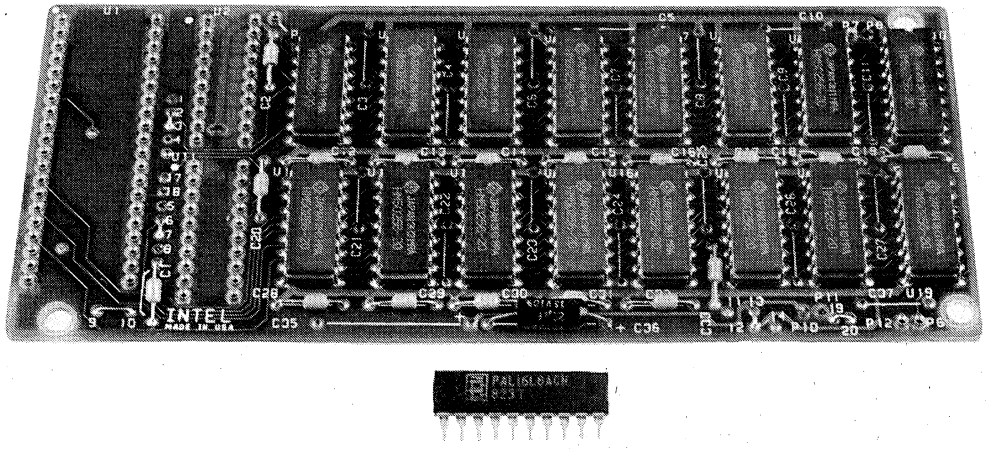
ORDERING INFORMATION

Part Number	Description
SBC 302	8K byte MULTIMODULE RAM

iSBC® 314
512K BYTE RAM MULTIMODULE™ BOARD

- **On-Board Memory Expansion for the iSBC 86/35 Single Board Computer**
- **iSBC 314 Module Provides 512K Bytes of Dual Port RAM Expansion for the iSBC 86/35 Board**
- **Reliable Mechanical and Electrical Interconnection**
- **Completes iSBC 86/35 Memory Array Providing a Full Megabyte Page of System Memory**
- **Increases System Throughput by Reducing Accesses to MULTIBUS® Global Memory**
- **Low Power Requirements**
- **Battery Backup Capability**

The iSBC 314 512K byte RAM MULTIMODULE board provides simple, low cost expansion to double the on-board RAM capacity of the iSBC 86/35 Single Board Computer host to one megabyte. This RAM MULTIMODULE option offers system designers a simple, practical solution to expanding and improving the memory capability and performance of the iSBC 86/35 board. The iSBC 314 memory is configured on-board and can be accessed as quickly as the standard iSBC 86/35 memory, eliminating the need for accessing additional memory via the MULTIBUS system bus.



280000-1

October 1986
Order Number: 280000-002

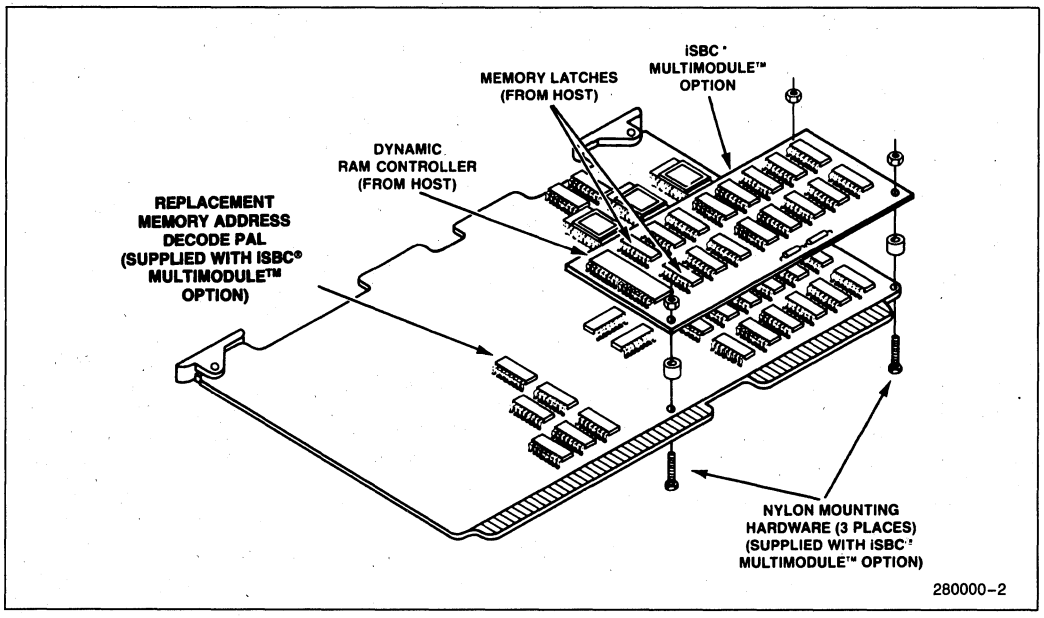


Figure 1. Installation of the MULTIMODULE™ RAM Module on the Host Single Board Computer

FUNCTIONAL DESCRIPTION

The iSBC 314 MULTIMODULE board measures 2.40″ by 5.75″ and mounts above the RAM array on the iSBC 86/35 Single Board Computer. The iSBC 314 board contains sixteen 256 Kbit x 1 dynamic RAM devices and three sockets; two for the memory latches and one for the Intel 8203 dynamic RAM controller. The addition of the iSBC 314 memory MULTIMODULE board to the iSBC 86/35 board makes possible a one megabyte single board solution; the full direct addressing capability of the iAPX 86 CPU.

To install the module, the latches and controller from the host iSBC 86/35 board, are removed and inserted into sockets on the iSBC 314 board. The module is then mounted onto the host board. Pins extending from the controller and latch sockets mate with device sockets underneath (see Figure 1). Additional pins mate to supply other signals to complete the electrical interface. The module is then secured at three additional points with nylon hardware to ensure the mechanical security of the assembly.

To complete the installation, one socketed PAL is replaced on the iSBC 86/35 board with the one supplied with the MULTIMODULE kit. This is the PAL which allows the host board logic to recognize its expanded on-board memory compliment.

SPECIFICATIONS

Word Size

8 or 16 bits (16-bit data paths)

Memory Size

512K bytes RAM

System Cycle Time (8 MHz, 2 Wait States)

750 ns (read); 750 ns (write)

NOTE:
1 wait state achieved with jumper change on iSBC 86/35 board.

Memory Addressing

iSBC 314 module with iSBC 86/35 board — 1M byte (total capacity); 0–FFFFFH. (See Figure 2, Memory Allocation)

Interface

The interface for the iSBC 314 MULTIMODULE board option is designed only for the iSBC 86/35 host board.

Wait-State Performance

A significant performance advantage of 2 wait-states is achieved when accessing memory on-board the iSBC 86/35 versus the performance of 6 wait-states when accessing memory off-board over the MULTIBUS. The iSBC 314 puts an additional 512K bytes of system memory on-board the iSBC 86/35 reducing the execution time by as much as 70%.

Memory Allocation

Segments of the combined host/MULTIMODULE RAM may be configured to be accessed either from off-board or on-board resources. The amount of memory allocated as either public or private resource may be configured in a variety of sizes. The address range boundaries for the 1 megabyte of RAM array of the iSBC 314 and iSBC 86/35 board combination are shown in Figure 2 for accesses from both on-board and off-board resources.

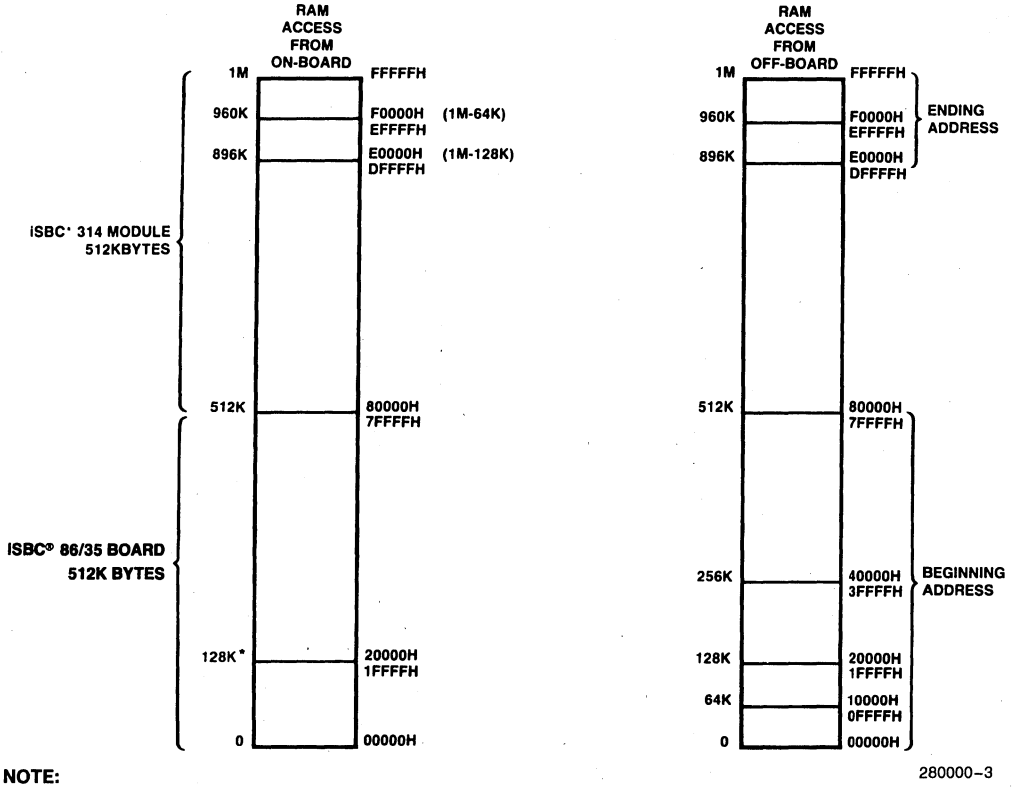
Auxiliary Power

The low power memory protection option included on the iSBC 86/35 board supports the iSBC 314 module.

Physical Characteristics

Width: 2.4 in. (6.10 cm)
Length: 5.75 in. (14.61 cm)
Depth*: 0.72 in. (1.83 cm)
Weight: 0.13 oz. (59g)

NOTE:
*Combined depth including host board.



280000-3

NOTE:
All memory above this boundary may be disabled under software control to allow access to MULTIBUS® system bus.

Figure 2. Address Range Selection

Electrical Characteristics

DC Power Requirements*

*Additional power required by the iSBC 314 MULTIMODULE is:

Typical: 60 mA @ +5V

Maximum: 140 mA @ +5V

Environmental Characteristics

Operating Temperature: 0°C to +55°C

Relative Humidity: to 90% (without condensation)

Reference Manual

All necessary documentation for the iSBC 314 MULTIMODULE board is included in the iSBC 86/35 Hardware Reference Manual (NOT SUPPLIED); Order Number: 146245-002.

Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051.

ORDERING INFORMATION

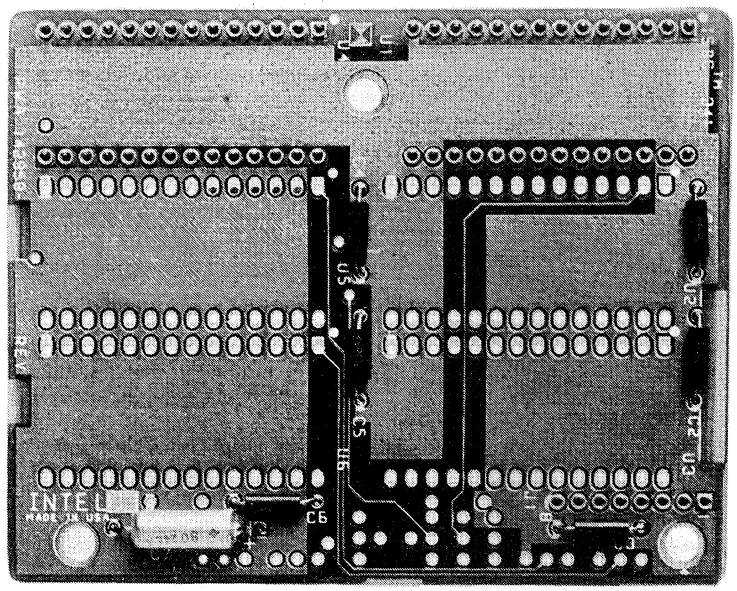
Part Number	Description
iSBC® 314	512K byte Memory MULTIMODULE option for iSBC 86/35 board

iSBC® 341
28-PIN MULTIMODULE™ EPROM

- **On-board Memory Expansion for iSBC® 86/05A, iSBC 88/25, iSBC 186/03A, iSBC 286/10A, iSBC 286/12, and iSBC 88/40A Microcomputers**
- **Supports JEDEC 24/28-Pin Standard Memory Devices, Including EPROMs, Byte-Wide RAMs, and E²PROMs**
- **Sockets for Up to 256K Bytes of Expansion with Intel 27512 EPROMs**
- **On-Board Expansion Provides "No Wait State" Memory Access with Selected Devices**
- **Simple, Reliable Mechanical and Electrical Interface**

The iSBC 341 28-pin MULTIMODULE EPROM board provides simple, low-cost expansion of the on-board EPROM capacity of the iSBC 86/05A Single Board Computer, the iSBC 88/25 Single Board Computer, iSBC 186/03A, iSBC 286/10A, iSBC 286/12 and the iSBC 88/40A Measurement and Control Computer. Four additional 28-pin sockets support JEDEC 24/28-pin standard devices, including EPROMs, byte-wide static and psuedo-static RAMs.

The MULTIMODULE expansion concept provides the optimum mechanism for incremental memory expansion. Mounting directly on the microcomputer, the benefits include low cost, no additional power requirements beyond the memory devices, and higher performance than MULTIBUS-based memory expansion.



280214-1

October 1986
Order Number: 280214-001

FUNCTIONAL DESCRIPTION

The iSBC 341 28-pin MULTIMODULE EPROM option effectively doubles the number of sockets available for EPROM on the base microcomputer board on which it is mounted. The iSBC 341 board contains six 28-pin sockets. Two of the sockets have extended pins which mate with two of the sockets on the base board. Two of the EPROMs which would have been inserted in the base board are then reinserted in the iSBC 341 sockets. Additional interface pins also connect chip select lines and power. The mechanical integrity of the assembly is assured with nylon hardware securing the unit in two places.

Through its unique interface, the iSBC 341 board can support 8- or 16-bit data paths. The data path width is determined by the base board—being 8 bits for the iSBC 88/40A and iSBC 88/25 microcomputers, and 8/16 bits for the iSBC 86/05A, iSBC 186/03A, iSBC 286/10A, and iSBC 286/12 boards.

SPECIFICATIONS

Word Size

8 or 8/16 bits (determined by data path width of base board).

Memory Size

256K bytes with available technology (JEDEC standard defines device pin-out to 512-bit devices).

Device Size (Bytes)	EPROM Type	Max iSBC® 341 Capacity (Bytes)
2K x 8	2716	8K
4K x 8	2732A	16K
8K x 8	2764	32K
16K x 8	27128	64K
32K x 8	27256	128K
64K x 8	27512	256K

Access Time

Varies according to base board and memory device access time. Consult data sheet of base board for details.

Memory Addressing

Consult data sheet of base board for addressing data.

POWER REQUIREMENTS

Devices(1)	Max Current @ 5V ±5%
2716	420 mA
2732A	600 mA
2764	600 mA

NOTE:
1. Incremental power drawn from host board for four additional devices.

Auxiliary Power

There are no provisions for auxiliary power (battery backup) on the iSBC 341 option.

Physical Characteristics

Width: 3.4 in. (8.64 cm)

Length: 2.7 in. (6.86 cm)

Height: 0.78 in. (1.98 cm)*

Weight: 5 oz. (141.5 gm)

*Includes height of mounted memory devices and base board.

All necessary mounting hardware (nylon screws, spacers, nuts) is supplied with each kit.

Environmental Characteristics

Operating Temperature: 0°C to +55°C

Relative Humidity: to 90% (without condensation)

Reference Manuals

All necessary documentation for the iSBC 341 module is included in the CPU board Hardware Reference Manuals (NOT SUPPLIED)

iSBC 186/03A — Order No. 148060-001
iSBC 86/05A — Order No. 147162-001
iSBC 88/25 — Order No. 143825-001
iSBC 88/40A — Order No. 147049-001
iSBC 286/10A — Order No. 147532-001
iSBC 286/12 — Order No. 147533-001

Manuals may be ordered from any Intel sales representative, distributor office, or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

ORDERING INFORMATION

Part Number	Description
SBC 341	28-Pin MULTIMODULE EPROM

MULTIBUS® II Memory Expansion Boards

7

PRELIMINARY

iSBC® MM01, MM02, MM04, MM08 HIGH PERFORMANCE MEMORY MODULES

- **Provides High Speed Parity Memory Expansion for Intel's iSBC 286/2X, iSBC 386/2X and iSBC 386/10X CPU Boards**
- **Available in 1M, 2M, 4M, and 8M Byte Sizes**
- **32 Bits Wide with Byte Parity**
- **Stackable to Provide up to 16M Bytes of High Speed Memory**
- **Supports 32-Bit, 16-Bit and 8-Bit Data Paths**
- **Supports Independent Read/Writes**
- **Easily Installed**

The iSBC MM01, iSBC MM02, iSBC MM04, and iSBC MM08 DRAM memory modules are members of Intel's complete line of iSBC memory and I/O expansion boards. The MM-Series of memory modules use a dedicated interface to maximize CPU/memory performance. The iSBC MM series of memory modules have been designed to provide both the on-board and expansion memory for the iSBC 286/2X, the iSBC 386/2X and the iSBC 386/10X CPU Boards.

The modules contain (respectively) 1M byte, 2M, 4M, and 8M bytes of read/write memory using surface mounted DRAM components (see Figure 1).

Due to the high speed interface of the memory modules, they are ideally suited in applications where memory performance is critical.

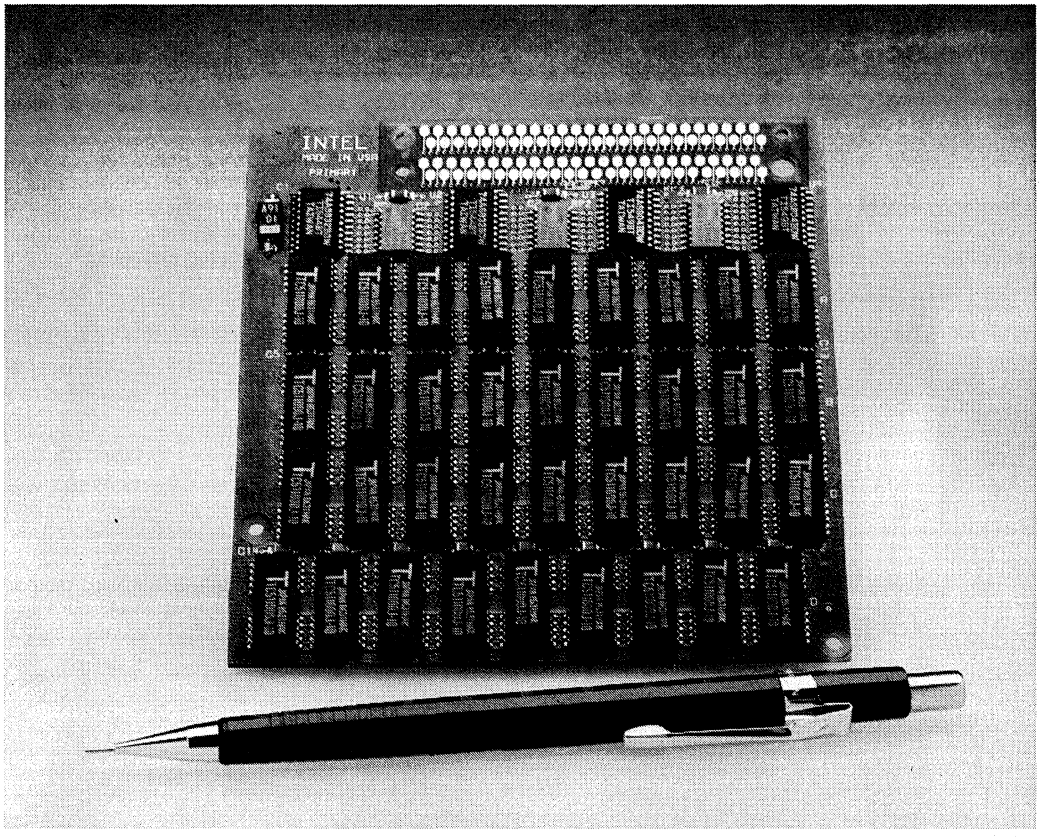


Figure 1. iSBC® MM08 Memory Module

280346-1

February 1987
Order Number: 280346-001

FUNCTIONAL DESCRIPTION

The iSBC MMxx memory modules provide high performance, 32-bit parity DRAM memory for the iSBC 286/2X and iSBC 386/2X MULTIBUS CPU boards and for the iSBC 386/10X MULTIBUS II CPU boards. These CPU boards come standard with one MMxx module installed, with memory expansion available through the addition of a second stackable iSBC MMxx module.

Memory Access Capabilities

The dynamic RAM memory of the memory modules is accessed through the dedicated memory module interface.

The MM memory module is designed for direct transfer of data between the CPU and the memory module without accessing the MULTIBUS interface.

MM01/MM02/MM04/MM08 Memory Size

The iSBC MM01, iSBC MM02, iSBC MM04, and iSBC MM08 modules can be stacked on the CPU baseboard in any combination of two memory modules to provide a total of 1-, 2-, 3-, 4-, 5-, 6-, 8-, 9-, 10-, 12-, or 16-M bytes of memory.

Data Bus Structure

The MMxx-series memory modules use a 32-bit wide data path with storage for byte parity that can accommodate 8-bit byte, 16-bit or 32-bit word data transfers. In addition, the data path is capable of independent byte operations. This means that one byte can be written while the other three bytes (or any other combination) can be read.

Parity

One parity bit is provided for each of the four, 8-bit bytes in the 32-bit wide data path. For special applications, the parity bits can serve as data bits making possible 9-, 18-, or 36-bit data transfers.

Memory Function

The module protocol supports standard dynamic RAM READ, WRITE, RAS* only REFRESH cycles, and CAS* before RAS* REFRESH.

Installation

The iSBC MMxx memory modules are easily installed by the user. Each module includes all necessary connectors, screws, and other hardware for installation, either as a second stacked module or as a replacement for a module with less memory.

SPECIFICATIONS

Word Size Supported

8-, 16-, or 32-bits

Memory Size

iSBC MM01	1,048,576 bytes
iSBC MM02	2,097,152 bytes
iSBC MM04	4,194,304 bytes
iSBC MM08	8,388,608 bytes

Access Time (All Densities)

Read/Write — 107ns (max)

The MMxx-series memory modules run with the iSBC 286/2X Boards at 10 MHz, and with the iSBC 386/2X and iSBC 386/10X Boards at 16 MHz and 20 MHz. Wait state performance information with each of these CPU baseboards is contained in the Hardware Reference Manual for the specific CPU baseboard.

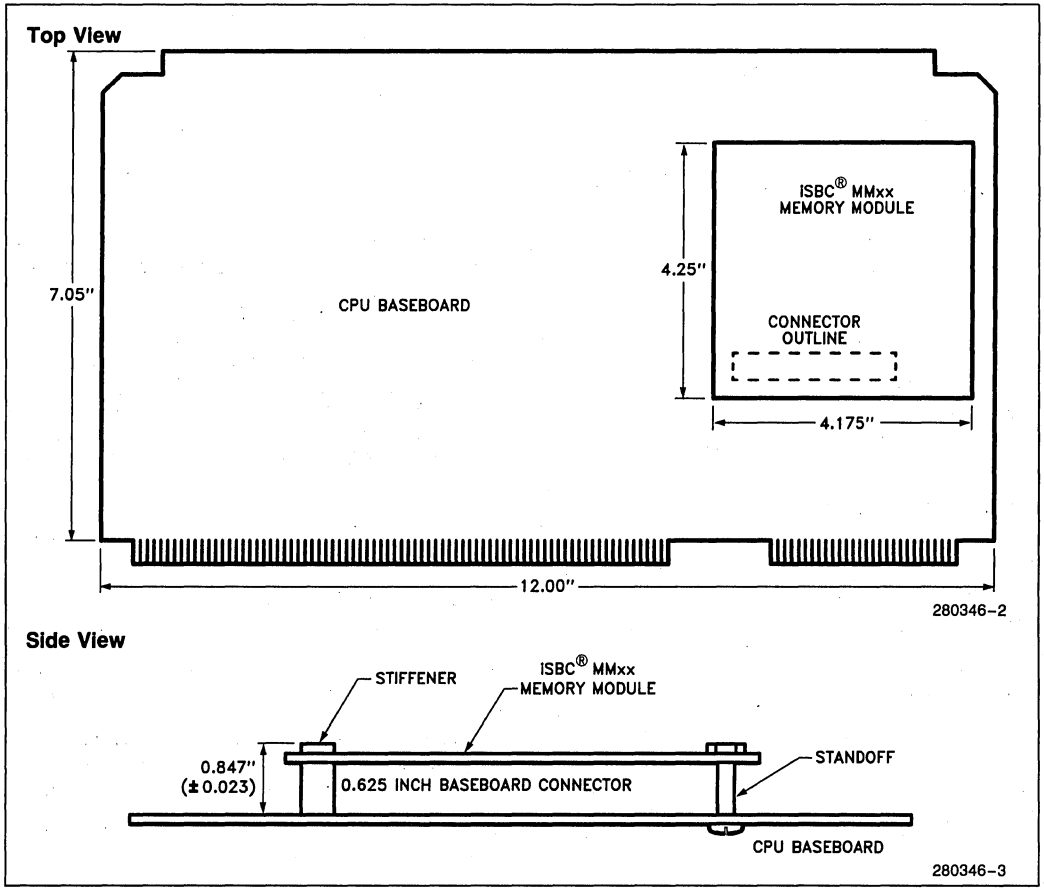
Cycle Time (All Densities)

Read/Write — 200ns (min)

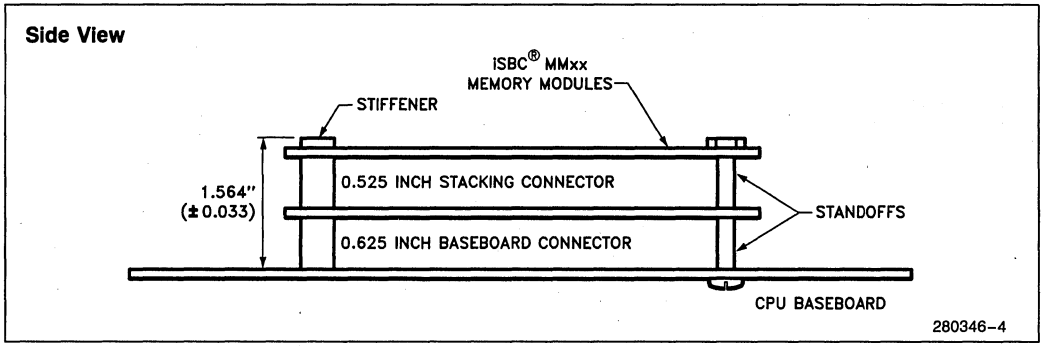
Power Requirements

Voltage −5 VDC ±5%

Memory addressing for the iSBC MMxx memory modules is controlled by the host CPU board over the memory module interface. The maximum system RAM size is 16M Bytes.



Single iSBC® MMxx Memory Module



Stacked iSBC® MMxx Memory Modules

Environmental Requirements

Operating Temperature — 0°C to 60°C

Storage Temperature — 40°C to +75°C

Cooling Requirement — 3 cubic feet per minute of airflow at an ambient temperature of 0°C to 60°C

Operating Humidity — To 95% relative humidity without condensation

Physical Dimensions

Module Alone:

Width — 4.250 inches (10,795 cm)

Length — 4.175 inches (10,604 cm)

Height — 0.500 inches (1,270 cm)

Weight — iSBC MM01/MM04: 2.5 ounces (70.0 gm)
iSBC MM02/MM08: 3.5 ounces (110.0 gm)

Module and Connector:

Weight — 1.7 ounces (47,4 gm) connector and stiffener only

Total Weight — iSBC MM01/MM04 and connector: 4.2 ounces (117,4 gm)

iSBC MM02/MM08 and connector: 5.2 ounces (145,4 gm)

Height — height from the top of the CPU baseboard to the highest point of the Memory Module:

ORDERING INFORMATION

Part Number	Description
iSBC MM01	1M Byte RAM Memory Module
iSBC MM02	2M Byte RAM Memory Module
iSBC MM04	4M Byte RAM Memory Module
iSBC MM08	8M Byte RAM Memory Module

The Memory Modules ship with the required hardware (connectors, mounting screws, stand-offs, etc.) to stack a second module on the module already mounted on the base CPU board.

For example, an iSBC MM01 stacked on an iSBC 286/21 will provide 2M bytes of total memory; an iSBC MM01 stacked on an iSBC 286/22 will provide 3M bytes total memory; an iSBC MM02 stacked on an iSBC 286/22 will provide 4M bytes of total memory; and so on.

REFERENCE MANUAL

iSBC 286/2X Hardware Reference Manual Order Number: 148920

iSBC 386/21/22/24/28 Single Board Computer Hardware Reference Manual Order Number: 149094

Manuals may be ordered from any Intel Sales Representative, Distributor Office or from the Intel Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051.

iSBC® MEM/312, 310, 320, 340
CACHE-BASED MULTIBUS® II RAM BOARDS

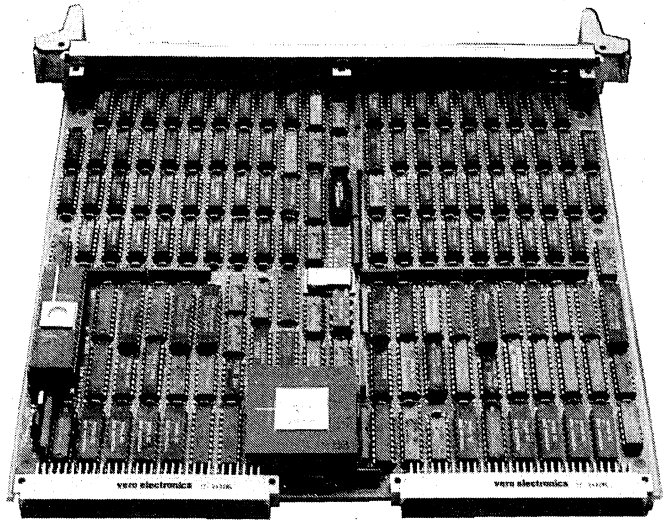
- **iSBC® MEM/3XX MULTIBUS® II Memory Boards Are High-Speed Cache-Based Boards with 8K Bytes of Cache RAM**
- **32-bit MULTIBUS® II Parallel System Bus (iPSB) and Local Bus Extension II (iLBX™ II Bus) Interface Support**
- **Zero Wait State Over iLBX™ on a Cache Hit, One Wait State for Cache Misses and Writes at 8 MHz**
- **Dual Port Memory with Four Versions Available:**

iSBC MEM/312	**½M Byte**
iSBC MEM/310	**1M Byte**
iSBC MEM/320	**2M Bytes**
iSBC MEM/340	**4M Bytes**

- **Double-high Eurocard Standard Form Factor, Pin and Socket DIN Connectors**
- **MULTIBUS II Software Interconnect Support for Dynamic Memory Configuration and Diagnostics with No Jumpers Necessary on the Board**
- **Built-In-Self-Test (BIST) Diagnostics On-Board with Both LED Indicators and Software Access to Error Information**
- **Automatic Memory Initialization at Power-Up and at Power-Fail Recovery**
- **Byte Parity Error Detection**

The iSBC MEM/312, 310, 320, 340 cache-based memory boards are the first Intel memory products to implement the MULTIBUS II system architecture. They have 32-bit architecture throughout, supporting 8-, 16-, and 32-bit central processors. The iSBC MEM/3XX (generally refers to this family of boards) memory boards are dual-ported, with access to the interfaces of both the MULTIBUS II Parallel System Bus (iPSB bus) and the iLBX II (Local Bus Extension).

In addition to the 32-bit memory transfer, the iSBC MEM/3XX high-speed cache control subsystem, standard on these boards, improves performance by allowing zero wait state read access over the iLBX II when data requested is in the cache memory.



280071-1

October 1986
Order Number: 280071-002

FUNCTIONAL DESCRIPTION

General

The iSBC MEM/312, 310, 320, 340 high-speed cache-based memory boards are physically and electrically compatible with the MULTIBUS II iPSB bus standard and the new iLBX II bus (Local Bus Extension) as outlined in the Intel MULTIBUS II specification. Figure 1 illustrates a typical multiprocessing MULTIBUS II system configuraton.

Architecture

The four main subsystems of the iSBC MEM/3XX boards are the cache controller subsystem, the cache memory subsystem, the DRAM memory subsystem, and the interconnect space subsystem (see Figure 2). The following sections describe these subsystems and their capabilities in more detail.

Cache Memory Capabilities

The cache memory system is designed around the 32-bit architecture of the main memory system and reduces read access timers. The 8K Bytes of 45 nsec SRAM allows zero wait state read accesses over the iLBX II bus when data requested is in the cache memory (cache hit). A cache hit takes only two iLBX II bus clocks (250 nsec at 8 MHz).

Each entry in the 8K Byte cache memory subsystem consists of a data field of 32-bits and a tag field of up to 9-bits (depending on board DRAM size). Each byte in the main memory DRAM array directly maps to one and only one entry on the cache array. This direct mapped cache array along with tag labels ensure data integrity and accurate identification of cache hits. The cache memory size and simple but effective replacement algorithm is designed to optimize both the probability of cache hits and the CPU bus utilization. On any miss or write access, the contents of one cache entry are updated to maintain consistency with the corresponding entry in the DRAM memory array.

Dual Port DRAM Capabilities

The iSBC MEM/312 module contains ½M Byte of read/write memory using 64K dynamic RAM compo-

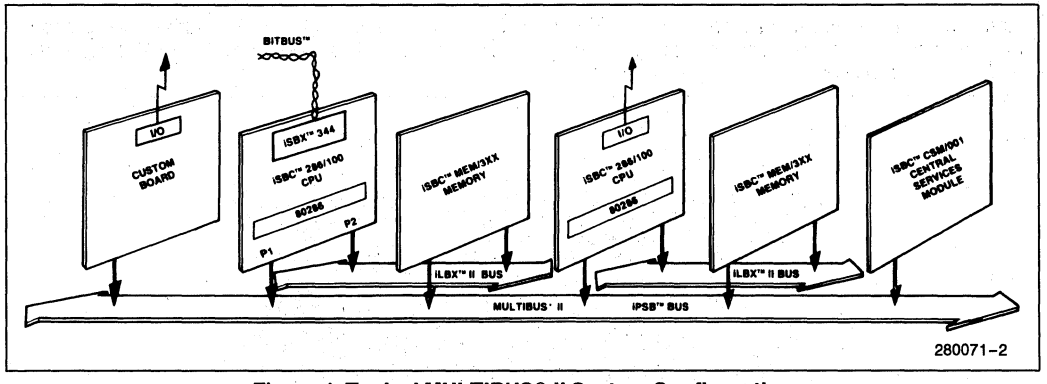


Figure 1. Typical MULTIBUS® II System Configuration

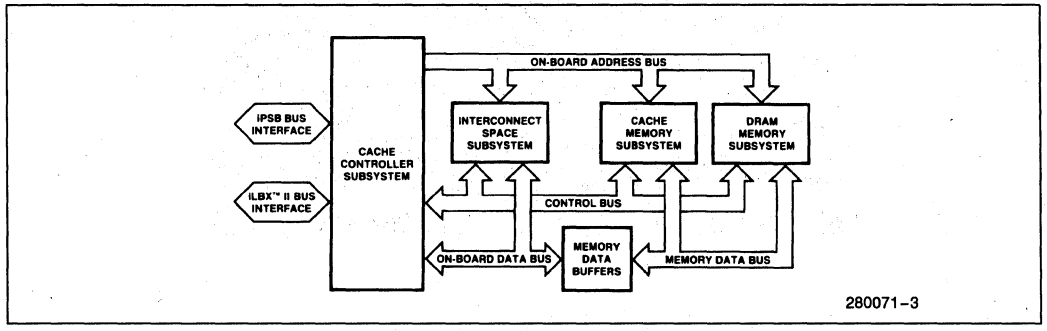


Figure 2. iSBC® MEM/3XX Board Block Diagram

nents. The iSBC MEM/310, MEM/320 and MEM/340 modules respectively contain 1M Byte, 2M Bytes and 4M Bytes of read/write memory using 256K dynamic RAM components.

The dual port capability of the iSBC MEM/3XX boards allows 32-bit access from either the iPSB bus interface or the iLBX II bus interface (see Figure 1). Due to the simple arbitration nature of the iLBX II bus interface and the cache memory subsystem, the iSBC MEM/3XX family allows optimal access to 20M Bytes of DRAM on the iLBX II bus.

System Memory Size

Using this series of memory boards the maximum system memory capacity based on one CPU board and 19 memory boards is 76M Bytes on the iPSB bus. The memory partitioning is independent for the iPSB bus interface and the iLBX II bus interface.

The start address can be on any 64K Byte boundary on the iPSB bus and any 64K Byte boundary on the iLBX II bus. Software configures the start and ending addresses through the interconnect space. No jumpers are needed.

Interconnect Space Capabilities

The iSBC MEM/3XX board module has a set of interconnect registers which allow the system software to dynamically configure and test the status of the memory board, replacing hardwired jumper functions. This interconnect subsystem also provides control and access to the Built-In-Self-Test (BIST) features. During power-up reset, the iSBC MEM/3XX board initializes the memory and cache, sets all interconnect registers to their default values and performs a self-test. Error information from both Built-In-Self-Test (BIST) and parity checking is indicated in front panel LEDs and recorded in interconnect space registers accessible to software.

Built-In-Self-Test (BIST)

Self-test/diagnostics have been built into the heart of the MULTIBUS II system. These confidence tests and diagnostics improve reliability and reduce manufacturing and maintenance costs. LED 1 (labelled BIST) is used to indicate the status of the Built-In Self Test. It is turned on when the BIST starts running and is turned off when the BIST completes successfully. The Built-In-Self-Test performed by the on-board microcontroller at power-up or at software command are:

1. **EPROM Checksum:**

   This test performs a checksum test on its internal EPROM to check operation of the 8751 microcontroller.

2. **Cache Data Test:**

   The microcontroller performs a sliding ones test on the cache memory in hit-only mode.

3. **Cache Address Test:**

   This test verifies that the cache address path is working properly.

4. **Refresh Check:**

   This test performs RAM test on a small portion of DRAM with an elapsed time between the write operation and the verification of the data.

5. **Dynamic RAM Address Test:**

   This test performs Address Rippled RAM test on the board memory (MISS ONLY operation mode).

6. **Dynamic RAM Data Test:**

   This test runs an AA-55 data pattern to check the DRAM data path.

7. **Parity Test:**

   This test injects parity errors in the DRAM array and then verifies that the board detects these errors.

These tests are described in detail in the User's Manual, Section 9-23.

Memory Initialization and Reset

Memory is initialized automatically during power-up. All bytes are set to 00.

Error Detection Using Byte Parity

Parity will detect all single bit parity errors on a byte parity basis and many muiltiple bit errors. LED 2 (labelled Parity) is used to indicate parity errors. LED 2 is turned on when a parity error is detected and turned off when the parity status register within interconnect space is cleared. This same LED turns on and off during power-up to verify operatoin of the LED.

Error information is recorded in interconnect space so it is accessible to software for error reporting.

SPECIFICATIONS

Word Size Supported

8-, 16-, 24-, and 32-bits

Memory Size

½ Megabyte (iSBC MEM/312) board
1 Megabyte (iSBC MEM/310) board
2 Megabytes (iSBC MEM/320) board
4 Megabytes (iSBC MEM/340) board

Access Times (All Densities)

MULTIBUS II Parallel System Bus—iPSB (@ 10 MHz)

Read: 562 ns (avg.)
775 ns (max.)

Write: 662 ns (avg.)
775 ns (max.)

NOTE:
Average access times assume 80% cache hit rates

iLBX™ II Bus—Local Bus Extension

Read: 250 ns (min.)
275 ns (avg.)
375 ns (max.)

Write: 375 ns (avg.)
375 ns (max.)

Base Address

iPSB Bus—any 64K Bytes boundary
iLBX II Bus—any 64K Bytes boundary

Power Requirements

Voltage: 5V DC ±5%

Product	Current
iSBC MEM/312 Board	3.5 A (typ) 6.0 A (max)
iSBC MEM/310 Board	3.5 A (typ) 6.0 A (max)
iSBC MEM/320 Board	3.5 A (typ) 6.0 A (max)
iSBC MEM/340 Board	4.1 A (typ) 6.7 A (max)

ENVIRONMENTAL REQUIREMENTS

Temperature: (inlet air) at 200 LFM airflow over boards
Non-Operating: −40 to +70°C
Operating: 0 to +55°C

Humidity: Non-operating: 95% RH @ 55°C
Operating: 90% RH @ 55°C

Physical Dimensions

The iSBC MEM/3XX boards meet all MULTIBUS II mechanical specifications as presented in the MULTIBUS II specification (#146077).

Double High Eurocard Form Factor:

Depth: 220 mm (8.6 in.)
Height: 233 mm (9.2 in.)
Front Panel Width: 20 mm (0.784 in.)

Weight:

iSBC MEM/312 board: 6720 gm (24 oz.)
iSBC MEM/310 board: 6160 gm (22 oz.)
iSBC MEM/320 board: 6720 gm (24 oz.)
iSBC MEM/340 board: 10080 gm (36 oz.)

Reference Manuals

iSBC MEM/3XX Board Manual (#146707-001)

Intel MULTIBUS II Bus Architecture Specification (#146077)

Manuals may be ordered from any Intel Sales Representative, Distributor Office, or from the Intel Literature Department. 3065 Bowers Ave., Santa Clara, CA 95051.

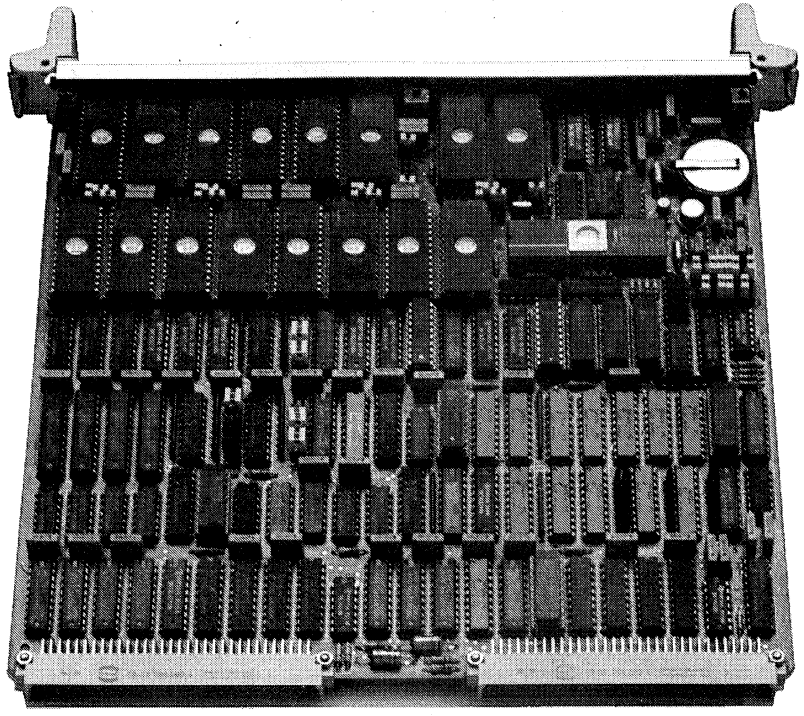
Ordering Information

Part Number	Description
iSBC MEM/312	½M Byte Cache Based MULTIBUS II RAM Board
iSBC MEM/310	1M Byte Cache Based MULTIBUS II RAM Board
iSBC MEM/320	2M Byte Cache Based MULTIBUS II RAM Board
iSBC MEM/340	4M Byte Cache Based MULTIBUS II RAM Board

iSBC® MEM/601 MULTIBUS® II UNIVERSAL SITE MEMORY EXPANSION BOARD

- **Supports EPROM, ROM, EEPROM, SRAM, and NVRAM**
- **Sixteen Sites Configured as Two Banks of Eight 28-Pin JEDEC Sockets**
- **Start Addresses for Each Bank Independently Assignable Anywhere on 64K Byte Boundaries Within the 4G Byte iPSB Memory Address Space**
- **Automatic Memory Initialization at Power-Up**
- **Optional On-Board Support for Lithium Battery Backup Memory Protect**
- **MULTIBUS® II Software Interconnect Support for Dynamic Memory Configuration and Diagnostics**
- **Fully Supports Either MULTIBUS II 32-Bit Parallel System Bus (iPSB) or 32-Bit Local Bus Extension (iLBX™ II) Bus**

The iSBC MEM/601 MULTIBUS II Universal Site Memory Board is a member of Intel's line of product offerings that utilize the advanced features of the MULTIBUS II system architecture. The iSBC MULTIBUS II Universal Site Memory Board expands system memory capacity and interfaces across either the MULTIBUS II Parallel System Bus (iPSB) or the high speed Local Bus Extension bus (iLBX II).



280261-1

October 1986
Order Number: 280261-001

FUNCTIONAL DESCRIPTION

General

The iSBC MEM/601 board contains two banks of eight standard 28-pin 600 mil DIP sockets. Either 28- or 24-pin devices may be inserted on the board. The actual capacity of the board is determined by the type and quantity of components installed by the user. The iSBC MEM/601 board is completely compatible with four different types and densities of devices (see Table 1). In addition, the board can be accessed by either the MULTIBUS II Parallel System Bus (iPSB) or Local Extension Bus (iLBX II).

Memory Array

The sixteen universal memory sites on the iSBC MEM/601 board are partitioned into two banks of 8 sites each. Within each bank the 8 sites are further partitioned into 2 groups of 4 sites each (see Figure 1). Each group of 4 sites can support the device types described in Table 1 and is configurable via an arrangement of push-in jumpers dedicated to each of the four groupings of 4 sites. Devices of the same density and speed must reside within each bank and devices of the same type must reside within each group.

Memory Address Decoding

The memory array is divided into two separate addressable banks. The addressing for each bank is independently software-configurable through MULTIBUS II interconnect space and is on 64K byte boundaries. Software must insure that the address space of one bank does not overlap the address space of the other bank otherwise memory errors would result.

Built-In-Self-Test and Interconnect Subsystem

Self test and diagnostics have been built into the heart of the MULTIBUS II system. These confidence

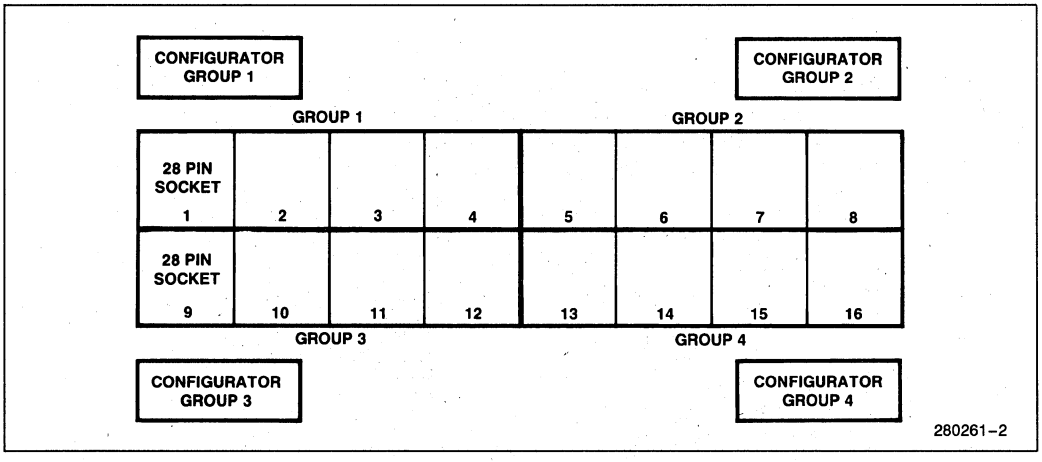


Figure 1. iSBC® MEM/601 Sixteen, 28-Pin Universal Site Memory Array

Table 1. Memory Devices Supported by the iSBC® MEM/601 Board

Type	2K x 8	4K x 8	8K x 8	16K x 8	32K x 8	64K x 8	
EPROM	2716	2732A	2764	27128	27256	27512	
ROM	Yes	Yes	Yes	Yes	Yes	Yes	
EEPROM	2817A	Yes	2864A	Yes	Yes	Yes	+5V Only
SRAM	TC 5516	Yes	TC 5565	Yes	TC 55257	Yes	NMOS and CMOS
Maximum Memory Capacity	32 KB	64 KB	128 KB	256 KB	512 KB	1 MB	

tests and diagnostics improve reliability and reduce manufacturing and maintenance costs. LED 1 (labelled BIST), is used to indicate the status of the built in self test. It is turned on when the BISTs start running and is turned off when the BISTs have successfully executed. Error information from the BISTs is recorded in the interconnect registers accessible to software. The built in self tests are performed by the on-board microcontroller at power-up or on command.

The iSBC MEM/601 board interconnect subsystem consists of an 8751 microcontroller for Built-In-Self-Test (BIST), program storage, status, control registers, and interconnect control logic. The interconnect subsystem receives requests to interconnect space across either the iPSB bus or the iLBX II bus depending on which interface is enabled. The interconnect subsystem is used by the software to configure the hardware.

Battery Backup

The iSBC MEM/601 board supports jumper selectable on-board or off board battery backup operation for CMOS SRAMs. Memory protection for the two memory banks can be supported with +5V from an off board power source or from the optional on board lithium battery. The memory content of the CMOS RAMs is protected during power-up and power-down by the protect signals from the iPSB bus.

Parallel System Bus Interface

The iPSB bus interface supports memory space and interconnect space and provides the capability of 8-, 16-, 24-, and 32-bit transfers,. The iPSB interface can be dynamically activated through the status register of the interconnect space under software control or can be jumper selectable. After a cold reset the iPSB is enabled and the Local Bus Extension (iLBX II) bus is disabled.

Local Bus Extension Interface

The iSBC MEM/601 board provides 8-, 16-, 24-, and 32-bit transfers across the Local Bus Extension (iLBX II) interface. The iLBX II bus interface is enabled by the status register of the interconnect space and can therefore be dynamically changed through software. It is also jumper selectable. After a cold reset, the iLBX II interface is disabled. The iPSB bus interface is always disabled when the iLBX II bus is enabled.

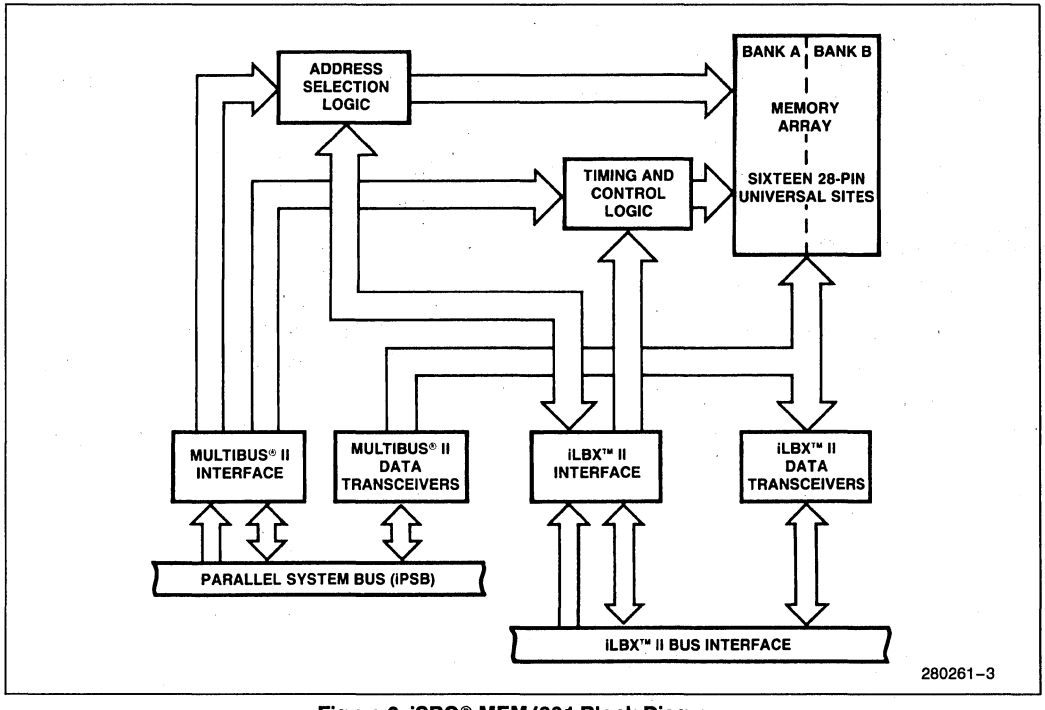


Figure 2. iSBC® MEM/601 Block Diagram

SPECIFICATIONS

Word Size 8-, 16-, 24, and 32-bits

Memory Size

Sockets are provided for up to sixteen JEDEC compatible 28-pin devices which can provide up to 1.0M Byte of EPROM/ROM/SRAM memory.

Access Times

	iPSB Bus	iLBX™ II Bus*
Read Cycle Without Replier Busy	300 ns	250 ns
Write Cycle Without Replier Busy	300 ns	250 ns
Read/Write with Agent Error	100 ns	10 ms

NOTES:
Access times are calculated without device speed included. True access times across either bus must include device access time and must be in 100 ns increments for the iPSB bus. Above calculations assume 1 bus cycle. Refer to the iSBC MEM/601 Memory Board User's Guide for exact formula to determine access times for specific operating configurations.

*Access times across the iLBX II bus assumes an 8.0 MHz bus clock. The actual formula is as follows:

T = 2(C) + D where: T is iLBXII Bus access time
C is 1/f, f = iLBX II Bus clock speed
D is Device access time

Power Requirements

Current with 2764A EPROMS installed @ +5V: 4.5A

Current with 2864A EEPROMS installed @ +5V: 5.5A

At 3V and 300 mA hours lithium battery rating, the expected retention time for standard CMOS SRAM memories will be approximately 24–36 hours.

ENVIRONMENTAL REQUIREMENTS

Temperature: Inlet air at 200 LFM airflow over boards

Non-operating: −40 to 70°C

Operating: 0 to 55°C

Humidity:

Non-operating: 95% RH @ 55°C
Operating: 90% RH @ 55°C

Physical Dimensions

The iSBC MEM/601 board meets all MULTIBUS II mechanical specifications as presented in the MULTIBUS II specification (#146077).

Double High Eurocard Form Factor

Depth: 220 mm (8.6 in.)
Height: 233 mm (9.2 in.)
Front Panel Width: 20 mm (0.784 in.)
Weight as shipped from factory: 543g (19 oz.)

Reference Manuals

#149149—iSBC MEM/601 Memory Board User's Guide

#146077—Intel MULTIBUS II Bus Architecture Specification

Manuals may be ordered from any Intel Sales Representative, Distributor Office, or from the Intel Literature Department, 3065 Bowers Ave., Santa Clara, CA., 95051.

Ordering Information

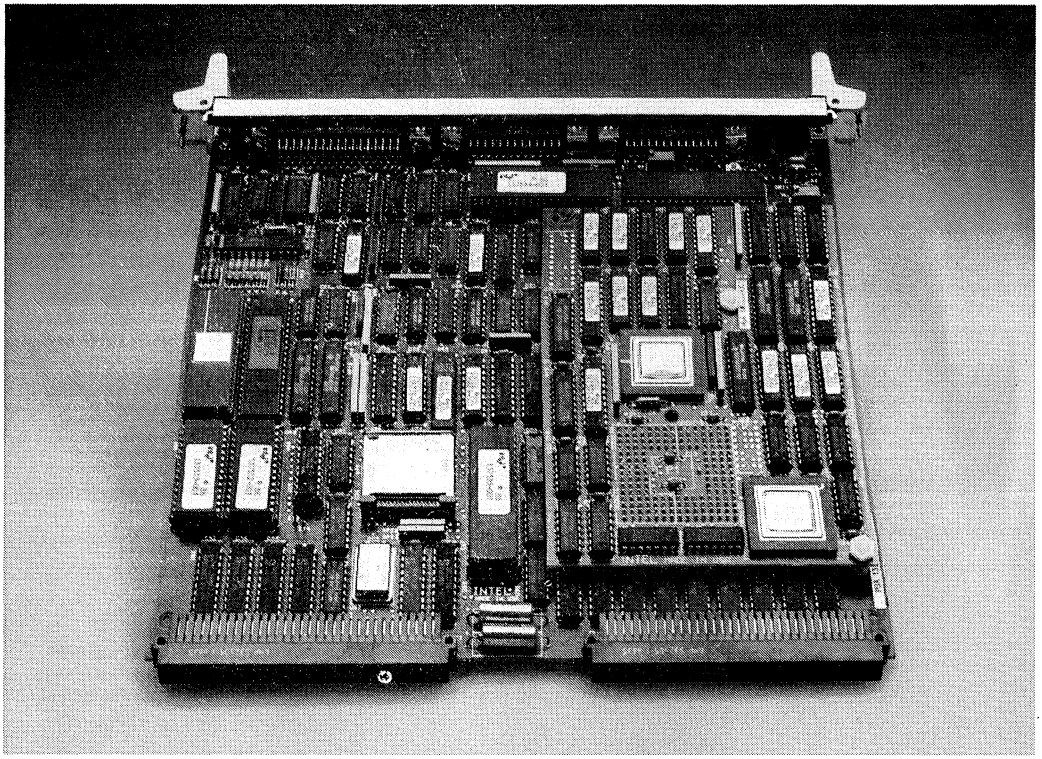
Part Number	Description
SBCMEM601	MULTIBUS II Universal Site Memory Expansion Board

Peripheral Controllers 8

iSBC® 186/224A MULTIBUS® II MULTI-PERIPHERAL CONTROLLER SUBSYSTEM

- **Complete I/O Subsystem for Mass Storage Devices**
- **Based on the 80186 Microprocessor**
- **On-Board Firmware Provides Concurrency of Operation**
- **Controls up to Four ST506/412 Winchester Disk Drives, up to Four SA450/460 Floppy Drives, and up to Four QIC-02 Streaming Tape Drives**
- **128K Bytes of On-Board DRAM Allows Multiple Track Caching for High Speed Winchester Data Access**
- **MPC (Message Passing Coprocessor) Single Chip Interface to the Parallel System Bus With Full Message Passing**
- **Software Configurability: Geographic Addressing**
- **Built-In-Self-Test (BIST) Diagnostics On-Board**

The iSBC 186/224A Multi-Peripheral Controller Subsystem supports the full Message Passing protocol of the MULTIBUS II System Architecture and provides peripheral I/O control for a wide variety of OEM applications. The iSBC 186/224A controller serves as a complete peripheral I/O subsystem and supports the predominant types of storage media: Winchester disks, floppy disks, and quarter-inch streaming tapes. On-board firmware for the board provides improved Winchester disk operation through multiple data track caching. This subsystem capability is provided on a single 8.7 x 9.2 inch double-high Eurocard form factor printed circuit board.



280713-1

February 1987
Order Number: 280713-002

ARCHITECTURE

Dual-Bus Architecture On-Board

The iSBC 186/224A controller is designed around a dual bus structure and is supported by real-time, multitasking firmware. The dual bus structure consists of the local bus and the I/O transfer bus. This dual-bus approach offers maximum task concurrency—allowing the 80186 CPU to execute code and/or manipulate data during data transfers to and from the various storage media.

The iSBC 186/224A controller uses the MULTIBUS II Parallel System Bus (iPSB) to transfer commands and data to requesting or sending agents and can send and receive both solicited and unsolicited messages as specified in the MULTIBUS II Bus Architecture Specification Handbook. (See Figure 1 for functional block diagram of the 186/224A board).

The local bus consists of the 80186 microprocessor, the EPROM MPC (for access to the iPSB), and interrupt control. The 80186 component controls the local bus and manages the interface between the iPSB and the controller. DMA channels internal to the 80186 are used for data transfers between on-board memory and the MPC.

The I/O Transfer bus supports data transfers between the iSBC 186/224A controller and the various peripheral devices. The Winchester, floppy, and tape interfaces reside on the I/O Transfer bus as do the DMA controller, track cache DRAM, and local bus arbitration logic.

The 8237A-5 DMA controller directly controls four independent DMA channels and provides the capability for performing time-multiplexed, concurrent data transfer operations between the respective device interfaces and the local DRAM.

A total of 128K bytes of zero wait state DRAM is provided on-board. This DRAM is local to the I/O Transfer bus. It is accessible to both the CPU and the DMA controller. It supports the 80186 stack and interrupt vectors and 64K bytes of Winchester track cache. The DRAM is configured for 16-bit (word) access but also supports byte-swapping.

This dual-bus architecture combined with the real-time control firmware and PCI command protocol allows the concurrent transfer of data between multiple storage devices and the controller and between the controller and the MULTIBUS II Parallel System Bus resulting in improved system level performance.

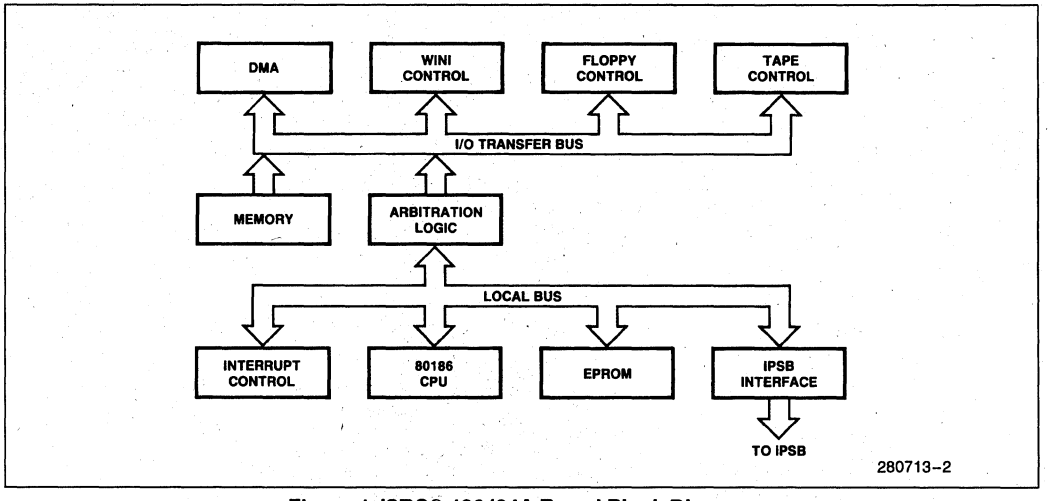


Figure 1. iSBC® 186/24A Board Block Diagram

Interconnect Space Subsystem

MULTIBUS II Interconnect Space is a standardized set of software configurable registers designed to hold and control board configuration information as well as system and board level diagnostics and testing information. Interconnect space is implemented with the 8751 microcontroller and the MPC bus interface silicon.

The read-only registers store information such as, board type, vendor I.D., firmware revision level, etc. The software configurable registers are used for controller options, identifying certain device characteristics, and diagnostics.

Built-In-Self-Test Diagnostics

On-board built-in-self-test (BIST) diagnostics provides confidence testing of the various functional areas of the iSBC 186/224A controller board. The initialization checks are performed by the 8751 microcontroller, while the BIST package is executed by the 80186 microprocessor.

BIST provides valuable testing and error reporting and recovery capability on MULTIBUS II boards, enabling the OEM to reduce manufacturing and maintenance costs. An LED on the board's front panel indicates the status of power-up diagnostics.

PCI Peripheral Communications Interface

PCI is a logical message-based peripheral controller interface to provide a standard software interface on peripheral I/O boards. This protocol provides a vehicle to issue multiple commands or statuses concurrently. This allows the 186/224A board to accept multiple commands and queue them in on-board memory.

BACKPLANE BUS INTERFACES

P1 Connector: This is used as the standard MULTIBUS II 32-bit parallel system bus. It contains all signals required to implement the full standard interface.

P2 Connector: The P2 connector is not electrically connected internally on the board.

Winchester Connections: One 50-pin D-type, right angle female, high density connector which provides all of the required signals for up top four Winchester disk drives.

Flexible Disk Connections: One 25-pin D-type connection which provides all of the required signals for up to four daisy-chained flexible disk drives.

QIC-02 Streaming Tape Connections: One 25 pin D-type connection which provides the required signals for up to four daisy-chained tape drives.

I/O Connectors: The I/O connections for each interface are on the front panel. In order to provide a reliable connection to the peripheral devices, additional ground lines are included at the connector.

SPECIFICATIONS

CPU: 5 MHz 80186 synchronized to 5 MHz 8237A-5 DMA controller

Memory: 128K bytes DRAM on-board for buffers and track cache

2 PROM sites contain Built-in-Self-Test (BIST) and PCI firmware

Mass Storage Device Compatibility

Winchester—Any ST506/412 compatible 5¼" drive.
Manufacturers include: Quantum, CMI, CDC, Maxtor, Memorex, Atasi.
Densities range from 10 MB to 140 MB.

Floppy—Any SA450/460 compatible 5¼" drive.
Manufacturers include: Teac, Shugart.
Sizes include half height, full height, 48TPI, 96TPI.

Tape—Any QIC-02 compatible, ¼" streaming tape drive.
Manufacturers include: Archive, Cipher, Tandberg.

Physical Dimensions

The iSBC 186/224A board meets all the mechanical specifications as presented in the MULTIBUS II specification (order #146077 rev. C).

DOUBLE-EUROCARD FORM FACTOR

Depth: 220 mm (8.6 in)

Height: 233 mm (9.2 in)

Front Panel Width: 20 mm (0.784 in.)

CONNECTORS

Interface	Connector	Part No.
iPSB bus (P1)	96 Pin DIN, Right Angle Female	603-2-IEC-C096-F
P2	96 Pin DIN, Right Angle Female, Not Connected Internally	603-2-IEC-C096-F
ST506/412 (Winchester)	50 Pin D Type, Right Angle Female, High Density (See Note)	
SA450/460 (Floppy)	25 Pin D-Type, Right Angle Female, (See Note)	
QIC-02 (Tape)	25 Pin D-Type, Right Angle Female, (See Note)	

NOTE:
The manufacturers below provide connectors which will plug into the connectors supplied on the iSBC 186/224A board front-panel.

Connector Type	Manufacturer	Pins	Part No.
Flat Ribbon Crimped	T&B Ansley	50	609-50P
	T&B Ansley	25	609-25P
Bulk Cable Solder Cup	Amlan	50	CDS50L
	Amlan	25	CDS25L
	ITT Cannon	50	DD-50P
	ITT Cannon	25	DB-25P
Pin Crimp	AMP	50	206438-1
	AMP	25	205436-1
	ITT Cannon	50	DDC-50P
	ITT Cannon	25	DBC-25P

Reference Manuals

iSBC 186/224A Board Hardware Reference Manual (order number 138272-001)

Intel MULTIBUS II Bus Architecture Specification (order number 146077)

Manual may be ordered from any Sales Representative, Distribution Office, or from the Intel Literature Department, 3065 Bowers Ave., Santa Clara, CA 95051.

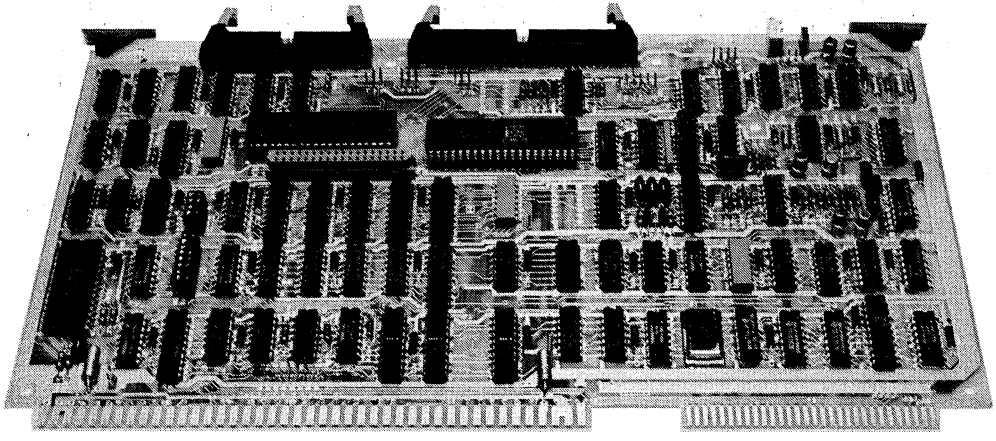
ORDERING INFORMATION

Part Number	Description
iSBC 186/224A	Multiperipheral Controller Subsystem

iSBC® 208
FLEXIBLE DISKETTE CONTROLLER

- **Compatible with All iSBC® 80, iSBC 86, and iSBC 88 Single Board Computers**
- **Controls Most Single and Double Density Diskette Drives**
- **On-Board iSBX™ Bus for Additional Functions**
- **User-Programmable Drive Parameters allow Wide Choice of Drives**
- **Phase Lock Loop Data Separator Assures Maximum Data Integrity**
- **Read and Write on Single or Multiple Sectors**
- **Single +5V Supply**
- **Capable of Addressing 16M Bytes of System Memory**

The Intel iSBC 208 Flexible Disk Controller is a diskette controller capable of supporting virtually any soft-sectored, double density or single density diskette drive. The standard controller can control up to four drives with up to eight surfaces. In addition to the standard IBM 3740 formats and IBM System 34 formats, the controller supports sector lengths of up to 8192 bytes. The iSBC 208 board's wide range of drive compatiblity is achieved without compromising performance. The operating characteristics are specified under user program control. The controller can read, write, verify, and search either single or multiple sectors. Additional capability such as parallel or serial I/O or special math functions can be placed on the iSBC 208 board by utilizing the iSBX bus connection.



280228-1

September 1986
Order Number: 280228-001

FUNCTIONAL DESCRIPTION

Intel's 8272 Floppy Disk Controller (FDC) circuit is the heart of the iSBC 208 Controlller. On-board data separation logic performs standard MFM (double density) and FM (single density) encoding and decoding, eliminating the need for external separation circuitry at the drive. Data transfers between the controller and memory are managed by a DMA device which completely controls transfers over the MULTIBUS® system bus. A block diagram of the iSBC 208 Controller is shown in Figure 1.

Universal Drives and the iSBC® 208 Controller

Because the iSBC 208 Controller has universal drive compatibility, it can be used to control virtually any standard- or mini-sized diskette drive. Moreover, the iSBC 208 Controller fully supports the iSBX bus and can be used with any iSBX module compatible with this bus. Because the iSBC 208 Controller is programmable, its performance is not compromised by its universal drive compatibility. The track-to-track access, head-load, and head-unload characteristics of the selected drive model are program specified. Data may be organized in sectors up to 8192 bytes in length.

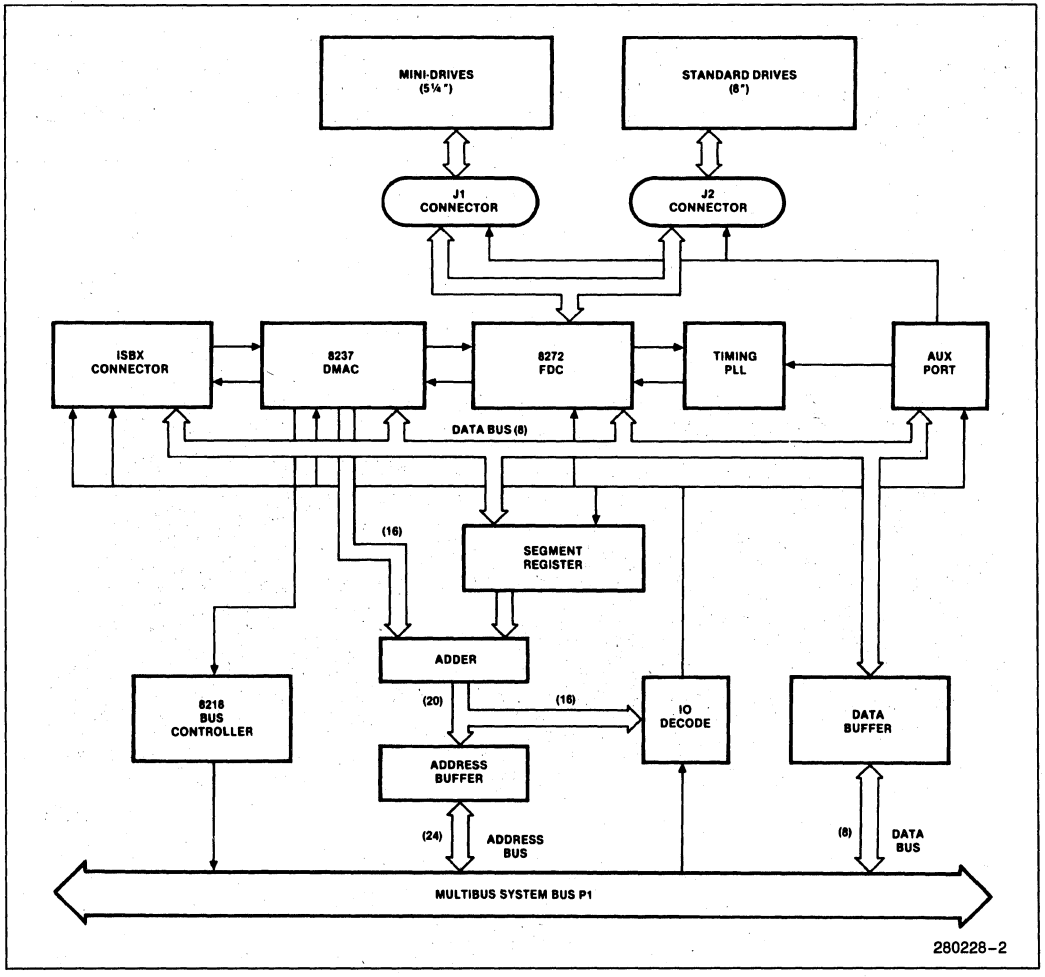


Figure 1. iSBC® 208 Flexible Disk Controller Block Diagram

Interface Characteristics

The standard iSBC 208 Controller includes an Intel 8272 Floppy Disk Controller chip which supports up to four drives, single or double sided.

SIMPLIFIED INTERFACE—The cables between the iSBC 208 Controller and the drive(s) may be low cost, flat ribbon cable with mass termination connectors. The mechanical interface to the board is a right-angle header with locking tabs for security of connection.

PROGRAMMING—The powerful 8272 FDC circuit is capable of executing high-level commands that simplify system software development. The device can read and write both single and multiple sectors. CRC characters are generated and checked automatically. Recording density is selected at each Read and Write to support the industry standard technique of recording basic media information on Track 0 of Side 0 in single density, and then switching to double density (if, necessary) for operations on other tracks.

Program Initiation—All diskette operations are initiated by standard input/output (I/O) port operations through an iSBC single board computer.

System software first initializes the controller with the operating characteristics of the selected drive. The diskette is then formatted under program control. For subsequent transfers, the starting memory address and transfer mode are specified for the DMA controller. Data transfers occur in response to commands output by the CPU.

Data Transfer—Once a diskette transfer operation has been initiated, the controller acts as a bus master and transfers data over the MULTIBUS at high speed. No CPU intervention is required until the transfer is complete as indicated either by the generation of an interrupt on the bus or by examination of a "done" bit by the CPU.

iSBX BUS SUPPORT—One connector is available on the iSBC 208 board which supports the iSBX system bus. This connector supports single-byte transfer as well as higher-speed transfers supervised by the DMA controller. Transfers may take place in polled or interrupt modes, user-selected. The presence of the iSBX bus allows many different functions to be added to the board. Serial I/O, parallel I/O and various special-purpose math functions are only a few of the capabilities available on iSBX MULTIMODULE boards.

SPECIFICATIONS

Compatibility

CPU — Any iSBC MULTIBUS computer or system main frame

Devices— Double or single density standard (8") and mini (5¼") flexible disk drives. The drives may be single or double sided. Drives known to be compatible are:

Standard (8")		Mini (5¼")	
Caldisk	143M	Shugart	450 SA 400
Remex	RFD 4000	Micropolis	1015-IV
Memorex	550	Pertec	250
MFE	700	Siemens	200-5
Siemens	FDD 200-8	Tandon	TM-100
Shugart	SA 850/800	CDC	9409
Pertec	FD 650	MPI	51/52/91/92
CDC	9406-3		

Diskette— Unformatted IBM Diskette 1 (or equivalent single-sided media); unformatted IBM Diskette 2D (or equivalent double-sided)

Equipment Supplied

iSBC 208 Controller
Reference Schematic
Controller-to-drive cabling and connectors are not supplied with the controller. Cables can be fabricated with flat cable and commercially-available connectors as described in the iSBC 208 Hardware Reference Manual

Physical Characteristics

Width: 6.75 inches (17.15 cm)
Height: 0.5 inches (1.27 cm)
Length: 12.0 inches (30.48 cm)
Shipping Weight: 1.75 pounds (0.80 Kg)
Mounting: Occupies one slot of iSBC system chassis or iSBC 604/614 Cardcage/Backplane. With an iSBX MULTIMODULE board mounted, vertical height increases to 1.13 inches (2.87 cm).

Electrical Characteristics

Power Requirements: +5 VDC @ 3.0A

Data Organization and Capacity

Standard Size Drives

	Double Density						Single Density					
	IBM System 34			Non-IBM			IBM System 3740			Non-IBM		
Bytes per Sector	256	512	1024	2048	4096	8192	128	256	512	1024	2048	4096
Sectors per Track	26	15	8	4	2	1	26	15	8	4	2	1
Tracks per Diskette	77			256			77			256		
Bytes per Diskette (Formatted, per diskette surface)	512,512 (256 bytes/sector) 591,360 (512 bytes/sector) 630,784 (1024 bytes/sector)			630,784			256,256 (128 byte/sector) 295,680 (256 bytes/sector) 315,392 (512 bytes/sector)			315,392		

Drive Characteristics

	Standard Size	Mini Size
	Double/Single Density	Double/Single Density
Transfer Rate (K bytes/s)	62.5/31.25	31.25/15.63
Disk Speed (RPM)	360	300
Step Rate Time (Programmable)	1 to 16 ms/track in 1 ms increments	2 to 32 ms/track in 2 ms increments
Head Load Time (Programmable)	2 to 254 ms in 2 ms increments	4 to 508 ms in 4 ms increments
Head Unload Time (Programmable)	16 to 240 ms in 16 ms increments	32 to 480 ms in 32 ms increments

Environmental Characteristics

Temperature: 0°C to 55°C (operating); −55°C to +85°C (non-operating)

Humidity: Up to 90% Relative Humidity without condensation (operating); all conditions without condensation or frost (non-operating)

Reference Manual

143078-001— iSBC 208 Flexible Disk Controller Hardware Reference Manual (NOT SUPPLIED).

Reference manuals may be ordered from any Intel sales representative, distributor office, or from Intel Literature Department, 3065 Bowers Avenue, Santa, Clara, CA 95051.

ORDERING INFORMATION

Part Number	Description
SBC 208	Flexible Disk Controller

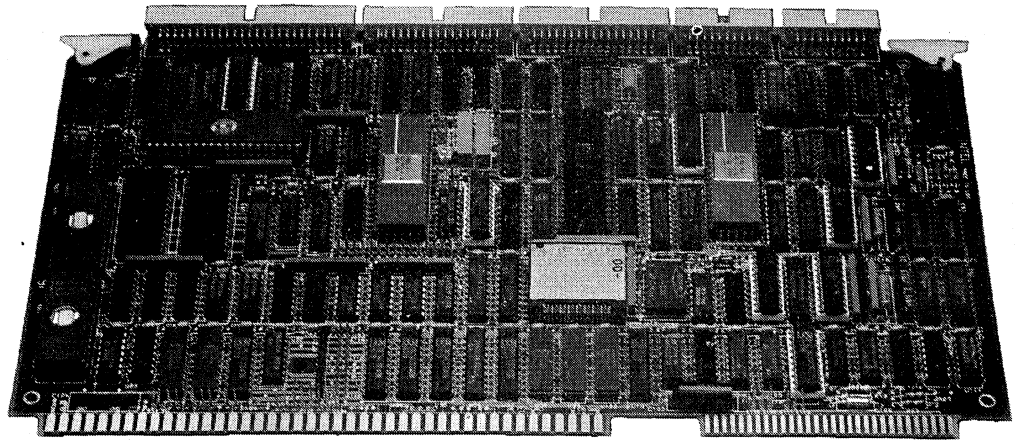
iSBC® 214
PERIPHERAL CONTROLLER SUBSYSTEM

- **Based on the 80186 Microprocessor**
- **Controls up to Two ST506/412 5¼" Winchester Disk Drives**
- **Controls up to Four Single/Double Sided and Single/Double Density 5¼" Flexible Disk Drives**
- **Controls up to Four QIC-02 Streaming Tape Drives**
- **Supports 20 or 24-Bit Addressing**
- **On-Board Diagnostics and Winchester ECC**
- **Incorporates Track Caching to Reduce Winchester Disk Access Times**
- **iRMX™ and XENIX* Operating System Support**

The iSBC 214 Subsystem is a single-board, multiple device controller that interfaces standard MULTIBUS® systems of three types of magnetic storage media. The iSBC 214 Peripheral Controller Subsystem supports the following interface standards: ST506/412 (Winchester Disk), SA 450/460 (Flexible Disk), and QIC-02 (¼" Streaming Tape).

The board combines the functionality of the iSBC 215 Generic Winchester Controller and the iSBC 213 Data Separator, the iSBX™ 218A Flexible Disk Controller, and the iSBX 217C ¼" Tape Drive Interface Module. The iSBC 214 Subsystem emulates the iSBC 215G command set, allowing users to avoid rewriting their software.

The iSBC 214 Peripheral Controller Subsystem offers a single slot solution to the interface of multiple storage devices, thereby reducing overall power requirements, increasing system reliability, and freeing up backplane slots for addtional functionality. In addition, the new iSBC 214 Subsystem can be placed in a 16 Megabyte memory space.



280089-1

*XENIX is a trademark of MICROSOFT Corp.

September 1986
Order Number: 280089-001

The iSBC 214 represents a new Peripheral Controller Subsystem architecture which is designed around a dual bus structure and supported by real-time, multitasking firmware. The 80186 controls the local bus and manages the interface between the MULTIBUS and the controller. It is responsible for high speed data transfers of up to 1.6 megabytes per second between the iSBC 214 Subsystem and host memory. The 80186 and the multitasking firmware decode the command request, allocate RAM buffer space, and dispatch the tasks.

A second bus, the I/O Transfer Bus, supports data transfers between the controller and the various peripheral devices. It is this dual bus system that allows the iSBC 214 Subsystem to provide simultaneous data transfers between the controller and the storage devices, and between the controller and the MULTIBUS. (See Figure 1).

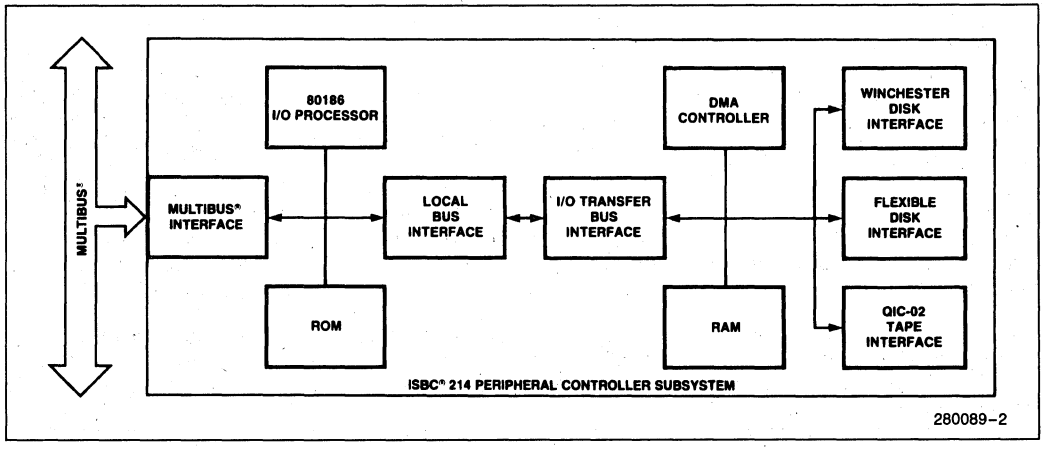


Figure 1. Block Diagram iSBC® 214 Peripheral Controller Subsystem

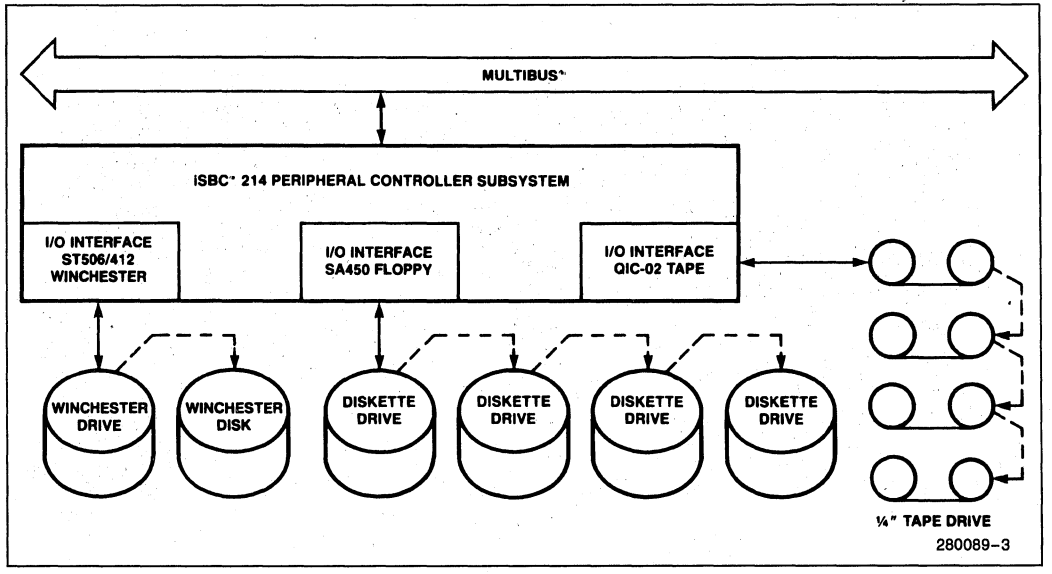


Figure 2. Fully Configured Peripheral Subsystem

The iSBC 214 Subsystem implements an intelligent track caching scheme through dynamic allocation of buffer space. This provides reduced access times to the Winchester disk and improved system performance. Operating systems with file management designed to handle sequential data can be supplied directly from the cache without incremental access to the disk.

FUNCTIONAL DESCRIPTION

Winchester Disk Interface

The iSBC 214 Subsystem provides control of one or two ST506/412 compatible Winchester devices and supports up to 16 Read/Write heads per drive. The Intel 82062 acts as the main controller taking care of FM/MFM encoding and decoding, bit stream serialization and deserialization, address mark detection and generation, sector identification comparisons, CRC error checking and format generation. The board uses a standard daisy-chained control cable and a separate data transfer cable for each device supported.

ECC

High data integrity is provided by on-board Error Checking Code logic. For burst error correction, a 32-bit code is appended to the sector data fields by the controller. During a read operation, the same logic regenerates the ECC polynomial and compares this second code to the appended ECC. The ECC logic can detect an erroneous data burst up to 32 bits in length with correction up to 11 bits.

If an ECC error is detected the controller automatically initiates a retry operation on the data transfer. If the maximum retry count is exceeded, the location of the bad data within the transfer buffer is identified and the 80186 then performs error correction on the data bytes.

Flexible Disk Interface

The Flexible Disk Controller performs all data separation, FM (single density) and MFM (double density) encoding, and CRC support. The 34-pin connector is designed to support the SA450/460 interface directly and up to four flexible disk devices may be connected to the controller.

Tape Controller Interface

The tape controller section of the iSBC 214 Subsystem is based on the 8742 Universal Peripheral Interface (UPI). It is capable of supporting up to four QIC-02 compatible streaming tape drives over a standard 50-pin daisy-chained cable.

All standard QIC-02 commands are supported. All drives must be capable of streaming at 30 or 90 inches per second.

MULTIBUS® Host Interface

The MULTIBUS connection consists of two standard printed circuit board edges that plug into MULTIBUS edge connectors on a backplane in the system bus. An active P1 connector is required and serves as the Host systems's communciation channel to the controller. An active P2 connector is optional and only required for supporting full 24-bit addressing and power fail signals.

SPECIFICATIONS

Compatibility

CPU—any iSBC MULTIBUS computer or system mainframe.

Winchester disk—Any ST506/412 compatible, 5.25″ disk drive.

Flexible disk—Any SA450/460 compatible, 5.25″ disk drive.

Tape drive—Any QIC-02 compatible, .25″ streaming tape drive.

Controller-to-drive cabling and connectors are not supplied with the controller. Cables can be fabricated with flat cable and commercially-available connectors as described in the iSBC 214 Hardware Reference Manual.

Physical Characteristics

Width: 6.75 in. (17.15 cm)
Height: 0.5 in. (1.27 cm)
Length: 12.0 in. (30.48 cm)
Shipping Weight: 19 oz. (540 g)

Ordering Information

iSBC 214 Peripheral Controller Subsystem.

Mounting: Occupies one slot or SBC system chassis or cardcage/backplane.

Electrical Characteristics

Power Requirements: +5 VDC @ 4.5A max.

Environmental Characteristics

Temperature: 10°C to 55°C with airflow of 200 linear feet per minute (operating); −55°C to +85°C (non-operating).

Humidity: Up to 90% relative humidity without condensation (operating); all conditions without condensation or frost (non-operating).

Reference Manual

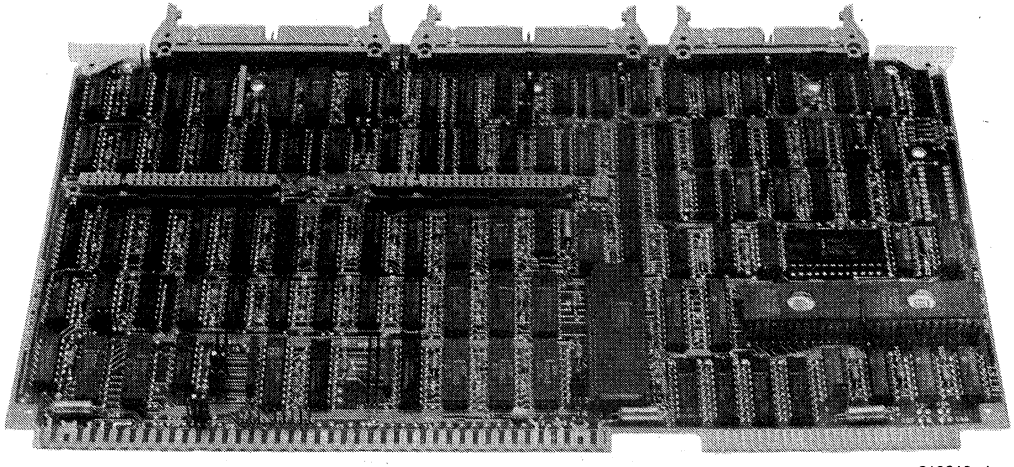
134910-001: iSBC 214 Peripheral Controller Subsystem Hardware Reference Manual (not supplied). Reference Manual may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051.

iSBC® 215
GENERIC WINCHESTER CONTROLLER

- **Controls up to Four 5¼", 8" or 14" Winchester Disk Drives from Over Ten Different Vendors**
- **Compatible with Industry Standard MULTIBUS® (IEEE 796) Interface**
- **Supports ANSI X3T9/1226 Standard Interface**
- **Software Drivers Available for iRMX™ 86, iRMX 88 and Xenix* Operating Systems**
- **Intel 8089 I/O Processor Provides Intelligent DMA Capability**
- **On-Board Diagnostics and ECC**
- **Full Sector Buffering On-Board**
- **Capable of Directly Addressing 16 MB of System Memory**
- **Removable Back-up Storage Available Through the iSBX™ 218A Flexible Disk Controller and the iSBX 217C ¼" Tape Interface Module**

Using VLSI technology, the iSBC 215 Generic Winchester Controller (GWC) combines three popular Winchester controllers onto one MULTIBUS board: the iSBC 215A open loop controller, the iSBC 215B closed loop controller, and an ANSI X3T9/1226 standard interface controller. The combined functionality of the iSBC 215 Generic Controller supports up to four 5¼", 8" or 14" Winchester drives from over 10 different drive vendors. Integrated back-up is available via two iSBX MULTIMODULE boards; the iSBX 218A module for floppy disk drives and the iSBX 217C module for ¼" tape units.

From the MULTIBUS side, the iSBC 215 GWC appears as one standard software interface, regardless of the drive type used. In short, the iSBC 215 GWC allows its user to change drive types without rewriting software. The iSBC 215 Generic Controller is totally downward compatible with its predecessors, the iSBC 215A and 215B controller; allowing existing iSBC 215A and 215B users to move quickly to the more powerful iSBC 215 Generic Winchester Controller. In addition, the iSBC 215 GWC directly addresses up to 16 megabytes of system memory.



210618-1

Xenix is a trademark of Microsoft Corp.

October 1986
Order Number: 210618-002

FUNCTIONAL DESCRIPTION

Disk Interface

The iSBC 215 Generic Winchester Controller can interface to over 10 different disk drives. To change drive types the user need only reconfigure a minimal number of board jumpers and, if required, insert the proper formatting information into the command parameter blocks.

The ANSI X3T9/1226 standard interface is a simple one-for-one flat cable connection from drive to controller.

Full On-Board Buffer

The iSBC 215 Generic controller contains enough on-board RAM for buffering one full data sector. The controller is designed to make use of this buffer in all transfers. The on-board sector buffer prevents data overrun errors and allows the iSBC 215 Generic Winchester Controller to occupy any priority slot on the MULTIBUS.

ECC

High data integrity is provided by on-board Error Checking Code (ECC) logic. When writing sector ID or data fields, a 32-bit ECC, for burst error correction, is appended to the field by the controller. During a read operation, the same logic regenerates the ECC polynomial to the appended ECC. The ECC logic can detect an erroneous data burst up to 32 bits in length and using an 8089 algorithm can correct an erroneous burst up to 11 bits in length.

iSBX™ Interface

Two iSBX bus connectors provide I/O expansion capability for the iSBC 215 GWC. With the optional addition of the iSBX 218A Flexible Disk Controller MULTIMODULE™ and or the iSBC 217C ¼" Tape Interface Module, the iSBC 215 GWC can be configured into one of four types of peripheral subsystems, see Table 1.

Table 1. Peripheral Subsystem Configurations

	iSBC® 215	iSBX™ 218A	iSBX™ 217C
Winchester Only	✓		
Winchester + Floppy	✓	✓	
Winchester + ¼" Tape	✓		✓
Winchester + Floppy + ¼" Tape	✓	✓	✓

Expanded I/O Capability

The iSBC 215 GWC controller allows the execution of user-written 8089 programs located in on-board or MULTIBUS system RAM. Thus the full capability of the 8089 I/O processor can be utilized for custom I/O requirements.

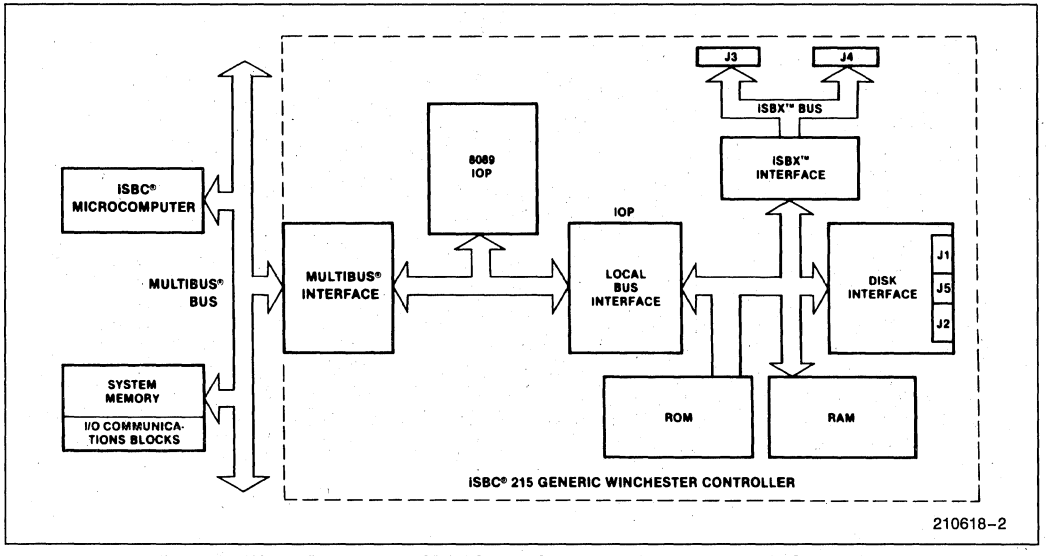
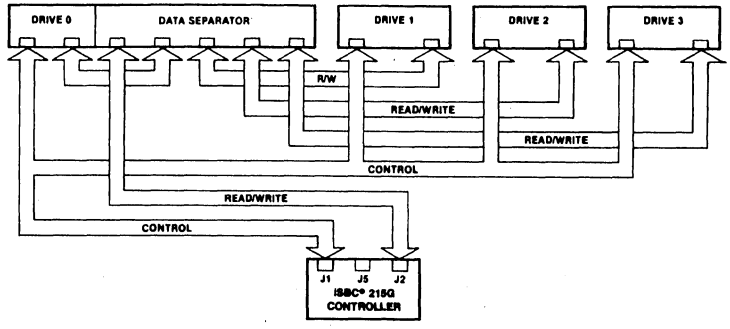


Figure 1. Block Diagram of iSBC® 215 Generic Winchester Disk Controller

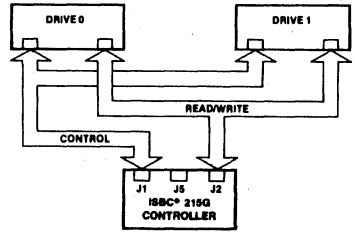
Interface with Shugart/Quantum/RMS Drives



210618-3

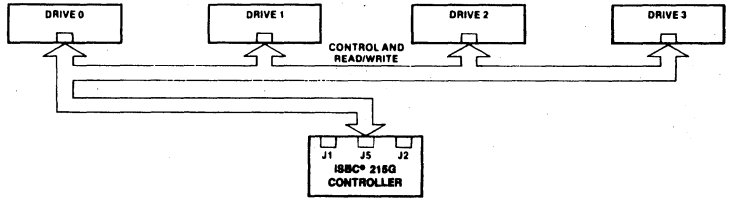
NOTE:
1. Shugart SA1000 or RMS Data Express.* *Data Express is a trademark of Rotating Memory Systems.

Interface with Memorex/Shugart Drives



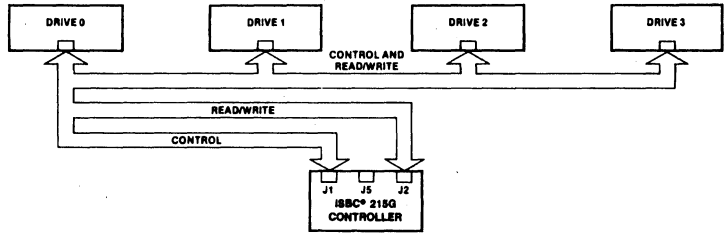
210618-4

Interface with ANSI Drive



210618-5

Interface with PRIAM Drives



210618-6

Figure 2. Controller to Drive Interfacing

MULTIBUS® Interface

The iSBC 215 Generic Controller interfaces to the system CPU(s) through MULTIBUS memory. The iSBC 215 Generic controller directly addresses 16 megabytes of system memory. Commands are passed to and from the iSBC 215 GWC via memory based parameter blocks. These parameter blocks are executed directly by the iSBC 215 GWC thus off-loading the system CPU(s). Data transfers to and from the iSBC 215 GWC are done via the high speed DMA capability of the Intel 8089 I/O processor.

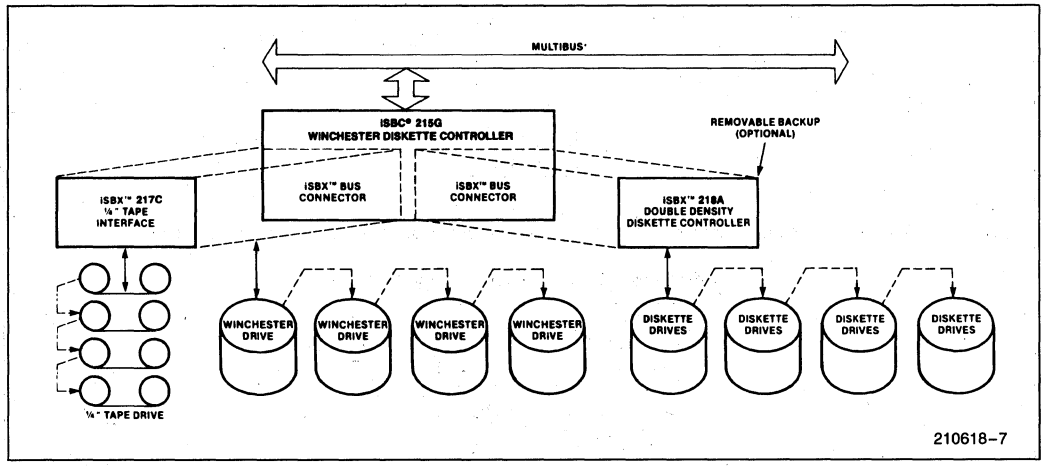


Figure 3. Subsystem Configuration (with Optional Diskette Backup)

SPECIFICATIONS

Compatibility

CPU—Any iSBC MULTIBUS computer or system mainframe.

Disk Drives—Winchester Disk Drives; both open-loop and closed-loop head positioner types. The following drives are known to be compatible:

Open-Loop
Shugart SA 1000 Series
Shugart SA 4000 Series
Memorex 100 Series
Quantum Q2000 Series
Fujitsu 2301, 2302
CDC 9410
RMS 5¼" Series
Rodine 5¼" Series
Ampex 5¼" Series
CMI 5¼" Series
Closed-Loop
Priam 8" and 14" Drive Series
ANSI
3M 8430 Series
Kennedy 6170 Series
Micropolis 8" Series
Pertec Trackstar Series
Priam 8" Series
Megavault (SLI) 8" Series
iSBX™ MULTIMODULE™ Boards
iSBX™ 218A Flexible Disk Controller
iSBX™ 217C ¼" Tape Interface

Equipment Supplied

iSBC 215 Generic Winchester Controller
Reference Schematic

Controller-to-drive cabling and connectors are not supplied with the controller. Cables can be fabricated with flat cable and commercially-available connectors as described in the iSBC 215G Hardware Reference Manual.

Physical Characteristics

Width:	6.75 in. (17.15 cm)
Height:	0.5 in. (1.27 cm)
Length:	12.0 in. (30.48 cm)
Shipping Weight:	19 oz. (0.54 kg)
Mounting:	Occupies one slot of iSBC system chassis or cardcage/backplane

With an iSBX MULTIMODULE board mounted, vertical height increases to 1.13 in. (2.87 cm).

Electrical Characteristics

Power Requirements

+5 VDC@4.52A max
−5 VDC@0.015A max[1]
+12 VDC@0.15A max[2]
−12 VDC@0.055A max[1,2]

NOTES:
1. On-board regulator and jumper allows −12 VDC usage from MULTIBUS.
2. Required for some iSBX MULTIMODULE boards.

Data Organization

Bytes/Sector	Sectors/Track(1) 128	256	512	1024
Priam 8″	72	42	23	12
Priam 14″	107	63	35	18
RMS/Shugart 8″ /Quantum/Ampes/Rodine/CM1	54	31	17	9
Fujitsu/Memorex	64	38	21	11
Shugart 14″	96	57	31	16
CDC Finch	64	41	23	12
3M (ANSI)	82	51	29	16
Megavault (ANSI)	73	43	21	12
Kennedy (ANSI)	74	43	23	12
Micropolis (ANSI)	71	44	25	13
Pertec (ANSI)	85	52	29	15

NOTE:
1. Maximum allowable for corresponding selection of bytes per sector.

Drives per Controller

5¼″ Winchester Disk Drives—Up to four RMS, CMI, Rodine or Ampex drives.

8″ Winchester Disk Drives—Up to four ANSI, Shugart, Quantum or Priam drives; up to two Memorex, CDC, or Fujitsu drives.

14″ Winchester Disk Drives—Up to four Priam drivers; up to two Shugart drives.

Flexible Disk Drives—Up to four drives through the optional iSBX 218A Flexible Disk Controller connected to the iSBC 215 GWC board's iSBX connector.

¼″ Tape Drives—Up to four drives through the optional iSBX 217C ¼″ Tape Interface Module connected to the iSBC 215 GWC board's iSBX connector.

Environmental Characteristics

Temperature—0° to 55°C (operating); −55°C to +85°C (non-operating)

Humidity—Up to 90% relative humidity without condensation (operating); all conditions without condensation or frost (non-operating).

Reference Manual

144780—iSBC 215 Generic Winchester Controller Hardware Reference Manual (NOT SUPPLIED)

Reference manuals may be ordered from any Intel sales representative, distributor office, or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051.

ORDERING INFORMATION

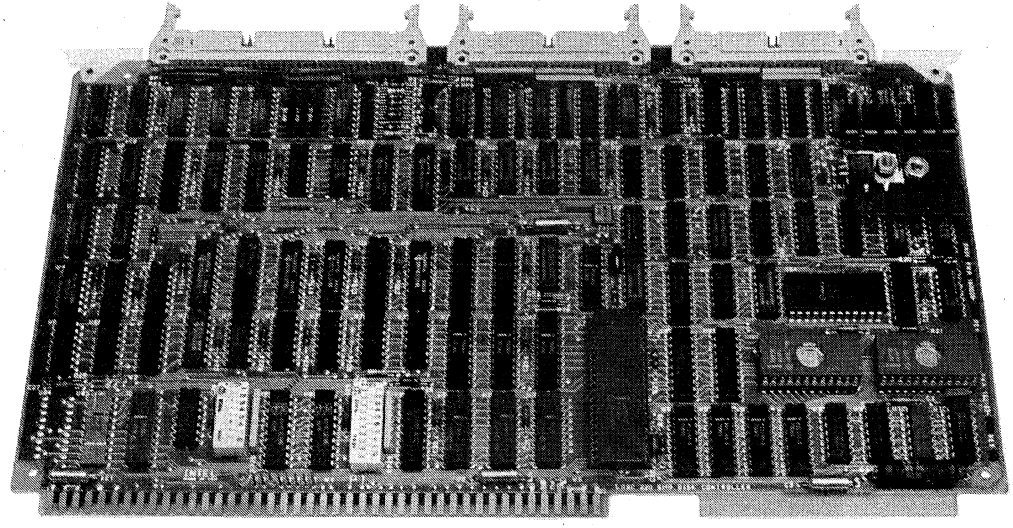
Part Number	Description
SBC 215G	Generic Winchester Controller

iSBC® 220
SMD DISK CONTROLLER

- **Controls up to Four Soft Sectored SMD Interface Compatible Disk Drives**
- **12 MB to 2.4 GB per Controller**
- **Compatible with all iSBC® 80, iSBC® 88, and iSBC® 86 Single Board Computers**
- **Intel 8089 I/O Processor Provides Two High Speed DMA Channels as well as Controller Intelligence**
- **Software Drivers Available for iRMX™ 286 and XENIX* Operating Systems**
- **On-Board Diagnostic and ECC**
- **Full Sector Buffering On-Board**
- **Capable of Addressing 1 MB of System Memory**
- **SMD Interface Available on Winchester, CMD, SMD and Large Fixed-Media Drives**

The iSBC 220 SMD Disk Controller brings very large mass storage capabilities to any iSBC 80, iSBC 88, or iSBC 86 MULTIBUS® system. The controller will interface to any soft sectored disk drive conforming to the industry standard SMD interface. Using simplified cable connections, up to four drives may be connected to the iSBC 220 Controller Board to give a total maximum capacity of 2.4 gigabytes. The Intel 8089 I/O Processor simplifies programming through the use of memory-based parameter blocks. A linked list technique allows the user to perform multiple disk operations.

*XENIX is a registered trademark of Microsoft.



143283-1

November 1986
Order Number: 143283-002

FUNCTIONAL DESCRIPTION

Full On-Board Buffer

The iSBC 220 SMD Controller contains enough on-board RAM for one full sector buffering. The controller is designed to make use of this buffer in all transfers. The on-board sector buffer prevents data overrun errors and allows the iSBC 220 SMD Controller to occupy any priority slot on the MULTIBUS.

ECC

High data integrity is provided by on-board Error Checking Code (ECC) logic. When writing sector ID or data fields, a 32-bit Fire code, for burst error correction, is appended to the field by the controller. During a Read operation, the same logic regenerates the ECC polynomial and compares this second polynomial to the appended ECC. The ECC logic can detect an erroneous data burst up to 32 bits in length and using an 8089 alrogithm can correct an erroneous burst up to 11 bits in length.

SMD Interface

High speed, reliable data transfers are a major benefit of suing the SMD interface. A data transfer rate of 1.2 MB is accomplished by using separate (radial) differential data line cabling for each drive. Control signals are daisy-chained from drive to drive.

Defective Track Handling

When a track is deemed defective, the host processor reformats the track, giving it a defective track code and enters the address of the next available alternate track. When the controller accesses a track previously marked defective, the controller automatically seeks to the assigned alternate track. The alternate track seek is totally automatic and invisible to the user.

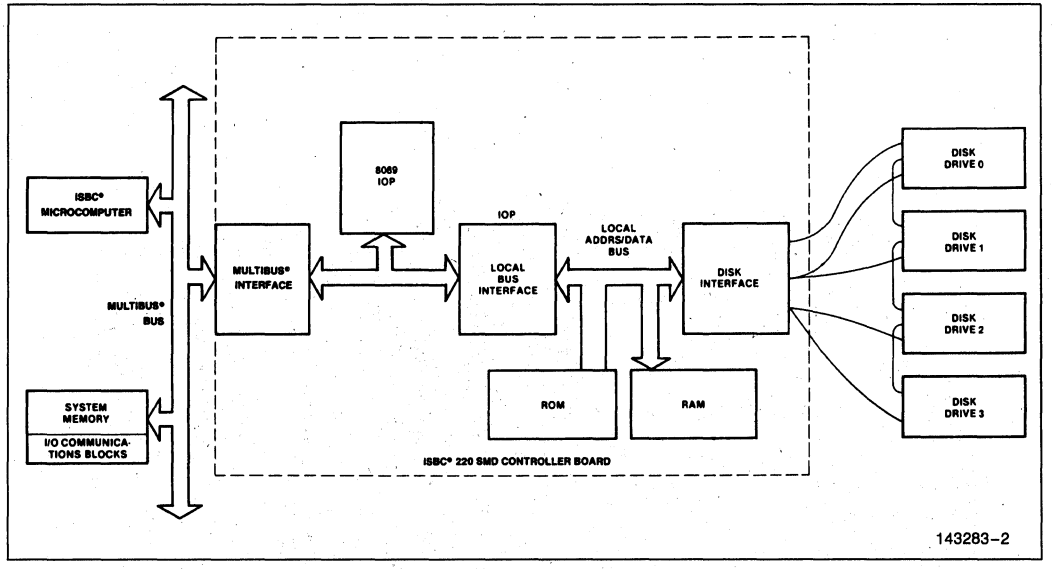


Figure 1. Simplified Block Diagram of iSBC® 220 SMD Disk Controller

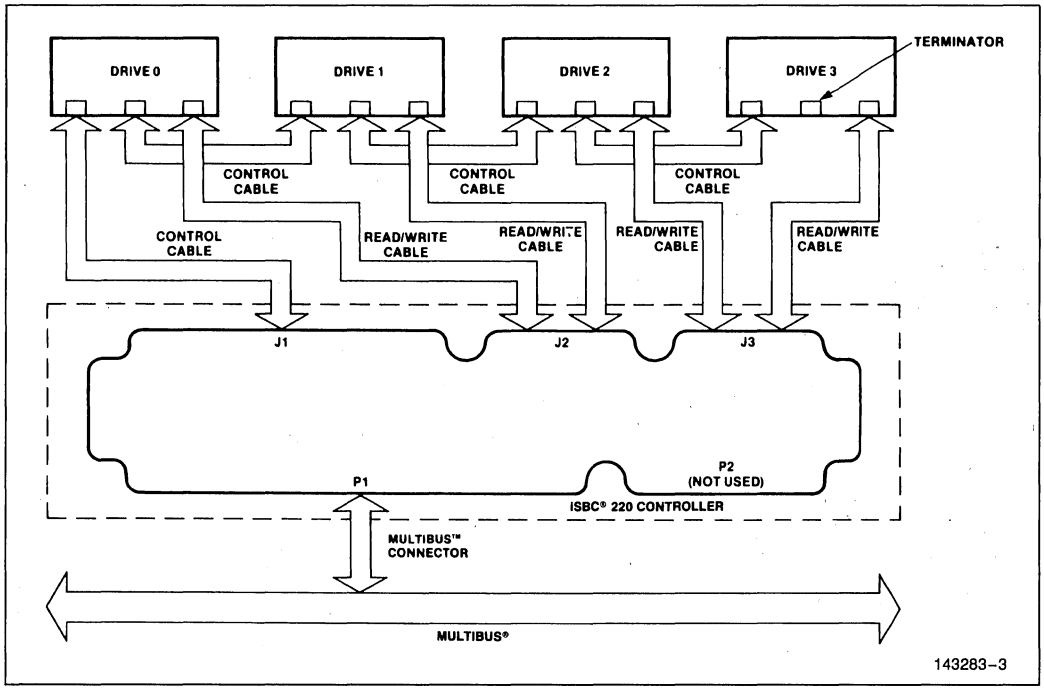


Figure 2. Typical Multiple Drive System

SPECIFICATIONS

Compatibility

CPU: Any iSBC MULTIBUS computer on system mainframe

Disk Drive: Any soft sectored SMD interface-compatible disk drive

Equipment Supplied

iSBC 220 SMD Disk Controller
Reference schematic

Controller-to-drive cabling and connectors are not supplied with the controller. Cables can be fabricated with flat cable and commercially-available connectors as described in the iSBC 220 SMD Disk Controller Hardware Reference Manual.

Physical Characteristics

Width: 6.75 in (17.15 cm)
Height: 0.5 in (1.27 cm)
Length: 12.0 in. (30.48 cm)
Shipping Weight: 19 oz. (0.54 kg)
Mounting: Occupies one slot of iSBC system chassis or cardcage/backplane

Electrical Characteristics

Power Requirements:
+5 VCD @ 3.25A max
−5 VDC @ 0.75A max(1)

NOTE:
1. On-board voltage regulator allows optional −12 VDC usage from MULTIBUS.

Data Organization and Capacity

Bytes per Sector(2): 128 256 521 1024
Sector per Track(2): 108 64 35 18

NOTE:
2. Software selectable.

Table 1. Drive Characteristics (Typical)

Disk (spindle) Speed	3600 rpm	
Tracks per Surface	823	
Head Positioning	Closed loop servo type, track following	
Access Time	Track to Track	6 ms
	Average	30 ms
	Maximum	55 ms
Data Transfer Rate	1.2 megabytes/second	
Storage Capacity	12 to 2.4 gigabytes	

Environmental Characteristics

Temperature: 0°C to 55°C (operating); −55°C to +85°C (non-operating)

Humidity: Up to 90% relative humidity without condensation (operating); all conditions without condensation or frost (non-operating)

Reference Manual

121597-001—iSBC 220 SMD Disk Controller Hardware Reference Manual (NOT SUPPLIED)

Reference manuals may be ordered from any Intel sales representative, distributor office, or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051.

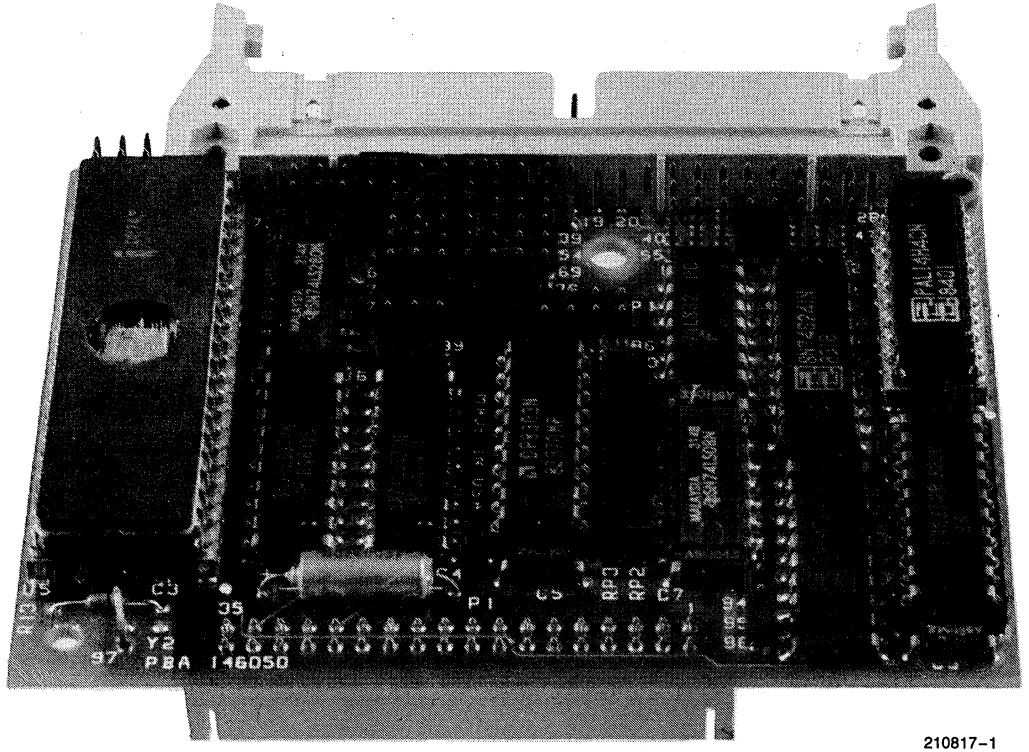
ORDERING INFORMATION

Part Number	Description
SBC 220	SMD Disk Controller

iSBX™ 217C ¼-INCH TAPE DRIVE INTERFACE MULTIMODULE™ BOARD

- **iSBX™ MULTIMODULE™ Interface Provides Tape Backup Capability for iSBC® 215 Generic Winchester Controller**
- **Configurable to Interface with up to Four QIC-02 Compatible or 3M HCD-75 Compatible Tape Drives**
- **Implements the QIC-02 with Parity Streaming Tape Interface Standard**
- **Supports Transfer Rates of 90K, 30K or 17K Bytes per Second Depending on Tape Speed**
- **Supported by iRMX™ 86 and XENIX* Operating Systems when Used on iSBC® 215 Generic Winchester Controller Board**
- **+5 Volt Only Operation**

The iSBX 217C ¼-Inch Tape Drive Interface module is a member of Intel's family of iSBX bus compatible MULTIMODULE products. iSBX MULTIMODULE boards plug directly onto any iSBX bus compatible host board, offering incremental on-board I/O expansion. The module is particularly useful for implementing cartridge tape back-up capability directly on the iSBC 215 Generic Winchester Disk Controller via DMA. The iSBX 217C board can also provide a low-cost tape storage interface for any Intel single board computer, with an iSBX connector, via programmed I/O. The iSBX 217C module interfaces with up to four streaming tape drives. Typically, these drives provide 20 to 45 megabytes of storage each. When used in conjunction with these drives and the iSBX 215 board, the module can transfer 20 megabytes of data from disk to tape in about fourteen minutes. Alternatively, the iSBX 217C board can interface with up to four 3M Company HCD-75 compatible start/stop tape drives, for those applications requiring access to individual data files on tape.



210817-1

*XENIX™ is a trademark of Microsoft Corporation.

October 1986
Order Number: 210817-002

FUNCTIONAL DESCRIPTION

The iSBX 217C module implements an interface between a host iSBC board and a cartridge ¼-inch magnetic tape drive, with a minimum of host software overhead. Data transfers may occur in either a direct memory access (DMA) or programmed I/O mode. The DMA mode is available only with host iSBC boards which have DMA capability. In both modes, the host must be able to transfer data at a rate of 90K, 30K or 17K bytes per second, depending on the speed of the tape drive.

Communication with the iSBC® Host

A command plus one-to-five parameter bytes are issued by the host iSBC board to the iSBX 217C module to initiate any tape interface operation. Commands for the QIC-02 and 3M interfaces are summarized in Table 1. If the function is a Read or a Write operation, the host must then be ready to transfer data a byte at a time to or from the module. In programmed I/O mode, with QIC-02 drives, the host polls the iSBX 217C status port to learn when the tape interface is ready for the next 512 byte data block. During the data block transfer, the host is interrupted by MWAIT/ when the interface is ready to transfer a data byte. With 3M tape drives, the host may be interrupted or use MDRQT to detect when the module is ready for the next byte transfer. In DMA mode, the host board uses the DMA Request signal (MDRQT) of the iSBX bus to synchronize the data transfer. At the conclusion of a tape operation, the iSBC host must read one or more of the iSBX 217C module's Sense Bytes to receive status information on the completed opeation. When the iSBX 217C module is used on the iSBC 215 Generic Winchester Controller board, these host requirements are fulfilled by the standard on-board firmware and are transparent to the user.

Table 1. Commands required by QIC-02 and 3M tape drives. Number indicates the parameter bytes required by the command. N indicates the command is not supported by the drive.

Hex Code	Command	Parameter Bytes		Type of Command
		QIC-2	3M	
00	Reset iSBX 217C Board	1	1	a
01	Initialize Drive	1	1	a
02	Write A Block	1	3	b
03	Write a File Mark	1	1	a
04	Read a Block	1	3	b
05	Read File Mark Command	1	N	a
06	Read Status	1	1	a
07	Rewind	1	N	a
08	Retension	1	N	a
09	Erase Tape	1	N	a
0C	Unload Tape	N	1	a
14	Continue	N	1	a
15	Write RAM	N	5	b
16	Read RAM	N	5	b
17	Verify	N	5	a
18	Run Selftest 1	1	N	a
1A	Read Extended Status	1	N	a
1B	Set Alternate Select Mode	1	N	a
1C	Return Raw Drive Status	1	N	a
20	Reset Bad Parity Flag	0	N	c
40	Start of Transfer (SOT)	1	1	c
80	End of Transfer (EOT)	1	1	c
81	Pause Command	1	N	c
82	Please Pause Command	1	N	c

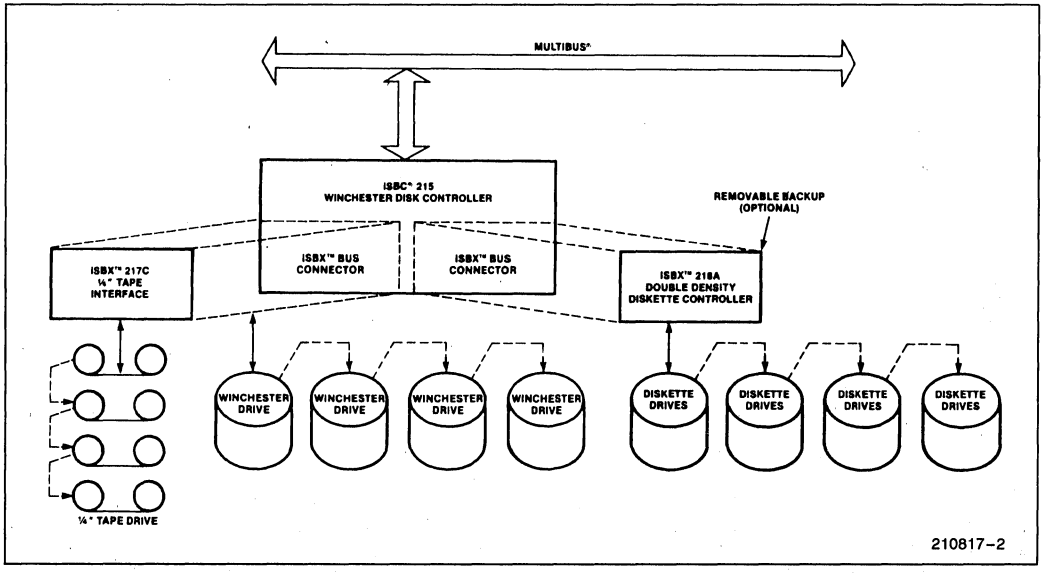


Figure 1. Subsystem Configuration (with optional Diskette and ¼" Tape Backup)

SPECIFICATIONS

Compatibility

Host—Any iSBC signal board computer or peripheral controller with an iSBX connector. The iSBC 215 Generic Winchester Controller includes on-board firmware to support the iSBX 217C under either the iRMX 86 or XENIX Operating Systems. The firmware on the iSBC 215A and iSBX 215B Winchester Controllers cannot support the iSBX 217C module.

Drives—Any QIC-02 or 3M HCD-75 interface compatible cartridge ¼-inch magnetic tape drive.

Transfer Rate

90K (one byte every 11 microseconds), 30K (one byte every 33 microseconds) or 17K (one byte every 53 microseconds) depending on tape drive speed.

Equipment Supplied

iSBX 217C Interface Module
Reference Schematic

Controller-to-drive cabling and connectors are not supplied. Cables can be fabricated with flat cable and commercially-available connectors as described in the Hardware Reference Manual.

Nylon mounting bolts

Physical Characteristics

Width: 3.08 inches (7.82 cm)
Height: 0.809 inches (2.05 cm)
Length: 3.70 inches (9.40 cm)
Shipping Weight: 3.5 ounces (99.2 gm)
Mounting: Occupies one single-wide iSBC MULTIMODULE position on boards

Electrical Characteristics

Power Requirements: +5 VDC @ 1.5A

Environmental Characteristics

Temperature: 0°C to +55°C (operating) @200 LFM; −55°C to +85°C (non operating)

Humidity: Up to 90% relative humidity without condensation (operating); all conditions without condensation or frost (non-operating)

Reference Manual

D146704-001— iSBX 217C Board Hardware Reference Manual (NOT SUPPLIED)

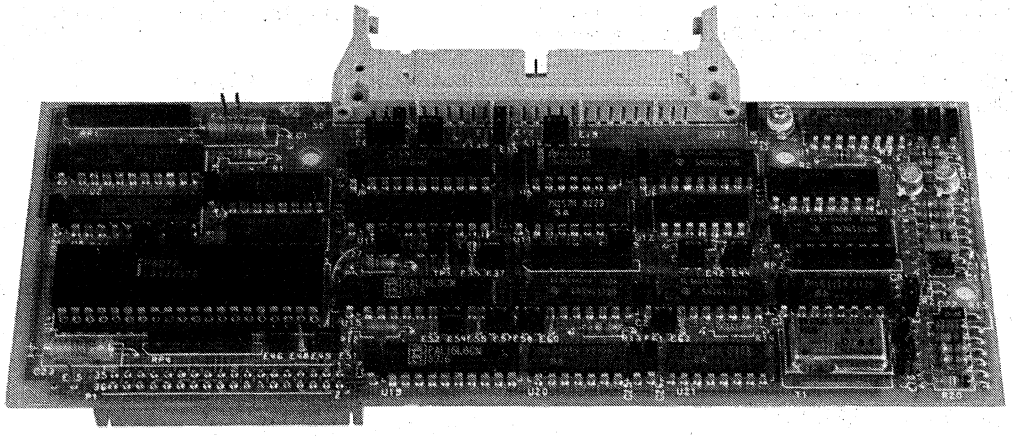
ORDERING INFORMATION

Part Number	Description
SBX 217C	Cartridge ¼-inch Tape Drive Interface

iSBX™ 218A
FLEXIBLE DISK CONTROLLER

- **iSBX™ Bus Compatible 8″ or 5.25″ Floppy Diskette Controller Module**
- **Hardware and Software Compatible with iSBX 218 Module**
- **Controls Most Single/Double Density and Single/Double Sided Floppy Drives**
- **User Programmable Drive Parameters Allow Wide Choice of Drives**
- **Motor On/Off Latch Under Program Control**
- **Drive-Ready Timeout Circuit for 5.25 Inch Floppy Drives**
- **Phase Lock Loop Data Separator Assures Data Integrity**
- **Read and Write on Single or Multiple Sectors**
- **Single +5 Volt Supply Required**

The Intel iSBX 218A Flexible Disk Controller module is a software and hardware compatible replacement for the iSBX 218 module and provides additional features. The iSBX 218A module is a double-wide iSBX module floppy disk controller capable of supporting virtually any soft-sectored, single/double density and single/double sided floppy drives. The controller can control up to four drives. In addition to the standard IBM 3740 and IBM system 34 formats, the controller supports sector lengths up to 8192 bytes. The iSBX 218A module's wide range of drive compatibility is achieved without compromising performance. The operating characteristics are specified under user control. The controller can read and write either single or multiple sectors.



503810-1

October 1986
Order Number: 503810-002

FUNCTIONAL DESCRIPTION

Intel's 8272 floppy Disk Controller (FDC) chip is the heart of the iSBX 218A Controller. On-board data separation logic performs standard MFM (double density) and FM (single density) encoding and decoding, eliminating the need for external separation circuitry at the drive. Data transfers between the controller and memory are managed by the intelligent device on the host board (usually an Intel 8-bit or 16-bit CPU). A block diagram of the iSBX 218A Controller is shown in Figure 1.

Universal Drive and iSBX™ 218A Controller

Because the iSBX 218A Controller has universal drive compatibility, it can be used to control virtually any standard-or mini-sized diskette drive. Moreover, the iSBX 218A Controller fully supports the iSBX bus and can be used with any single board computer which provides this bus interface. Because the iSBX 218A Controller is programmable, its performance is not compromised by its universal drive compatibility. The track-to-track access, head-load, and head-unload characteristics of the selected drive model are program specified. Data may be organized in sectors up to 8192 bytes in length.

Interface Characteristics

The standard iSBX 218A Controller includes an Intel 8272 Floppy Disk Controller chip which supports up to four drives, single or double sided.

SIMPLIFIED INTERFACE—The cable between the iSBX 218A Controller and the drive(s) may be low cost, flat ribbon cable with mass termination connectors. The mechanical interface to the board

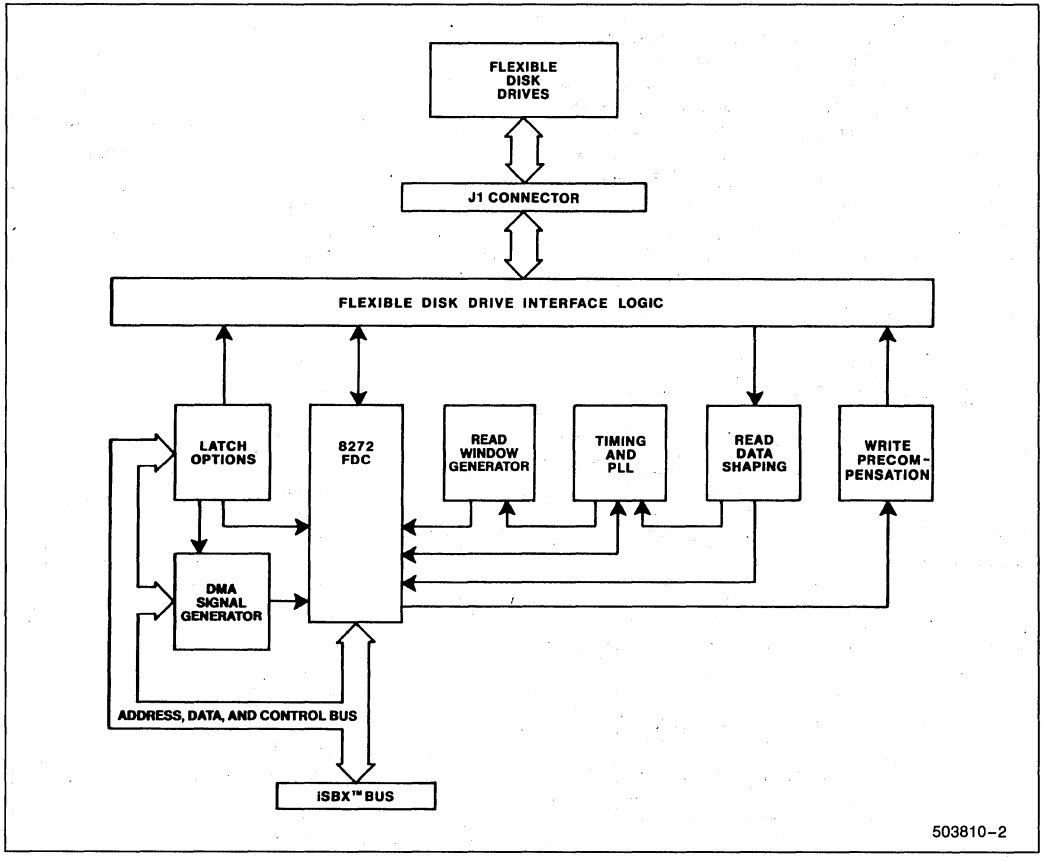


Figure 1. Block Diagram of iSBX™ 218A Board

is a right-angle header with locking tabs for security of connection.

PROGRAMMING—The powerful 8272 FDC circuit is capable of executing high-level commands that simplify system software development. The device can read and write both single and multiple sectors. CRC characters are generated and checked automatically. Recording density is selected at each Read and Write to support the industry standard technique of recording basic media information on Track 0 or Side 0 in single density, and then switching to double density (if necessary) for operations on other tracks.

PROGRAM INITIATION—All diskette operations are initiated by standard iSBX bus input/output (I/O) operations through the host board. System software first initializes the controller with the operating characteristics of the selected drive. The diskette is then formatted under program control. Data transfers occur in response to commands output by the CPU.

DATA TRANSFER—Once a diskette transfer operation has been initiated, the controller will require a data transfer every 13 microseconds (double density) or 26 microseconds (single density). Most CPUs will operate in a polled mode, checking controller status and transferring bytes when the controller is ready. Boards utilizing the Intel 8080 chip, such as the iSBC 80/10B board, will be restricted to single density operation with the iSBX 218A Controller, due to these speed requirements.

DMA OPERATION—The iSBX 218A module can be used either with or without a DMA controller on the host board. Standard DMA controllers provide a DACK (DMA Acknowledge) signal for proper DMA operation with the 8272. The iSBX 218A's on-board DACK generator provides the interface to allow the iSBX 218A module to be used with DMA controllers such as Intel's 8089 and 80186 processors that do not provide a DACK signal.

SPECIFICATIONS

Compatibility

CPU—Any single board computer or I/O board implementing the iSBX bus interface and connector.

Devices—Double or single density standard (8") and mini (5¼") flexible disk drives. The drives may be single or double sided. Drives known to be compatible are indicated in the table to the right.

Standard (8")		Mini (5¼")	
Caldisk	143M	Shugart	450/400
Remex	RFD 4000	Shugart	460/410
Memorex	550	Micropolis	1015-IV
MFE	700	Pertec	250
Siemens	FDD 200-8	Siemens	200-5
Shugart	SA 850/800	Tandon	TM-100
Shugart	SA 860/810	CDC	9409
Pertec	FD650	MPI	51/52/91/92
CDC	9406-3		

Data Organization and Capacity

Standard Size Drives

	Double Density						Single Density					
	IBM System 34			Non-IBM			IBM System 3740			Non-IBM		
Bytes per Sector	256	512	1024	2048	4096	8192	128	256	512	1024	2048	4096
Sectors per Track	26	15	8	4	2	1	26	15	8	4	2	1
Tracks per Diskette	77			77			77			77		
Bytes per Diskette (Formatted, per diskette surface)	512,512 (256 bytes/sector) 591,360 (512 bytes/sector) 630, 784 (1024 bytes/sector)			630,784			256,256 (128 byte/sector) 295,680 (256 bytes/sector) 315, 392 (512 bytes/sector)			315,392		

Diskette—Unformatted IBM Diskette 1 (or equivalent single-sided media); unformatted IBM Diskette 2D (or equivalent double-sided).

Equipment Supplied

iSBX 218A Controller

Reference Schematic

Controller-to-drive cabling and connectors are not supplied with the controller. Cables can be fabricated with flat cable and commercially-available connectors as described in the iSBX 218A Hardware Reference Manual.

Nylon Mounting Screws and Spacers

Physical Characteristics

Width: 3.15 inches (8.0 cm)

Height: 0.83 inches (2.1 cm)

Length: 7.5 ounces (19.1 cm)

Weight: 4.5 ounces (126 gm)

Mounting: Occupies one double-wide iSBX MULTIMODULE™ position on boards; increases board height (host plus iSBX board) to 1.13 inches (2.87 cm).

Electrical Characteristics

Power Requirements: +5VDC @ 1.7A max.

Environmental Characteristics

Temperature: 0°C to +55° (operating); −55°C to +85°C (non-operating).

Humidity: Up to 90% Relative Humidity without condensation (operating); all conditions without condensation or frost (non-operating).

Reference Manual

145911-001— iSBX 218A Flexible Disk Controller Hardware Reference Manual (NOT SUPPLIED).

Reference manuals may be ordered from any Intel sales representative, distributor office, or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

Drive Characteristics

	Standard Size	Mini Size
	Double/Single Density	**Double/Single Density**
Transfer Rate (K bytes/sec)	62.5/31.25	31.25/15.63
Disk Speed (RPM)	360	300
Step Rate Time (Programmable)	1 to 16 ms/track in 1 ms increments	2 to 32 ms/track in 2 ms increments
Head Load Time (Programmable)	2 to 254 ms in 2 ms increments	4 to 508 ms in 4 ms increments
Head Unload Time (Programmable)	16 to 240 ms in 16 ms increments	32 to 480 ms in 32 ms increments

ORDERING INFORMATION

Part Number	Description
SBX 218A	Flexible Disk Controller

Graphics

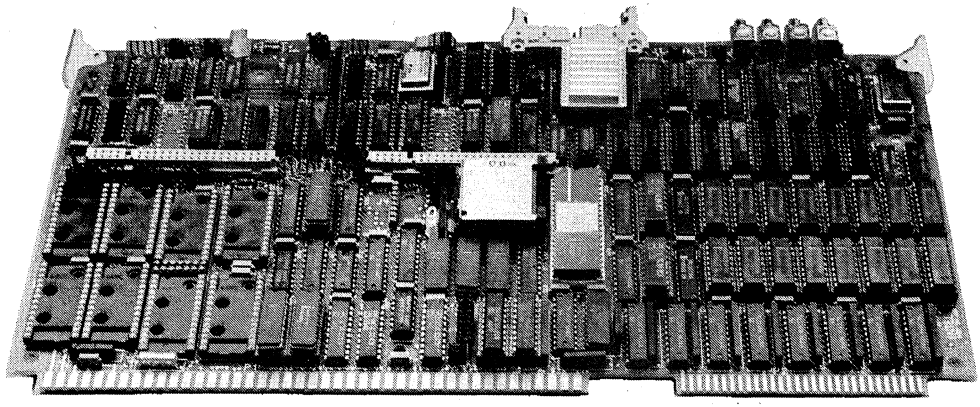
9

iSBC® 186/78A
INTELLIGENT VIDEO GRAPHICS CONTROLLER

- 8 MHz 80186 Integrated Microprocessor
- Top Drawing Speeds of 1.25M Pixels/sec Polygon Drawing Rate: 150K Pixels/sec
- Programmable Frame Rate and Size
- Simultaneous Multiwrite into All Planes
- Two iSBX™ Bus Connectors
- DMA to Local Bus from iSBX™ MULTIMODULE™, Local Memory, and MULTIBUS® System Bus
- Optional VDI (Virtual Device Interface) Graphics Software Resides On-Board
- Look-Up Table Generates up to 16 out of a Possible 4096 Colors
- i82720 Graphic Display Controller
- Resolution of 640 x 480 (Non-Interlaced) or 1024 x 800 (Interlaced)
- Eight 28-Pin Memory Sites
- Multiple Co-Resident Frame Buffers
- Serial Input Support for Human Interfaces via iSBX™ MULTIMODULE™ Board
- Full RS-343 or RS-170 Support

The iSBC 186/78A VGC (Video Graphics Controller) is the newest member of Intel's growing family of microcomputer graphics products. It provides an economical, off-the-shelf graphics solution for OEM applications. The local microprocessor (80186) adds on-board intelligence to off-load graphics functions from the host CPU. Powerful bit-mapped graphics are made possible by the Intel 82720 Graphics Display Controller (GDC). This display controller supports high level drawing commands including arcs, circles, rectangles, area filling, zoom, panning and scrolling.

The iSBC 186/78A VGC board functions either as a host CPU with integral graphics, or as a dedicated graphics controller. Graphics applications can communicate directly with the optional on-board VDI (Virtual Device Interface), a standard graphics software interface. Applications that will benefit from the iSBC 186/78A VGC include process control monitoring, automatic test equipment, transaction processing, and instrumentation.



231035-1

*XENIX is a trademark of MICROSOFT
*UNIX is a trademark of Bell Labs

October 1987
Order Number: 231035-004

ARCHITECTURAL OVERVIEW

The iSBC 186/78A integrates both a high performance 80186 microprocessor and a medium resolution graphics display controller on one board, serving both the computational and display requirements of today's interactive applications. The iSBC 186/78A VGC operates with Intel's standard graphics software (iVDI 720), an implementation of the proposed Virtual Device Interface standard.

In the past, MULTIBUS graphics boards combined two functional blocks on a single iSBC board; e.g., graphics control and MULTIBUS interface logic. Now, Intel has integrated a third block; an on-board 80186 microprocessor provides a control center for the local graphics capabilities. In addition, the large display memory area allows multiple buffering of consecutive images for a tremendous improvement in image display performance. Each of these functional areas is highlighted in Figure 1, and detailed in separate sections.

Such high integration results in two significant benefits to the user: (1) increased system performance by off-loading the graphics routines from the host CPU board, and (2) increased savings due to the compact, single board implementation. Distributed graphics processing results in a system cost that is more directly proportional to the number of users serviced, without adversely impacting per-user performance.

In low cost applications, the on-board microprocessor also allows the iSBC 186/78A VGC to function as a host CPU with integral graphics.

GRAPHICS PROCESSOR FUNCTIONS

Graphics Display Controller

The Intel 82720 GDC is an intelligent graphics controller designed to operate as the heart of a raster-scan computer graphics display system. The 82720 GDC performs all the basic timing needed to generate the raster display and manage the display memory. In addition, the 82720 GDC supports several high level graphics figure drawing functions. Table 1 highlights the 82720 command set.

Both the graphics mode and the mixed mode of the 82720 GDC are supported, although the iSBC 186/78A VGC does not use an external character generator. The internal zoom-write feature of the GDC is fully supported. There is no external zoom circuitry. DMA to and from the display memory is supported via the MULTIBUS data bus, the local bus or through the iSBX data bus.

Display Memory

The iSBC 186/78A VGC contains 512K bytes of high-speed display memory, all of which is under the control of the 82720 GDC. The 82720 GDC controls both writing and reading data to and from the display memory and refreshing the screen.

The configuration of on-board display memory may be set under user program control. The display memory may be segmented into multiple frame buffers, for example: three 640 x 480 x 4 frame buffers

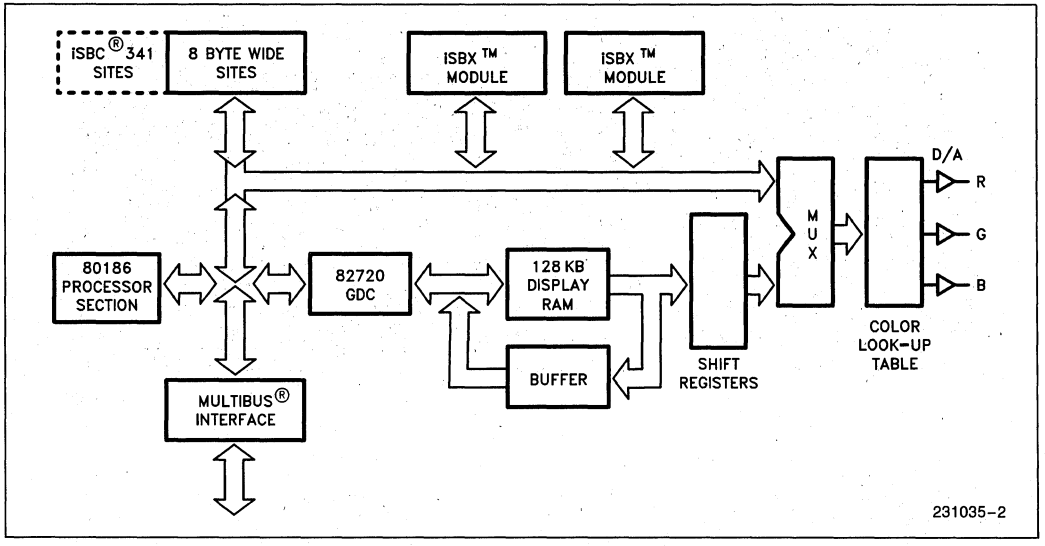


Figure 1. Block Diagram

Table 1. 82720 Command Library

Video Control Commands	
RESET:	Resets the GDC to its idle state.
SYNCH:	Specifies the video display format.
Display Control Commands	
START:	Ends idle mode and unblanks the display.
BCTRL:	Controls the blanking and unblanking of the display.
ZOOM:	Specifies the zoom factors for graphics character writing.
CURS:	Sets the position of the cursor in display memory.
PRAM:	Defines the starting address and lengths of display areas, and specifies the eight bytes for the graphics character.
PITCH:	Specifies the width of the X dimension in display memory.
Drawing Control Commands	
WDAT:	Writes data words or bytes into display memory.
MASK:	Sets the mask register contents.
FIGS:	Specifies the parameters for the drawing processor.
FIGD:	Draws the figure as specified.
GCHRD:	Draws the graphics character into display memory.
Data Read Commands	
RDAT:	Reads data words or bytes from display memory.
CURD:	Reads the cursor position.
LPRD:	Reads the light pen address.

or four 512 x 512 x 4 frame buffers. Display memory is read or written 16 bits at a time by the 82720 GDC. Both display cycles and read-modify-write (RMW) cycles may be controlled by the user. During display cycles, data is read from the display memory and sent to the CRT for display, starting at the upper left hand of the screen and moving down toward the bottom right corner. During RMW cycles, data is transferred between the GDC and the display memory.

In monochrome mode, all 256K 16-bit words are treated as a contiguous block of memory, where a logical "1" in memory is displayed as an illuminated pixel. In color mode, four color planes exist in memory and are written into (multi-write) and displayed simultaneously. Each plane consists of 64K 16-bit words.

Video Output

The iSBC 186/78A VGC controls both monochrome and color monitors, providing TTL (0V–5V) or analog (0V–0.7V) signal outputs. The iSBC 186/78A VGC operates with a broad range of CRT horizontal scan-rates. (The scan-rate is related to the pixel clock rate and the desired display resolution.) The pixel clock rate is selected by a jumper on the board, and may be either 20 MHz or 25 MHz. The pixel clock oscillator may be changed by the user to support monitors with lower bandwidths.

MONOCHROME MONITORS

The iSBC 186/78A VGC video outputs and sync signals may be either TTL or analog level signals. The sync signals are available as separate vertical and horizontal sync signals (Vsync and Hsync) or as a composite sync signal (Csync). When the iSBC 186/78A VGC operates in the monochrome mode, the analog video signal can provide a 16-level grey scale.

COLOR MONITORS

When operating in the color mode, the iSBC 186/78A VGC video outputs are Red, Green, and Blue video signals, with a maximum of 16 individual colors displayed at one time. The Red and Blue output signals are always analog. The Green output signal may be analog or TTL. The analog signals are generated in a 12-bit look-up table that provides a possible 4096 colors. When the Green output is analog, it may be combined with the composite sync signal, producing a Sync-on-Green signal. The vertical and horizontal sync signals (Vsync and Hsync) are available on separate outputs or they may be combined to generate a composite sync signal (Csync).

GRAPHICS CONTROL CENTER

Central Processing Unit

The 80186 component is a high-performance, high-integration 16-bit microprocessor. It combines several of the most common components onto a single chip including DMA (Direct Memory Access), interval timers, clock generator, and a PIC (Programmable Interrupt Controller). The 80186 CPU provides up to a 100% performance improvement over the 8086 CPU at an equivalent clock rate.

Three internal 16-bit programmable timers are provided. On the iSBC 186/78A VGC, two of these flexible timers are connected to four external pins (two pins per timer). They can be used to count or time

external events, generate nonrepetitive waveforms, etc. The third timer is not connected to any external pins, and is useful for real-time coding and time delay applications. User software can configure each timer independently to select the desired function. Available functions include: Interrupt on terminal count, programmable one-shot, rate generator, square-wave generator, software triggered strobe, hardware triggered strobe, and event counter. In addition, the third timer can be used as a prescaler for the other two timers, or as a DMA request source. The contents of each counter may be read at any time during system operation.

A 6-byte instruction queue provides pre-fetching of sequential instructions and can reduce the 500 ns minimum instruction cycle to 333 ns for queued instructions. The stack oriented architecture readily supports modular programming by facilitating fast, simple intermodule communication along with other programming constructs needed for asynchronous real-time systems.

The 80186 CPU uses a dynamic relocation scheme that allows separation of command procedures from data for efficient memory utilization. Four segment registers (code, stack, data, extra) contain program loaded offset values which are used to map 16-bit addresses to 20-bit addresses. Each register maps 64K bytes at a time. Activation of a specific register is controlled, both explicitly by program control, and implicitly by specific functions and instructions. In addition, the iSBC 186/78A VGC has external logic to provide access to the full 16M byte range of the MULTIBUS address space.

Both DMA channels provided by the 80186 CPU are supported on the iSBC 186/78A VGC. These channels allow a direct path from the MULTIBUS or iSBX bus to local memory. Indirect access to the display memory is also possible under 82720 GDC control.

A flag byte signaling mechanism aids in creating an interprocessor communication scheme. This includes: (1) the ability to set/reset interrupts and (2) board reset.

Instruction Set

The 80186 instruction library is a superset of that for the 8086. Therefore, object code compatibility was maintained while 10 instructions were added. The new instructions include: Block I/O, Enter and Leave subroutines, Push Immediate, Multiply Quick, Array Bounds Checking, Shift and Rotate by Immediate, and Pop and Push All.

Universal Memory Sites for Local Memory

Eight 28-pin JEDEC-compatible sockets are provided for using 2732, 2764, 27128, 27256 and 27512 EPROMs and their respective ROMs. Other JEDEC-standard pinout devices are also supported, including byte-wide static RAMs and iRAMs. Expansion to a total of 12 sockets is available by adding the iSBC 341 memory module. With the iSBC 341 memory module installed, the board supports up to 768K bytes of local storage (using 27512 EPROMs).

The eight sockets are divided into four blocks of two each (for high ahd low byte), or six blocks when using the iSBC 341 memory module. These independent blocks allow the user to mix many different kinds of 28-pin devices for increased application flexibility. Two different kinds of components may be used at any one time and all devices on the optional iSBC 341 memory module must be the same. The memory decode PAL is socketed so that the user may replace it with a custom PAL configured to suit their particular application.

Interrupt Control

The iSBC 186/78A VGC board uses the programmable interrupt controller (PIC) within the 80186 component, and allows 5 on-board vectored interrupt levels. The highest priority interrupt is the Non-Maskable Interrupt (NMI) line which is tied directly to the 80186 CPU. This interrupt is typically used to signal catastrophic events (e.g. power failure). The PIC provides prioritization and vectoring for the other 4 interrupt requests from on-board I/O resources and from the MULTIBUS system bus. The PIC then resolves the requests according to the programmable priority resolution mode, and if appropriate, issues an interrupt to the CPU.

Interrupt service requests to the iSBC 186/78A VGC may originate from 22 sources. Table 2 contains a list of devices and functions capable of generating interrupts. Most of these interrupts may be jumpered (user configurable) to the desired interrupt request level.

iSBX™ MULTIMODULE™ Expansion

The iSBC 186/78A VGC has two iSBX MULTIMODULE connectors, both support the 8-bit and 16-bit iSBX data buses. The addition of iSBX MULTIMODULE boards provides I/O functions to suit most application requirements. These I/O functions can in-

Table 2. Interrupt Request Sources

Device	Function	Number Interrupts
MULTIBUS interface INT0–INT7	Requests from resident MULTIBUS CPU or peripheral controller boards	8
Internal 80186 timer and DMA	Timer 0, 1, 2, outputs (function determined by timer mode) and 2 DMA channel interrupts	5
iSBX interfaces	Function determined by iSBX MULTIMODULE boards	6
Bus fail-safe timer	Indicates addressed resident MULTIBUS device has not responded to command within 6 msec	1
GDC vertical retrace	Synchronization of screen blanking	1
Flag Byte	Board identification	1

clude parallel and serial I/O, analog I/O, and mass storage device control. Mounting iSBX MULTIMODULEs directly on the single board computer often results in less interface logic, lower power, simpler packaging, higher performance, and lower costs than an alternative full-size iSBC board solution. See Figure 2 for an example of a minimal system where iSBX MULTIMODULE boards are added to an iSBC 186/78A VGC acting as the host CPU.

Each of the iSBX connectors on the iSBC 186/78A VGC provides all of the signals necessary to interface to the local on-board bus, including 16 data lines for maximum data transfer rates. All iSBX MULTIMODULE boards, designed with 8-bit data paths and using the 8-bit iSBX connector, are also supported on the iSBC 186/78A VGC. A broad range of iSBX MULTIMODULE options are available from Intel.

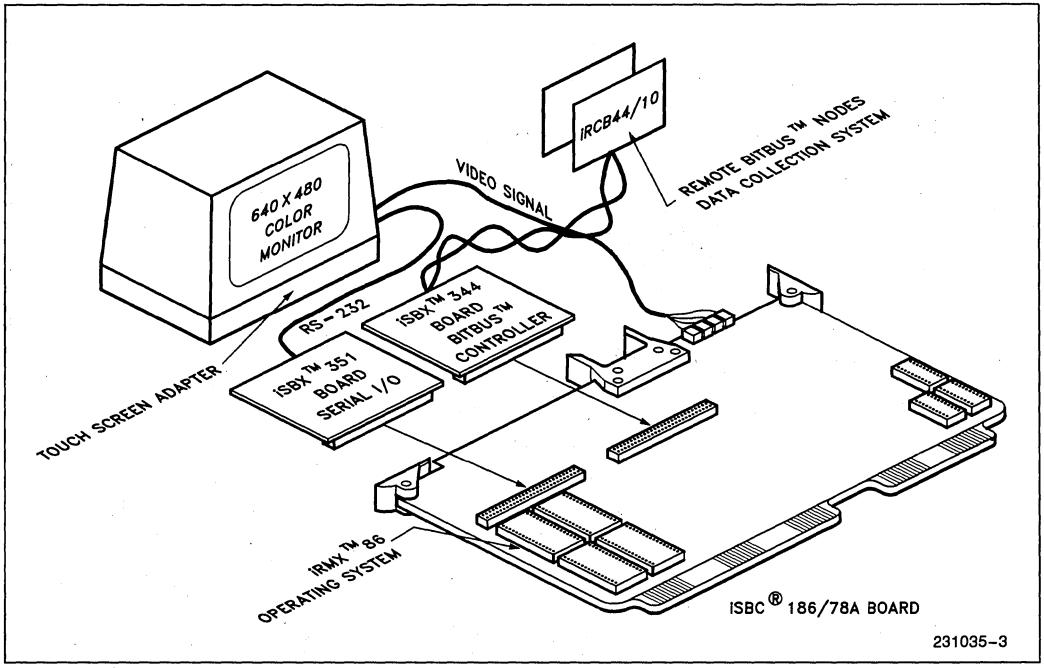


Figure 2. iSBC® 186/78A as a Host-CPU

MULTIBUS® SYSTEM ARCHITECTURE

System Bus—Overview

The MULTIBUS system bus is Intel's industry standard (IEEE 796) microcomputer bus structure. Both 8-bit and 16-bit single board computers are supported with 24 address and 16 data lines. A MULTIBUS system can be expanded by using a variety of MULTIBUS board products, such as the iSBC 186/78A VGC. The bus structure also allows very powerful distributed processing configurations with multiple processors, including multiple iSBC 186/78A VGC boards, for the most demanding microcomputer applications.

Multimaster Capabilities

For those applications requiring additional processing capacity and the benefits of multiprocessing (i.e. several CPUs and/or controllers logically sharing system tasks), the iSBC 186/78A VGC provides full MULTIBUS bus arbitration control logic. This control logic allows up to three iSBC 186/78A VGCs, or other bus masters, to share the system bus using a serial (daisy chain) priority scheme. Up to 16 busmasters may share the MULTIBUS system bus with an external parallel priority decoder. In addition to the multiprocessing configurations made possible with multimaster capability, the MULTIBUS system bus also provides an efficient mechanism for all forms of DMA (Direct Memory Access) transfers. Figure 3 shows a multiuser, multimaster configuration.

MULTIBUS® Expansion

Memory and I/O capacity may be increased and additional functions added by using Intel MULTIBUS compatible expansion boards. System memory for the 80186 microprocessor may be expanded by adding RAM boards, EPROM boards, or memory combination boards. Digital I/O and analog I/O expansion boards are available. Floppy disk and hard-disk controllers are available on MULTIBUS expansion boards or iSBX MULTIMODULE boards. Modular, expandable backplanes and cardcages are available to support multi-board systems.

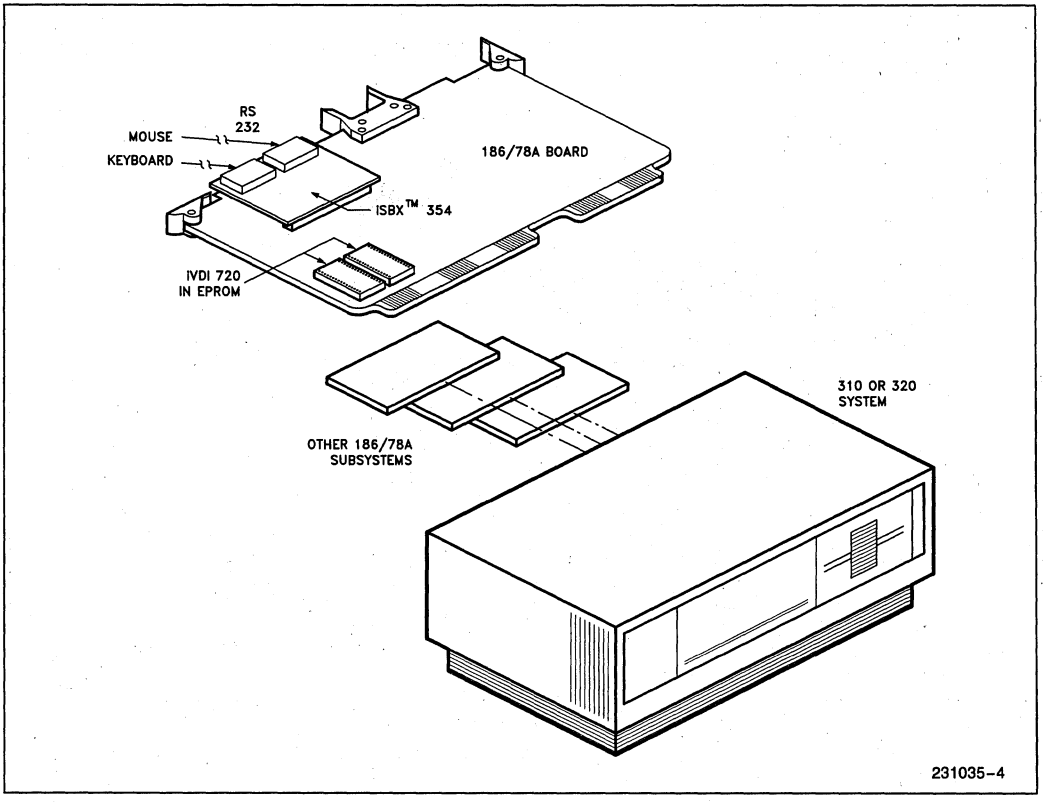


Figure 3.

GRAPHICS SOFTWARE (OPTIONAL)

iVDI 720 Command Interpreter

The iVDI 720 Virtual Device Interpreter provides the iSBC 186/78A VGC with a Virtual Device Interface (VDI) that is consistent with the graphics software standard defined by the ANSI X3 organization. The iVDI 720 software decodes high-level commands to streamline the development of application code. It also supports a variety of input device drivers including digitizing tablets and mice. The standard software interface provides a smooth upgrade path, simplifying the transition to future hardware devices.

The proposed ANSI standard defines the encoding of high-level text and graphics commands. The iVDI 720 software decodes a binary representation of these proposed commands, and allows consistent formatting and storage of VDI encoded images.

The iVDI 720 Graphics Virtual Device Interpreter is designed for EPROM installation on the iSBC 186/78A VGC. Graphics functions can then be offloaded to the iSBC 186/78A VGC, permitting the host CPU board to concentrate on system level operations such as database management or network communications.

iRMX™ 86/iRMX 286 Software Device Driver

The iRMX 86 and iRMX 286 software are Intel's real-time, multi-tasking operating systems. The iVDI 720 software package furnishes the software device driver required to operate the board in an iRMX software environment. It creates a predictable environment for the input and output of high-level commands between the user and system, or among the graphics peripherals attached to the system, such as a mouse, tablet, printer or plotter. The iRMX driver includes PL/M and C language bindings.

SPECIFICATIONS

Word Size

Instruction–8, 16, 24, or 32 bits
Data –8 or 16 bits

System Clock

8.00 MHz ±0.1%

Instruction Cycle Time

8 MHz –500 ns
–333 ns (assumes instruction in queue)

NOTE:
Basic instruction is defined as the fastest instruction time (i.e., two clock cycles).

Memory Response Time

286 ns for zero wait-states (address to data-valid)

Memory Capacity (Max)

EPROM	512K bytes (768K with iSBC 341 MULTIMODULE) using 27512s
E^2PROM	16K bytes (24K with iSBC 341 MULTIMODULE) using 2817As
iRAM	64K bytes (96K with iSBC 341 MULTIMODULE) using 51C86s

Static RAM same as iRAM

PHYSICAL CHARACTERISTICS

Length:	12.00 in. (30.48 cm)
Height:	7.05 in (17.90 cm)
Depth:	0.50 in. (1.78 cm)
	1.13 in. (2.82 cm) with iSBC Memory Expansion and MULTIMODULEs, or iSBX MULTIMODULE boards
Weight:	18.3 ounces (519 gm) excluding any MULTIMODULE boards

Connectors

Interface	Double-sided	Centers	Supplier
MULTIBUS System	86 pin (P1)	0.156 in.	Viking 3KH43/9AMK12 Wire Wrap
iSBX Bus (8- and 16-bit)	36/44 (J2, J3)	0.100	Viking 000294-0001
Video Interface - or -	26 (J1) 5 pcs. (J7–11)	0.1 SMC-type	3M 3399-6026 flat cable Sealectro 50-007-0000, with Belden 174/U coax

ELECTRICAL CHARACTERISTICS

Power Requirements: 8.4A @ +5±5% Vdc (Maximum); 4.9A @ +5 ±5% Vdc (typical)

ENVIRONMENTAL REQUIREMENTS

Operating Temperature: 0° to 55°C with 200 lfm air flow

Relative Humidity: to 90% without condensation

REFERENCE MANUAL

147393-001— iSBC 186/78A Video Graphics Subsystem Hardware Reference Manual

RELATED LITERATURE

210883-001— MULTIBUS Handbook

280002-001— iVDI 720 Data Sheet (Virtual Device Interface)

146717-002— iVDI 720 Graphics Software Reference Manual

142686-001— iSBX Specification

210451-001— 80186 Data Sheet

210655-001— Intel 82720 Data Sheet

Literature and Hardware Reference Manual may be ordered from an Intel Sales Representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

ORDERING INFORMATION

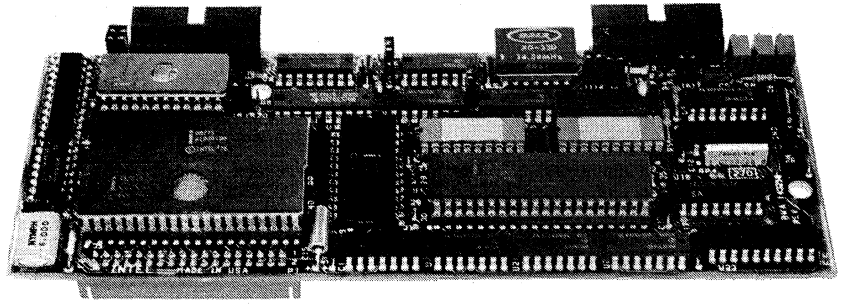
Part Number	Description
iSBC 186/78A	Intelligent Video Graphics Subsystem

iSBX™ 270
ALPHA-NUMERIC DISPLAY CONTROLLER

- **Complete Video Display Controller on a Double-Wide iSBX™ MULTIMODULE™ Board**
- **Interfaces to either Black and White or Color Display Monitors**
- **Displays 7 x 9, 5 x 7, or 6 x 8 Character Fonts**
- **High Level Software Interface via a Pre-Programmed 8041A UPI**
- **Interchangeable Character Fonts Available in EPROM**
- **Keyboard and Light Pen Interface Provided On-Board**
- **50 Hz or 60 Hz Frame Rate Operation**
- **Provides Cursor Control, Reverse Video, Blinking, Underline, Highlight and Page or Scroll Mode**
- **Compatible with All 8/16 Bit iSBC® Boards which Support the Intel iSBX Bus**
- **Graphics Capability via Pre-Defined Graphic Character Fonts**

The iSBX 270 Video Display Controller (VDC) is a complete video controller on a standard double wide Intel iSBX MULTIMODULE board. Providing either black and white (B&W) or eight-color displays, the iSBX 270 VDC brings alphanumeric video control to the iSBX bus. Any computer board or system supporting the Intel iSBX MULTIMODULE bus is compatible with the iSBX 270 VDC, including most board and system products from Intel. Additionally, the iSBX 270 VDC supports keyboard and light pen I/O on-board; this simplifies the design of intelligent terminals.

The iSBX 270 module allows the user to add high level video display capability to his/her computer system with a minimal cost and effort. Typical applications for the iSBX 270 VDC include video displays for industrial operator stations, word processing systems, data base management products and many other uses.



210220-1

October 1986
Order Number: 210220-001

FUNCTIONAL DESCRIPTION

iSBX™ Interface

The iSBX 270 VDC interfaces to the Intel iSBX bus via the 8041A Universal Peripheral Interface (UPI) Microcomputer. The 8041A, under firmware control, provides communication between the base board and the iSBX 270 controller circuitry via the iSBX data and control lines. Data may be displayed immediately following power up, using default initialization provided by the 8041A UPI. In addition, eight high-level commands are provided by the iSBX 270 firmware; these eight commands are used to alter the default initialization of the controller and determine status. Following initialization, characters are displayed on the CRT by simply writing to the proper I/O port.

CRT Interface

The iSBX 270 VDC will interface to many B&W and RGB color display monitors. For B&W monitors, the iSBX 270 board provides TTL level signals for video, vertical sync, and horizontal sync. Additionally, in B&W, two levels of intensity (normal and highlight) are supported under program control.

When operating in the color mode, the iSBX 270 module provides TTL level 75 ohm line drivers for Red, Green, and Blue Video and sync allowing 8 different colors to be displayed.

Composite video is not provided on the iSBX 270 MULTIMODULE board; however, with minimal external circuitry, composite video can be added (circuit design available; contact the local Intel Sales Office for details).

Table 1 lists several CRT vendors compatible with the iSBX 270 VDC.

Table 1. CRT's (B&W and Color)(1)

Type	Vendor	Model #
B&W	Ball Brothers	TTL 120, TV 120, TV 50
	Motorola	M3570
	TSD	MDC-15
	ELSTON	DM30-12B0-51-A04
Color	Ball Brothers	7-015-0131
	IDT	19AC
	CONRAC	5711C13
	NEC	1202DH
	MITSUBISHI	C-3419

NOTE:
1. This in no way constitutes an endorsement by Intel Corporation of these companies' products. The companies listed are known to provide products compatible with the iSBX 270 board.

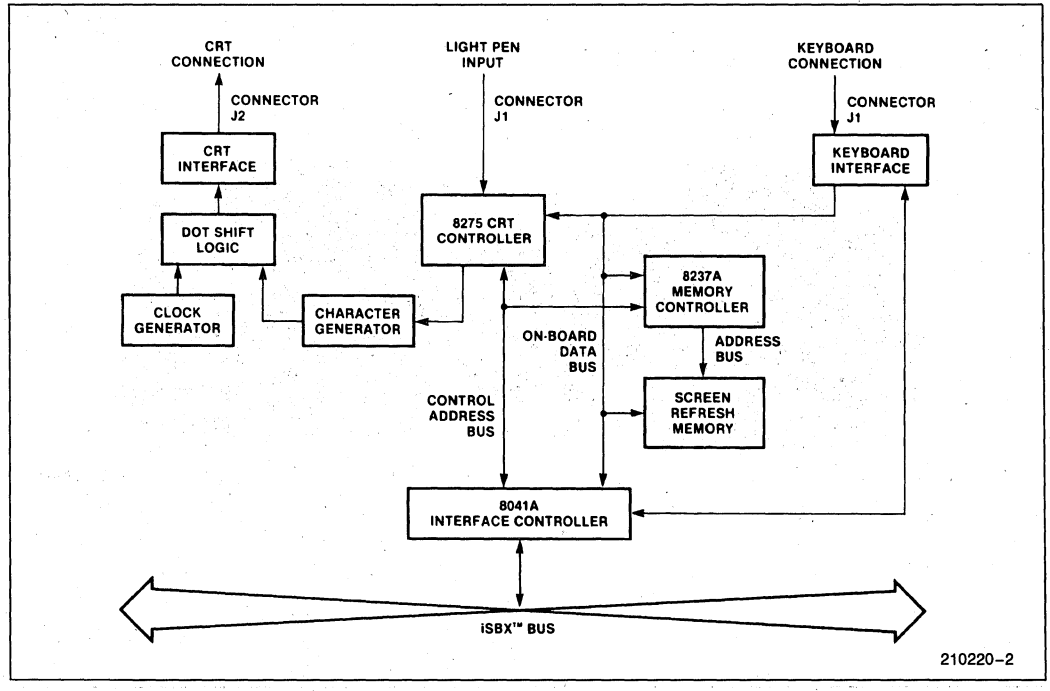


Figure 1. iSBX™ 270 VDC Block Diagram

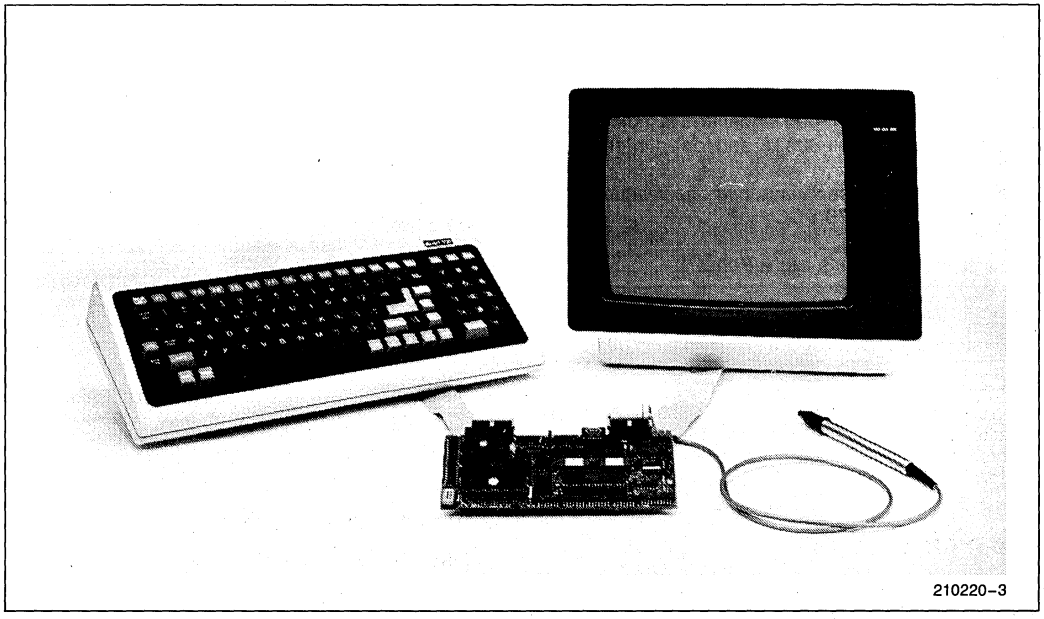


Figure 2. The iSBX™ 270 VDC Interfaces to a User-Supplied Video CRT, Keyboard and Light Pen

CRT Controller

The CRT Controller performs all timing and data buffering functions for the CRT. The iSBX 270 VDC uses the Intel 8275 CRT Controller (for additional details refer to the 8275 data sheet available from Intel.)

Screen Refresh

The iSBX 270 VDC contains 4K bytes of high speed static RAM, as well as a high speed DMA controller (8237A). The 8237A, under the control of the 8041A UPI, takes care of both writing data to the screen and refreshing the screen.

Character Generation

The character fonts (128 characters, including alphabetic, numeric, and special characters) that are displayed on the CRT are stored in EPROM. The need may arise to display different character fonts, i.e., those used in international systems or custom symbols which are application specific. With the iSBX 270 VDC the user may modify any or all of the character fonts by simply reprogramming the EPROM. In addition, the user may utilize a larger EPROM to obtain up to 256 characters.

Keyboard Interface

The iSBX 270 VDC also interfaces to a keyboard I/O device via the J1 edge connector. The keyboard interface of the iSBX 270 VDC accepts up to eight TTL parallel data lines and one TTL strobe, either positive or negative. Keyboard input is indicated by a status bit in the 8041A and/or an interrupt. In addition, control lines are provided for visual and/or audible indicators.

Table 2 lists several keyboards that interface to the iSBX 270 VDC.

Table 2. Keyboards(1)

Vendor	Model #
Advanced Input Devices	SK-067
Cherry	B70-05AB
Cherry	CB80-07AA
Chomerics	AN26109/AE26203
Cortron	35-500014
Keytronic	L1648
Keytronic	L1660
Keytronic	L1674-03
Keytronic	L1752
Microswitch	66SD6-7
Microswitch	87SD30-8

NOTE:
1. This in no way constitutes an endorsement by Intel Corporation of these companies' products. The companies listed are known to provide products compatible with the iSBX 270 board.

Light Pen Interface

Light pen I/O devices may be directly interfaced to the iSBX 270 VDC. A light pen hit is triggered on the rising edge of the light pen signal and is indicated by a status bit in the UPI 8041A and/or an interrupt.

Table 3 lists a light pen vendor whose product interfaces to the iSBX 270 VDC.

Table 3. Light Pens(1)

Vendor	Model #
Information Control Co.	LP-700

NOTE:
1. This in no way constitutes an endorsement by Intel Corporation of this companies' products. The company listed is known to provide products compatible with the iSBX 270 board.

SPECIFICATIONS

Controller Characteristics

DISPLAY

Programmable to a maximum of 35 rows × 80 columns of characters.

CRT OUTPUTS

B&W: TTL level HSYNC, VSYNC, Video.

Color: TTL level, 75Ω line drivers for RGB and combined sync provide 8 different display colors.

FRAME RATE

50 Hz or 60 Hz via jumper settings (non-interlaced)

CHARACTER FONTS

5 x 7, 7 x 9, or 6 x 8 jumperable with appropriate crystal. Character generator uses 2716 EPROM. Also compatible with 2732A EPROM's. For generation of special fonts, please refer to iSBX 270 VDC Hardware Reference Manual.

VIDEO CONTROL

Reverse video, blinking, underline, highlight, cursor control and page or scroll mode.

TV MONITOR

Most video display monitors with a 10 MHz bandwidth or better.

LIGHT PEN INPUT

TTL level pulse, maximum 50 ns rise time, minimum 100 ns hold time.

Compatibility

CPU

Any iSBC single board computer or I/O board compatible with the MULTIBUS system bus and implementing the iSBX bus and connector.

Physical Characteristics

Width: 3.08 inches (7.82 cm)

Height: 0.8 inches (2.05 cm)

Length: 7.5 inches (19.05 cm)

Weight: 0.5 pounds (0.175 Kg)

Mounting: Occupies one double-wide iSBX MULTIMODULE position on boards; increases board height (host plus iSBX board) to 1.14 inches (2.90 cm).

Electrical Characteristics

Power Requirements: +5 VDC @ 1.3A

Environmental Characteristics

Temperature: 0°C to 55°C (operating); −55°C to +85°C (non-operating)

Humidity: Up to 90% relative humidity without condensation (operating); all conditions without condensation or frost (non-operating).

Equipment Supplied

iSBX 270 VDC Controller
Reference Schematic

Cabling and connectors from the VDC controller to the CRT, keyboard and light pen are not supplied with the controller. Cables can be fabricated with commercially available cable and connectors as described in the iSBX 270 Hardware Reference Manual.

Reference Manual

143444—001— iSBX 270 Video Display Controller Hardware Reference Manual (NOT SUPPLIED).

Reference Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051.

ORDERING INFORMATION

Part Number	Description
SBX 270	Video Display Controller MULTI-MODULE Board

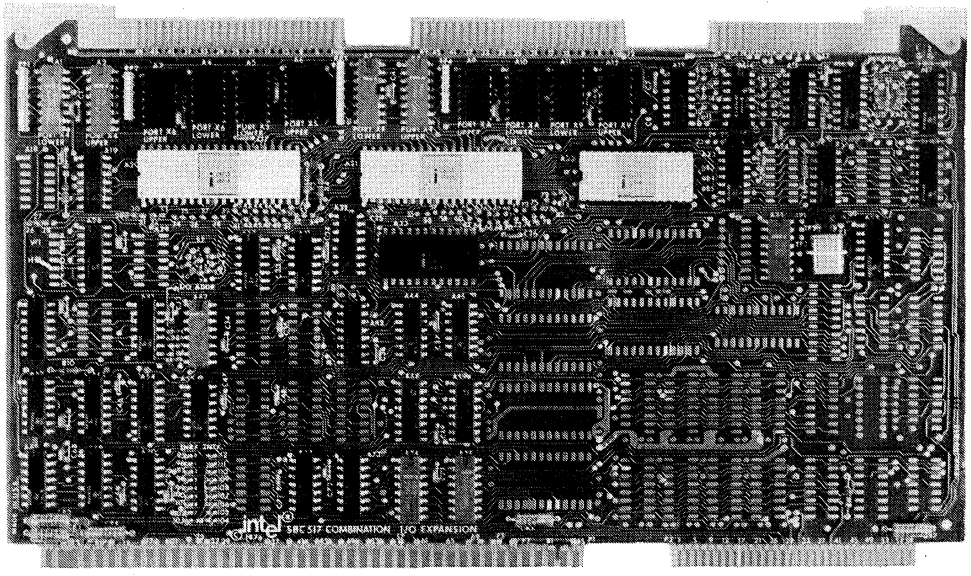
Digital and Analog I/O Expansion

10

iSBC® 517
COMBINATION I/O EXPANSION BOARD

- **48 Programmable I/O Lines with Sockets for Interchangeable Line Drivers and Terminators**
- **Synchronous/Asynchronous Communications Interface with RS232C Drivers and Receivers**
- **Eight Maskable Interrupt Request Lines with a Pending Interrupt Register**
- **1 ms Interval Timer**

The iSBC 517 Combination I/O Expansion Board is a member of Intel's complete line of iSBC memory and I/O expansion boards. The board interfaces directly with any iSBC single board computer via the system bus to expand serial and parallel I/O capacity. The combination I/O board contains 48 programmable parallel I/O lines. The system software is used to configure the I/O lines to meet a wide variety of system peripheral requirements. The flexibility of the I/O interface is significantly enhanced by the capability of selecting the appropriate combination of optional line drivers and terminators to provide the required sink current, polarity, and drive/termination characteristics for each application. A programmable RS232C communications interface is provided on the iSBC 517. This interface may be programmed by the system software to provide virtually any asynchronous or synchronous serial data transmission technique (including IBM Bi-Sync). A comprehensive RS232C interface to CRTs, RS232C compatible cassettes, and asynchronous and synchronous modems is thus on the board. An on-board register contains the status of eight interrupt request lines which may be interrogated from the system bus, and each interrupt request line is maskable under program control. The iSBC 517 also contains a jumper selectable 1 ms interval timer and interface logic for eight interrupt request lines.



280229-1

October 1986
Order Number: 280229-001

FUNCTIONAL DESCRIPTION

Programming Flexibility

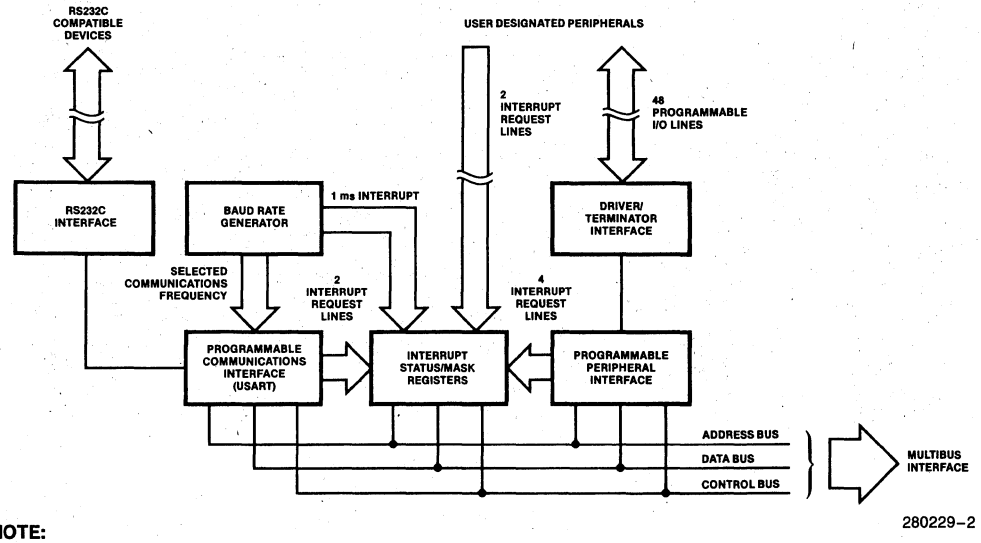
The 48 programmable I/O lines on the iSBC 517 are implemented utilizing two Intel 8255 programmable peripheral interfaces. The system software is used to configure these programmable I/O lines in any of the combinations of unidirectional input/output, and bidirectional ports indicated in Table 1. In order to take full advantage of the large number of possible I/O configurations, sockets are provided for interchangeable I/O line drivers and terminators to provide the required sink current, polarity, and drive/termination characteristics for each application. The 48 programmable I/O lines and signal ground lines are brought out to two 50-pin edge connectors that mate with flat, round, or woven cable. Typical I/O read access time is 280 nanoseconds. Typical I/O read cycle time is 600 nanoseconds.

Communications Interface

The programmable communications interface on the iSBC 517 is provided by an Intel 8251 Universal Synchronous/Asynchronous Receiver/Transmitter (USART). The USART can be programmed by the system software to select the desired asynchronous or synchronous serial data transmission technique (including IBM Bi-Sync). The mode of operation (i.e., synchronous or asynchronous), data format, control character format, parity, and asynchronous serial transmission rate are all under program control. The 8251 provides full duplex, double-buffered transmit and receive capability, and parity, overrun, and framing error detection are all incorporated in the USART. The comprehensive RS232C interface on the board provides a direct interface to RS232C compatible equipment. The RS232C serial data lines and signal ground lines are brought out to a 26-pin edge connector that mates with RS232C compatible flat or round cables.

Interrupt Request Lines

Interrupt requests may originate from eight sources. Four jumper selectable interrupt requests can be automatically generated by the programmable peripheral interface when a byte of information is ready to be transferred to the CPU (i.e., input buffer is full) or a character has been transmitted (i.e., output data buffer is empty). Two jumper selectable interrupt requests can be automatically generated by the USART when a character is ready to be transferred to the CPU (i.e., receive buffer is full) or a character has been transmitted (transmit buffer is empty). These six interrupt request lines are all maskable under program control. Two interrupt request lines may be interfaced directly from user designated peripheral devices via the I/O edge connector. An onboard register contains the status of all eight interrupt request lines, and may be interrogated by the CPU. Each interrupt request line is maskable under program control. Routing for the eight interrupt request lines is jumper selectable. They may be ORed



NOTE:
Interrupts originating from the programmable communications interface and programmable peripheral interface are jumper selectable.

Figure 1. iSBC® 517 Combination I/O Expansion Board Block Diagram

Table 1. Input/Output Port Modes of Operation

Ports	Lines (qty)	Mode of Operation					
		Unidirectional				Bidirectional	Control
		Input		Output			
		Unlatched	Latched & Strobed	Latched	Latched & Strobed		
1	8	X	X	X	X	X	
2	8	X	X	X	X		
3	4	X		X			X(1)
	4	X		X			X(1)
4	8	X	X	X	X	X	
5	8	X	X	X	X		
6	4	X		X			X(2)
	4	X		X			X(2)

NOTES:
1. Part of port 3 must be used as control port when either port 1 or port 2 are used as a latched and strobed input or a latched and strobed output port or port 1 is used as a bidirectional port.
2. Part of port 6 must be used as a control port when either port 4 or port 5 are used as a latched and strobed input or a latched and strobed output port or port 4 is used as a bidirectional port.

to provide a single interrupt request line for the iSBC 80/10B, or they may be individually provided to the system bus for use by other iSBC single board computers.

Interval Timer

Each board contains a jumper selectable 1 ms interval timer. The timer is enabled by jumpering one of the interrupt request lines from the I/O edge connector to a 1 ms interval interrupt request signal originating from the baud rate generator.

SPECIFICATIONS

I/O Addressing

Port	1	2	3	4	5	6	8255 No. 1 Control	8255 No. 2 Control	USART Data	USART Control
Address	X4	X5	X6	X8	X9	XA	X7	XB	XC	XD

NOTE:
X is any hex digit assigned by jumper selection.

I/O Transfer Rate

Parallel—Read or write cycle time 760 ns max
Serial—(USART)

Frequency (kHz) (Jumper Selectable)	Baud Rate (Hz)		
	Synchronous	Asynchronous (Program Selectable)	
		÷16	÷64
153.6	—	9600	2400
76.8	—	4800	1200
38.4	38400	2400	600
19.2	19200	1200	300
9.6	9600	600	150
4.8	4800	300	75
6.98	6980	—	110

Serial Communications Characteristics

Synchronous—5–8 bit characters; internal or external character synchronization; automatic sync insertion.

Asynchronous—5–8 bit characters; peak characters generation; 1, 1½, or 2 stop bits; false start bit detectors.

Interrupts

Eight interrupt request lines may originate from the programmable peripheral interface (4 lines), the USART (2 lines), or user specified devices via the I/O edge connector (2 lines) or interval timer.

Interrupt Register Address

X1 Interrupt mask register
X0 Interrupt status register

NOTE:
X is any hex digit assigned by jumper selection.

Timer Interval

1.003 ms ±0.1% when 110 baud rate is selected
1.042 ms ±0.1% for all other baud rates

Interfaces

Bus—All signals TTL compatible
Parallel I/O—All signals TTL compatible
Serial I/O—RS232C
Interrupt Requests—All TTL compatible

Connectors

Interface	Pins (qty)	Centers (in.)	Mating Connectors
Bus	86	0.156	CDC VPB01E43A00A1
Parallel I/O	50	0.1	3M 3415-000 or TI H312125
Serial I/O	26	0.1	3M 3462-000 or TI H312113
Auxiliary(1)	60	0.1	AMP PE5-14559 or TI H311130

NOTE:
1. Connector heights and wire-wrap pin lengths are not guaranteed to conform to Intel OEM or system packaging. Auxiliary connector is used for test purposes only.

Line Drivers and Terminators

I/O Drivers—The following line drivers and terminators are compatible with all the I/O driver sockets on the iSBC 517:

Driver	Characteristics	Sink Current (mA)
7438	I,OC	48
7437	I	48
7432	NI	16
7426	I,OC	16
7409	NI,OC	16
7408	NI	16
7403	I,OC	16
7400	I	16

NOTE:
I = Inverting; NI = non-inverting; OC = open-collector.

Ports 1 and 4 have 25 mA totem-pole drivers and 1 kΩ terminators.

I/O Terminators—220Ω/330Ω divider or 1 kΩ pullup

Bus Drivers

Function	Characteristics	Sink Current (mA)
Data	Tri-state	50
Commands	Tri-state	25

Physical Characteristics

Width: 12.00 in. (30.48 cm)
Height: 6.75 in. (17.15 cm)
Depth: 0.50 in. (1.27 cm)
Weight: 14 oz. (397.3 gm)

Electrical Characteristics

Average DC Current
V_{CC} = +5V ±5%
V_{DD} = +12V ±5%
V_{AA} = −12 ±5%
I_{CC} = 2.4 mA max
I_{DD} = 40 mA max
I_{AA} = 60 mA max

NOTE:
Does not include power required for optional I/O drivers and I/O terminators. With eight 220Ω/330Ω input terminators installed, all terminator inputs low.

Environmental Characteristics

Operating Temperature—0°C to +55°C

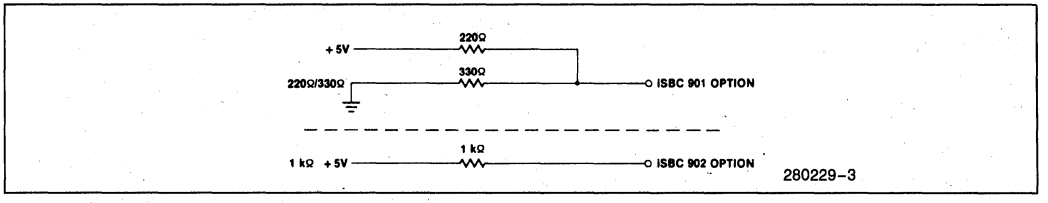
Reference Manual

9800388B—iSBC 517 Hardware Reference manual (NOT SUPPLIED)

Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

ORDERING INFORMATION

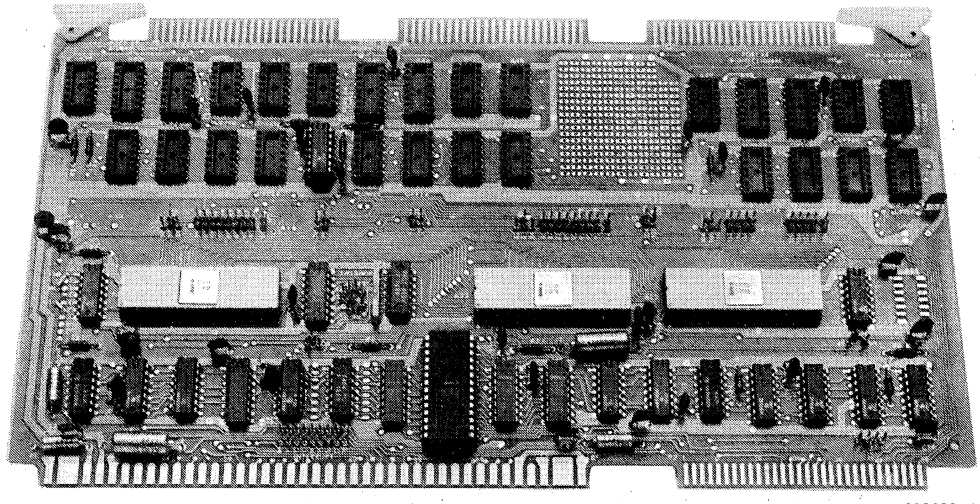
Part Number	Description
SBC 517	Combination I/O Expansion Board



iSBC® 519
PROGRAMMABLE I/O EXPANSION BOARD

- **iSBC® I/O Expansion via Direct MULTIBUS® Interface**
- **72 Programmable I/O Lines with Sockets for Interchangeable Line Drivers and Terminators**
- **Jumper Selectable I/O Port Addresses**
- **Jumper Selectable 0.5, 1.0, 2.0, or 4.0 ms Interval Timer**
- **Eight Maskable Interrupt Request Lines with Priority Encoded and Programmable Interrupt Algorithms**

The iSBC 519 Programmable I/O Expansion Board is a member of Intel's complete line of iSBC memory and I/O expansion boards. The iSBC 519 interfaces directly to any iSBC single board computer via the system bus to expand input and output port capacity. The iSBC 519 provides 72 programmable I/O lines. The system software is used to configure the I/O lines to meet a wide variety of peripheral requirements. The flexibility of the I/O interface is further enhanced by the capability of selecting the appropriate combination of optional line drivers and terminators to provide the required sink current, polarity, and drive/termination characteristics for each application. Address selection is accomplished by using wire-wrap jumpers to select one of 16 unique base addresses for the input and output ports. The board operates with a single +5V power supply.



280230-1

October 1986
Order Number: 280230-001

FUNCTIONAL DESCRIPTION

The 72 programmable I/O lines on the iSBC 519 are implemented utilizing three Intel 8255A programmable peripheral interfaces. The system software is used to configure the I/O lines in any combination of undirectional input/output and bidirectional ports indicated in Table 1. In order to take full advantage of the large number of possible I/O configurations, sockets are provided for interchangeable I/O line drivers and terminators. The 72 programmable I/O lines and signal ground lines are brought out to three 50-pin edge connectors that mate with flat, round, or woven cable.

Interval Timer

Typical I/O read access time is 350 nanoseconds. Typical I/O read/write cycle time is 450 nanoseconds. The interval timer provided on the iSBC 519 may be used to generate real time clocking in systems requiring the periodic monitoring of I/O functions. The time interval is derived from the constant clock (BUS CCLK) and the timing interval is jumper selectable. Intervals of 0.5, 1.0, 2.0, and 4.0 milliseconds may be selected when an iSBC single board computer is used to generate the clock. Other timing intervals may be generated if the user provides a separate constant clock reference in the system.

Eight-Level Vectored Interrupt

An Intel 8259A programmable interrupt controller (PIC) provides vectoring for eight interrupt levels. As shown in Table 2, a selection of three priority processing algorithms is available to the system designer so that the manner in which requests are serviced

Table 1. Input/Output Port Modes of Operation

Ports	Lines (qty)	Mode of Operation					Control
		Unidirectional				Bidirectional	
		Input		Output			
		Unlatched	Latched & Strobed	Latched	Latched & Strobed		
1,4,7	8	X	X	X	X	X	
2,5,8	8	X	X	X	X		
3,6,9	4	X		X			X(1,2,3)
	4	X		X			X(1,2,3)

NOTES:
1. Part of port 3 must be used as a control port when either port 1 or port 2 are used as a latched and strobed input or a latched and strobed output port or port 1 is used as a bidirectional port.
2. Part of port 6 must be used as a control port when either port 4 or port 5 are used as a latched and strobed input or a latched and strobed output port or port 4 is used as a bidirectional port.
3. Part of port 9 must be used as a control port when either port 7 or port 8 are used as a latched and strobed input or a latched and strobed output port or port 7 is used as a bidirectional port.

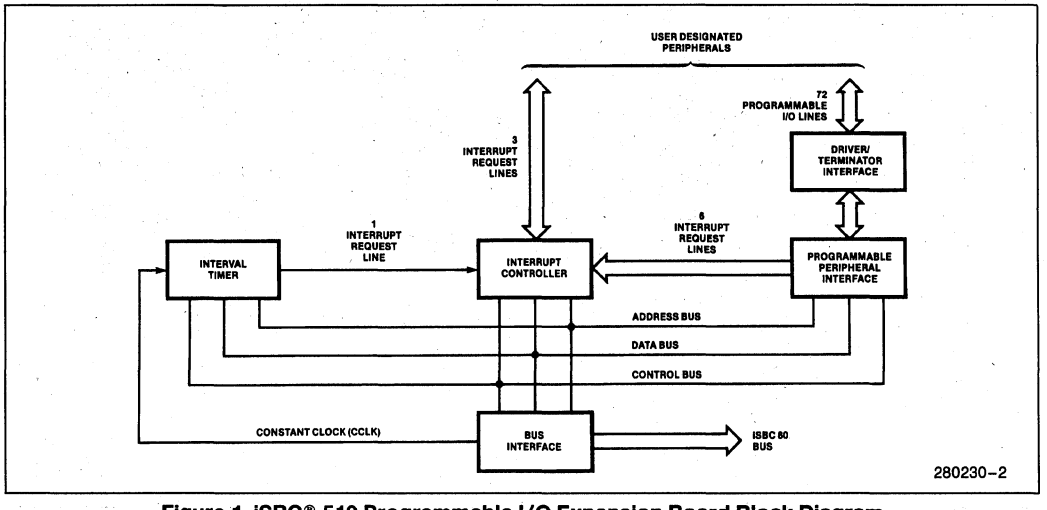


Figure 1. iSBC® 519 Programmable I/O Expansion Board Block Diagram

Table 2. Interrupt Priority Options

Algorithm	Operation
Fully nested	Interrupt request line priorities fixed at 0 as highest, 7 as lowest.
Auto-rotating	Equal priority. Each level, after receiving service, becomes the lowest priority level until next interrupt occurs.
Specific priority	System software assigns lowest priority level. Priority of all other levels are based in sequence numerically on this assignment.

may be configured to match system requirements. Priority assignments may be reconfigured dynamically via software at any time during system operation. The PIC accepts interrupt requests from the programmable parallel I/O interfaces, the interval timer, or direct from peripheral equipment. The PIC then determines which of the incoming requests is of the highest priority, determines whether this request is of higher priority than the level currently being serviced, and if appropriate, issues an interrupt to the system master. Any combination of interrupt levels may be masked through storage, via software, of a single byte to the interrupt mask register of the PIC.

Interrupt Request Generation—Interrupt requests may originate from 10 sources. Six jumper selectable interrupt requests can be automatically generated by the programmable peripheral interfaces when a byte of information is ready to be transferred to the system master (i.e., input buffer is full) or a character has been transmitted (i.e., output data buffer is empty). Three interrupt request lines may be interfaced to the PIC directly from user designated peripheral devices via the I/O edge connectors. One interrupt request may be generated by the interval timer.

Bus Line Drivers—The PIC interrupt request output line may be jumper selected to drive any of the nine interrupt lines on the MULTIBUS. Any of the onboard request lines may also drive any interface interrupt line directly via jumpers and buffers on the board.

SPECIFICATIONS

Addressing

Port	1	2	3	8255 No. 1 Control	4	5	6	8255 No. 2 Control	7	8	9	8255 No. 3 Control
Address	X0	X1	X2	X3	X4	X5	X6	X7	X8	X9	XA	XB

Interrupts

Register Addresses (hex notation, I/O address space)
XD Interrupt request register
XC In-service register
XD Mask register
XC Command register
XD Block address register
XC Status (polling register)

NOTE:
Several registers have the same physical address; sequence of access and one data bit of control word determines which register will respond.

Ten interrupt request lines may originate from the programmable peripheral interface (6 lines), or user specified devices via the I/O edge connector (3 lines), or interval timer (1 line).

Interval Timer

Output Register—Timer interrupt register output is cleared by an output instruction to I/O address XE or XF(1).

Timing Intervals—500, 1,000, 2,000 and 4,000 ms ±1%; jumper selectable(2).

NOTES:
1. X is any hex digit assigned by jumper selection.
2. Assumes constant clock (CCLK) frequency of 9.216 MHz ±1%.

Interfaces

Bus—All signals TTL compatible
Parallel I/O—All signals TTL compatible
Interrupt Requests—All TTL compatible

Connectors

Interface	Pins (qty)	Centers (in.)	Mating Connectors
Bus	86	0.156	Viking 3KH43/9AMK12
Parallel I/O	50	0.1	3M 3415-000 or TI H312125
Serial I/O	26	0.1	3M 3462-000 or TI H312113
Auxiliary(1)	60	0.1	AMP PE5-14559 or TI H311130

NOTE:
1. Connector heights and wirewrap pin lengths are not guaranteed to conform to Intel OEM or System packaging.

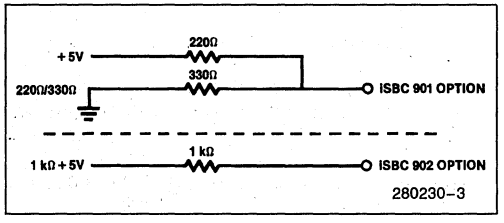
Line Drivers and Terminators

I/O Drivers—The following line drivers and terminators are compatible with all the I/O driver sockets on the iSBC 519:

Driver	Characteristics	Sink Current (mA)
7438	I,OC	48
7437	I	48
7432	NI	16
7426	I,OC	16
7409	NI,OC	16
7408	NI	16
7403	I,OC	16
7400	I	16

NOTE:
I = inverting; NI = non-inverting; OC = open-collector.

I/O Terminators—220Ω/330Ω divider or 1 kΩ pull-up.



Ports 1, 4 and 7 may use any of the drivers or terminators shown above for unidirectional (input or output) port configurations. Either terminator and the following bidirectional drivers and terminators may be used for ports 1, 4 and 7 when these ports are used as bidirectional ports.

Bidirectional Drivers

Driver	Characteristics	Sink Current (mA)
Intel 8216	NI,TS	25
Intel 8226	I, TS	50

NOTE:
I = inverting, NI = non-inverting; TS = three-state

Terminators (for ports 1, 4 and 7 when used as bidirectional ports)

Supplier	Product Series
CTS	760-
Dale	LDP14k-02
Beckman	899-1

Bus Drivers

Function	Characteristics	Sink Current (mA)
Data	Tri-state	50
Commands	Tri-state	25

Physical Characteristics

Width: 12.00 in. (30.48 cm)
Height: 6.75 in. (17.15 cm)
Depth: 0.50 in. (1.27 cm)
Weight: 14 oz. (397.3 gm)

Electrical Characteristics

Average DC Current

Voltage	Without Termination(1)	With Termination(2)
V_{CC} = +5V ±5%	I_{CC} = 1.5A max	3.5A max

NOTES:
1. Does not include power required for operational I/O drivers and I/O terminators.
2. With 18 220Ω/330Ω input terminators installed, all terminator inputs low.

Environmental Characteristics

Operating Temperature: 0°C to +55°C

Reference Manual

9800385B—iSBC 519 Hardware Reference manual (NOT SUPPLIED)

Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

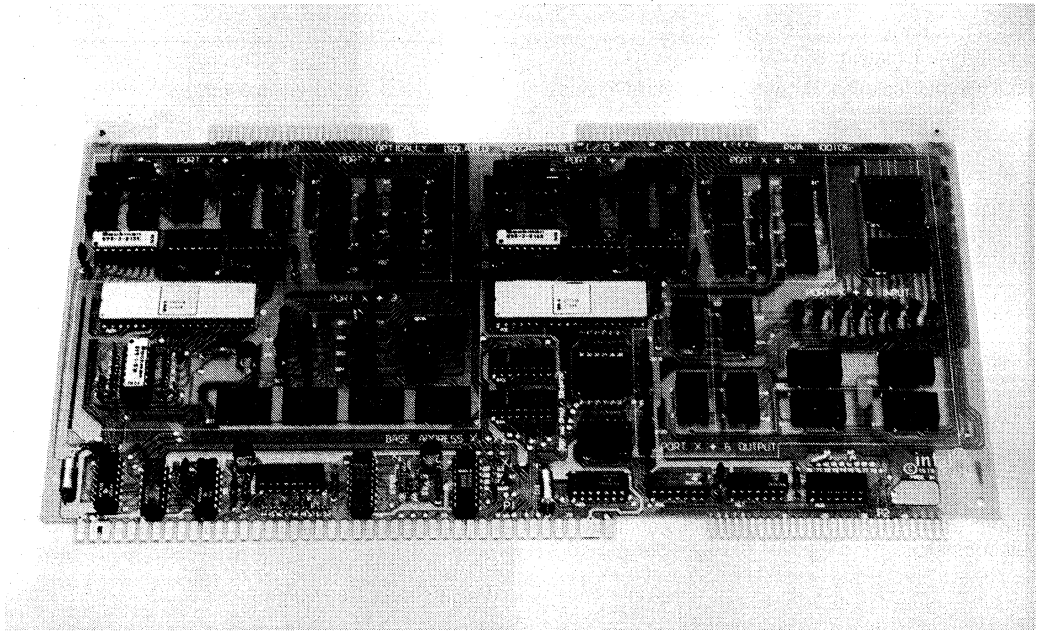
ORDERING INFORMATION

Part Number	Description
SBC 519	Programmable I/O Expansion Board

iSBC® 556
OPTICALLY ISOLATED I/O BOARD

- **Up to 48 Digital Optically Isolated Input/Output Data Lines for MULTIBUS® Systems**
- **Choice of**
  - **— 24 Fixed Input Lines**
  - **— 16 Fixed Output Lines**
  - **— 8 Programmable Lines**
- **Provisions for Plug-In, Optically Isolated Receivers, Drivers, and Terminators**
- **Voltage/Current Levels**
  - **— Input up to 48V**
  - **— Output up to 30V, 60 mA**
- **Common Interrupt for up to 8 Sources**
- **+5V Supply Only**

The iSBC 556 Optically Isolated I/O Board provides 48 digital input/output lines with isolation between process application or peripheral device and the system CPU board(s). The iSBC 556 contains two 8255A programmable interface devices, and sockets for user supplied optically isolated drivers, receivers, and input resistor terminators, together with common interrupt logic and interface circuitry for the system bus. Input signals can be single-ended or differential types with user defined input range (resistor terminator and opto-isolated receiver selection), allowing flexibility in design of voltage and threshold levels. The output allows user selection of Opto-Isolated Darlington Pair which can be used as an output driver either as an open collector or current switch.



280231-1

November 1986
Order Number: 280231-001

Table 1. I/O Ports Opto-Isolator Receivers, Drivers, and Terminators

Port No. X = I/O Base Address	Type of I/O	Lines (qty)	Resistor Terminator Pac-Rp 16-Pin DIP Bourns 4116R-00 or Equivalent	Dual Opto-Isolator 8-Pin DIP Monsanto MC T66 or Equivalent	Driver 7438 or Equivalent	Pull-Up iSBC® 902
X + 0	Input	8	1	4	—	
X + 1	Output	8	—		—	
X + 2	Input/ Control	8	1		—	
X + 4	Input	8	1	4	—	
X + 5	Output	8			—	
X + 6	Input/ Output Control	8	1 if input		2 if input	2 if input
X + 7						

SPECIFICATIONS

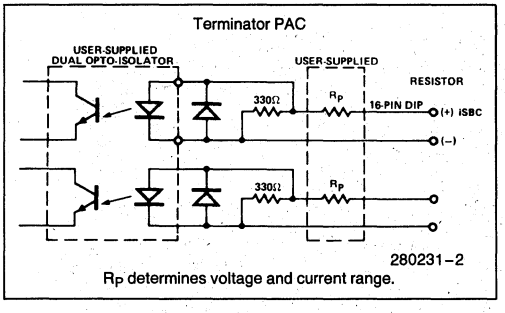
Number of Lines

24 input lines
16 output lines
8 programmable lines: 4 input — 4 output

I/O Interface Characteristics

Line-to-Line Isolation: 235V DC or peak AC

Input/Output Isolation: 500V DC or peak AC



R_P determines voltage and current range.

Bus Interface Characteristics

All data address and control commands are iSBC 80 bus compatible.

I/O Addressing

Port	8255 #1			Control	8255 #2			Control
	A	B	C		A	B	C	
Address	X+0	X+1	X+2	X+3	X+4	X+5	X+6	X+7

Where: base address is from 00H to 1FH (jumper selectable)

Connectors

Interface	Pins qty.	Centers in.	Centers cm	Mating Connectors
P1 iSBC bus	86	0.156		Viking 3KH43/9AMK12
J1 16 fixed input & 8 fixed output lines	50	0.1		3M 3415-000 or TI M312125
J2 8 fixed input, 8 fixed output, & 8 programmable input/ output lines	50	0.1		3M 3415-000 or TI M312125

Physical Characteristics

Width: 12.00 in. (30.48 cm)
Height: 6.75 in. (17.15 cm)
Depth: 0.50 in. (1.27 cm)
Weight: 12 oz. (397.3 gm)

Electrical Characteristics

Average DC Current

V_{CC} = +5V ±5%, 1.0A without user supplied isolated receiver/driver

I_{CC} = 1.6A max with user supplied isolator receiver/driver

Environmental Characteristics

Temperature: 0°C to 55°C

Relative Humidity: 0% to 90%, non-condensing

Reference Manual

502170— iSBC 556 Hardware Reference Manual (Order Separately)

Reference manuals are shipped with each product only if designated SUPPLIED (see above). Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

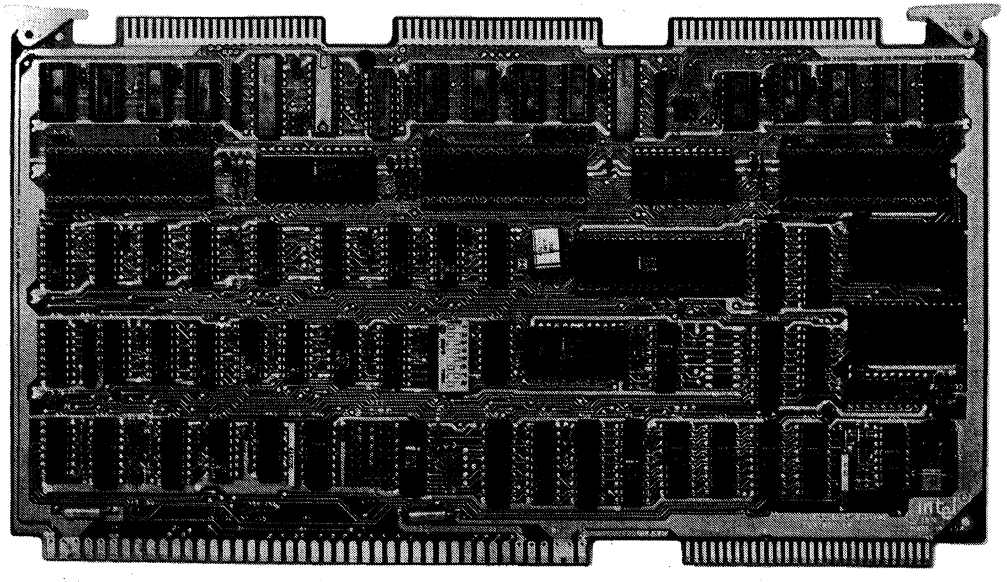
ORDERING INFORMATION

Part Number	Description
SBC 556	Optically Isolated I/O Board

iSBC® 569
INTELLIGENT DIGITAL CONTROLLER

- **Single Board Digital I/O Controller with up to Four Microprocessors to Share the Digital Input/Output Signal Processing**
- **3 MHz 8085A Central Control Processor**
- **Three Sockets for 8041/8741A Universal Peripheral Interface (UPI-41A) for Distributed Digital I/O Processing**
- **Three Operational Modes**
  - **— Stand-Alone Digital Controller**
  - **— MULTIBUS® Master**
  - **— Intelligent Slave (Slave to MULTIBUS Master)**
- **2K Bytes of Dual Port Static Read/Write Memory**
- **Sockets for up to 8K Bytes of Intel 2758, 2716, 2732 Erasable Programmable Read Only Memory**
- **48 Programmable Parallel I/O Lines with Sockets for Interchangeable Line Drivers or Terminators**
- **Three Programmable Counters**
- **12 Levels of Programmable Interrupt Control**
- **Single +5V Supply**
- **MULTIBUS Standard Control Logic Compatible with Optional iSBC 80 and iSBC® 86 CPU, Memory, and I/O Expansion Boards**

The Intel iSBC® 569 Intelligent Digital Controller is a single board computer (8085A based) with sockets for three 8041A/8741A Universal Peripherals Interface chips (UPI-41A). These devices, which are programmed by the user, may be used to offload the 8085A processor from time consuming tasks such as pulse counting, event sensing and parallel or serial digital I/O data formatting with error checking and handshaking. The iSBC 569 board is a complete digital controller with up to four processors on a single 6.75 inches x 12.00 inches (17.15 cm x 30.48 cm) printed circuit board. The 8085A CPU, system clock, read/write memory, non-volatile memory, priority interrupt logic, programmed timers, MULTIBUS control and interface logic, optional UPI processors and optional line driver and terminators all reside on one board.



280232-1

October 1986
Order Number: 280232-001

FUNCTIONAL DESCRIPTION

Intelligent Digital Controller

Three Modes of Operation—The iSBC 569 Intelligent Digital Controller is capable of operating in one of three modes; stand alone controller, bus master, or intelligent slave.

Stand Alone Controller—The iSBC 569 board may function as a stand alone, single board controller with CPU, memory, and I/O elements on a single board. Five volt (+5VDC) only operation allows configuration of low cost controllers with only a single power supply voltage. The on-board 2K bytes RAM and up to 16K bytes ROM/EPROM, as well as the assistance of three UPI-41A processors, allow significant digital I/O control from a single board.

Bus Master—In this mode of operation, the iSBC 569 controller may interface with and control iSBC expansion memory and I/O boards, or even other iSBC 569 Intelligent Digital Controllers configured as intelligent slaves (but no additional bus masters).

Intelligent Slave—The iSBC 569 controller can perform as an intelligent slave to any 8- or 16-bit MULTIBUS master CPU by offloading the master of digital control related tasks. Preprocessing of data for the master is controlled by the on-board 8085A CPU which coordinates up to three UPI-41A processors.

Using the iSBC 569 board as an intelligent slave, multi-channel digital control can be managed entirely on-board, freeing a system master to perform other system functions. The dual port RAM memory allows the iSBC 569 controller to process and store data without MULTIBUS memory contention.

Simplified Programming

By using Intel UPI-41A processors for common tasks such as counting, sensing change of state, printer control and keyboard scanning/debouncing, the user frees up time to work on the more important application programming of machine or process optimization. Controlling the Intel UPI-41A processors becomes a simple task of reading or writing command and data bytes to or from the data bus buffer register on the UPI device.

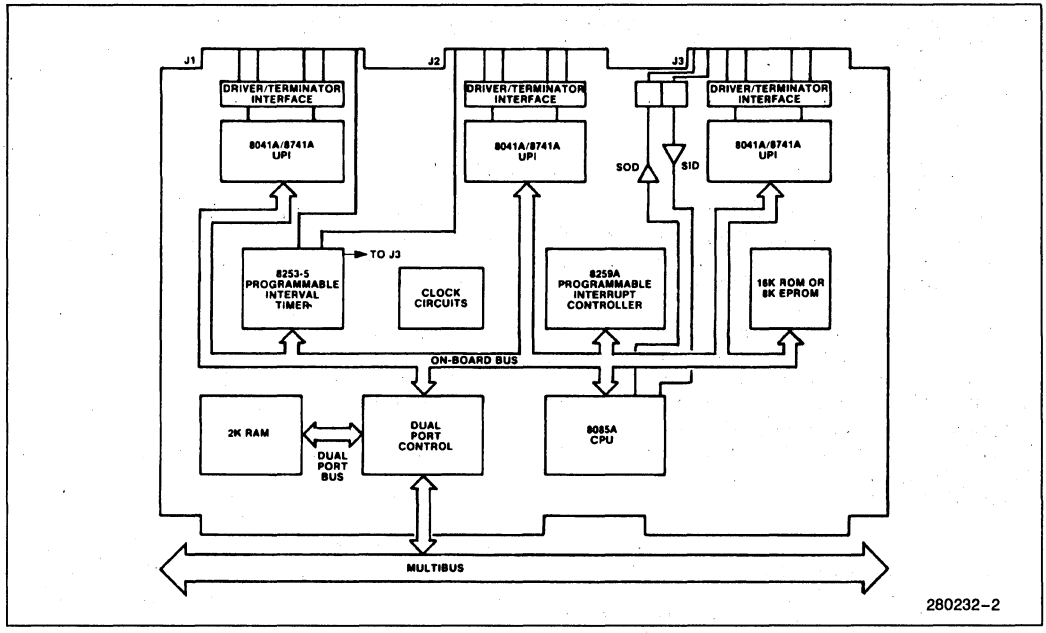


Figure 1. iSBC® 569 Intelligent Digital Controller Block Diagram

Central Processing Unit

A powerful Intel 8085A 8-bit CPU, fabricated on a single LSI chip, is the central processor for the iSBC 569 controller. The six general purpose 8-bit registers may be addressed individually or in pairs, providing both single and double precision operations. The program counter can address up to 64K bytes of memory using iSBC expansion boards. The 16-bit stack pointer controls the addressing of an external stack. This stack provides sub-routine nesting bounded only by memory size. The minimum instruction execution time is 1.30 microseconds. The 8085A CPU is software compatible with the Intel 8080A CPU.

Bus Structure

The iSBC 569 Intelligent Digital Controller utilizes a triple bus architecture concept. An internal bus is used for on-board memory and I/O operations. A MULTIBUS interface is available to provide access for all external memory and I/O operations. A dual port bus with controller enables access via the third bus to 2K bytes of static RAM from either the on-board CPU or a system master. Hence, common data may be stored in on-board memory and may be accessed either by the on-board CPU or by system masters. A block diagram of the iSBC 569 functional components is shown in Figure 1.

RAM Capacity

The iSBC 569 board contains 2K bytes of read/write memory using Intel 2114 static RAMs. RAM accesses may occur from either the iSBC 569 controller or from any other bus master interfaced via the MULTIBUS system bus. The iSBC 569 board provides addressing jumpers to allow the on-board RAM to reside within a one megabyte address space when accessed via the system bus. In addition, a switch is provided which allows the user to reserve a 1K byte segment of on-board RAM for use by the 8085A CPU. This reserved RAM space is not accessible via the system bus and does not occupy any system address space.

EPROM/ROM Capacity

Two sockets for up to 16K bytes of nonvolatile read only memory are provided on the iSBC 569 board. Nonvolatile memory may be added in 1K byte increments up to a maximum of 2K bytes using Intel 2758 erasable and electrically reprogrammable ROMs (EPROMs); in 2K byte increments up to a maximum of 4K bytes using Intel 2316 ROMs or 2716 EPROMs; in 4K byte increments up to 8K bytes maximum using Intel 2732 EPROMs; or in 8K byte increments up to 16K bytes maximum using Intel 2364 ROMs (both sockets must contain same type ROM/EPROM). All on-board ROM/EPROM operations are performed at maximum processor speed.

Universal Peripheral Interfaces (UPI-41A)

The iSBC 569 Intelligent Digital Controller board provides three sockets for user supplied Intel 8041A/8741A Universal Peripheral Interface (UPI-41A) chips. Sockets are also provided for the associated line drivers and terminators for the UPI I/O ports. The UPI-41A processor is a single chip microcomputer containing a CPU, 1K byte of ROM (8041A) or EPROM (8741A), 64K bytes of RAM, 16 programmable I/O lines, and an 8-bit timer/event counter. Special interface registers included in the chip allow the UPI-41A processor to function as a slave processor to the iSBC 569 controller board's 8085A CPU. The UPI processor allows the user to specify algorithms for controlling peripherals directly thereby freeing the 8085A for other system functions. For additional information, including UPI-41A instructions, refer to the UPI-41 User's Manual (Manual No. 9800504).

Programmable Timers

The iSBC 569 Intelligent Digital Controller board provides three independently programmable interval timer/counters utilizing one Intel 8253 Programmable Interval Timer (PIT). The Intel 8253 PIT provides three 16-bit BCD or binary interval timer/counters. Each timer may be used to provide a time reference for each UPI™ processor or for a group of UPI processors. The output of each timer also connects to the 8259A Programmable Interrupt Controller (PIC) providing the capability of timed interrupts. All gate inputs, clock inputs, and timer outputs of the 8253 PIT are available at the I/O ports for external access.

Timer Functions—In utilizing the iSBC 569 controller, the systems designer simply configures, via software, each timer to meet systems requirements. The 8253 PIT modes are listed in Table 1. The contents of each counter may be read at any time during system operation with simple read operations for event counting applications. The contents of each counter can be read "on-the-fly" for time stamping events or time clock referenced program initiations.

Table 1. 8253 Programmable Timer Functions

Function	Operation
Interrupt on Terminal Count	When terminal count is reached, an interrupt request is generated.
Programmable One-Shot	Output goes low upon receipt of an external trigger edge or software command and returns high when terminal count is reached. This function is retriggerable.
Rate Generator	Divide by N counter. The output will go low for one input clock cycle, and the period from one low-going pulse to the next is N times the input clock period.
Square-Wave Rate Generator	Output will remain high until one-half the count has been completed, and go low for the other half of the count.
Software Triggered Strobe	Output remains high until software loads count (N). N counts after count is loaded, output goes low for one input clock period.
Hardware Triggered Strobe	Output goes low for one clock period N counts after rising edge on counter trigger input. The counter is retriggerable.
Event Counter	On a jumper selectable basis, the clock input becomes an input from the external system. CPU may read the number of events occurring after the counting "window" has been enabled or an interrupt may be generated after N counts occur in the system.

Interrupt Capability

The iSBC 569 Intelligent Digital Controller provides interrupt service for up to 12 interrupt sources. Any of the 12 sources may interrupt the on-board processor. Four interrupt levels are handled directly by the 8085A CPU and eight levels are serviced from an Intel 8259A Programmable Interrupt Controller (PIC) routing an interrupt request output to the INTR input of the 8085A.

8085A Interrupt—Each of four direct 8085A interrupt inputs has a unique vector memory address. An 8085A jump instruction at each of these addresses then provides software linkage to interrupt service routines located independently anywhere in the memory.

8259A Interrupts—The eight interrupt sources originate from both on-board controller functions and the system bus:

UPI-41A Processors—One interrupt from each of three UPI processor sockets.

8253 PIT—One interrupt from each of three outputs.

MULTIBUS System Bus—one of eight MULTIBUS interrupt lines may be jumpered to either of two 8259A PIC interrupt inputs.

Programmable Reset—The iSBC 569 Intelligent Digital Controller board has a programmable output latch used to control on-board functions. Three of the outputs are connected to separate UPI-41A RESET inputs. Thus, the user can reset any or all of the UPI-41A processors under software control. A fourth latch output may be used to generate an interrupt request onto the MULTIBUS interrupt lines. A fifth latch output is connected to a light-emitting diode which may be used for diagnostic purposes.

Expansion Capabilities

When the iSBC 569 controller is used as a single board digital controller, memory and I/O capacity may be expanded using Intel MULTIBUS compatible expansion boards. In this mode, no other bus masters may be in the system. Memory may be expanded to a 64K byte capacity by adding user specified combinations of RAM boards, EPROM boards, or combination boards. Input/output capacity may be increased by adding I/O expansion boards. Multiple iSBC 569 boards may be included in an expanded system using one iSBC 569 Intelligent Digital Controller as the system master and additional controllers as intelligent slaves.

Intelligent Slave Programming

When used as an intelligent slave, the iSBC controller appears as an additional RAM memory module. System bus masters communicate with the iSBC 569 boards as if it were just an extension of system memory. To simplify this communication, the user has been given some specific tools:

Flag Interrupt—The Flag Interrupt is generated any time a write command is performed by an off-board CPU to the first location of iSBC 569 RAM. This interrupt provides a means for the master CPU to notify the iSBC 569 controller that it wished to establish a communications sequence. The flag interrupt is cleared when the on-board processor reads the first location of its RAM. In systems with more than one intelligent slave, the flag interrupt provides a unique

interrupt to each slave outside the normal MULTIBUS interrupt lines (INT0/-INT7/).

RAM—The on-board 2K byte RAM area that is accessible to both an off-board CPU and the on-board 8085A may be configured for system access on any 2K boundary.

MULTIBUS® Interrupts—The third tool to improve system operation as an intelligent slave is access to the MULTIBUS interrupt lines. The iSBC 569 controller can both respond to interrupt signals from an off-board CPU, and generate an interrupt to the off-board CPU via the system bus.

System Development Capability

Software development for the iSBC 569 Intelligent Digital Controller board is supported by the Intellec® Microcomputer Development System including a resident macroassembler, text editor, system monitor, a linker, object code locator, and Library Manager. In addition, both PL/M AND FORTRAN language programs can be compiled to run on the iSBC 569 board. A unique incircuit emulator (ICE-85™) option provides the capability of developing and debugging software directly on the iSBC 569 board. This greatly simplifies the design, development, and debug of iSBC 569 system software.

SPECIFICATIONS

8085A CPU

Word Size: 8, 16 or 24 bits

Cycle Time: 1.30 μs ±0.1% for fastest executable instruction; i.e., four clock cycles.

Clock Rate: 3.07 MHz ±0.1%

System Access Time

Dual port memory—725 ns

Memory Capacity

On-board ROM/EPROM—2K, 4K, 8K, or 16K bytes of user installed ROM or EPROM.

On-board RAM—2K bytes of static RAM. Fully accessible from on-board 8085A. Separately addressable from system bus.

Off-board expansion—up to 64K bytes of EPROM/ROM or RAM capacity.

I/O Capacity

Parallel-Timers—Three timers, with independent gate input, clock input, and timer output user-accessible. Clock inputs can be strapped to an external source or to an on-board 1.3824 MHz reference. Each timer is connected to a 8259A Programmable Interrupt Controller and may also be optionally connected to UPI processors.

UPI-I/O—Three UPI-41A interfaces, each with two 8-bit I/O ports plus the two UPI Test Inputs. The 8-bit ports are user-configurable (as inputs or outputs) in groups of four.

Serial—1 TTL compatible serial channel utilizing SID and SOD lines of on-board 8085A CPU.

On-Board Addressing

All communications to the UPI-41A processors, to the programmable reset latch, to the timers, and to the interrupt controller are via read and write commands from the on-board 8085A CPU.

Memory Addressing

On-board ROM/EPROM—0-07FF (using 2758 EPROMs); 0-OFFF (using 2716 EPROMs or 2316 ROMs); 0-1FFF (using 2732 EPROMs); 0-3FFF (using the 2364 ROMs)

On-board RAM—8000-87FF System access—any 2K increment 00000-FF800 (switch selection); 1K bytes may be disabled from bus access by switch selection.

I/O Addressing

Source	Addresses
8253	0E0H-0E3H
UPI0	0E4H-0E5H
UPI1	0E6H-0E7H
UPI2	0E8H-0E9H
PROGRAMMABLE RESET	0EAH-0EBH
8259A	0ECH-0EDH

Timer Specifications

Input Frequencies—jumper selectable reference

Internal: 1.3824 MHz ±0.1% (0.723 μs, nominal)
External: User supplied (2 MHz maximum)

Output Frequencies (at 1.3824 MHz)

Function	Min[1]	Max[1]
Real-time interrupt interval	1.45 μsec	47.4 msec
Rate Generator (frequency)	21.09 Hz	691.2 KHz
1. Single 16-bit binary count		

Interfaces

MULTIBUS™ Interface—All signals compatible with iSBC and MULTIBUS architecture

Parallel I/O—All signals TTL compatible

Interrupt Requests—All TTL compatible

Timer—All signals TTL compatible

Serial I/O—All signals TTL compatible

Connectors

Interface	Pins (qty)	Centers (in.)	Mating Connectors
Bus	86	0.156	Viking 3KH43/9AMK12
Parallel I/O	50	0.1	3M 3415-000 or TI H312125

Physical Characteristics

Width: 30.48 cm (12.00 inches)

Depth: 17.15 cm (6.75 inches)

Thickness: 1.27 cm (0.50 inch)

Weight: 3.97 gm (14 ounces)

Electrical Characteristics

DC Power Requirements—+5V @ 2.58A with no optional devices installed. For each 8741A add 135 mA. For each 220/330 resistor network, add 60 mA. Add the following for each EPROM/ROM installed.

Type	+5.0V Current Requirement	
	1ROM	2ROM
2758	100 mA	125 mA
2716	100 mA	125 mA
2316E	120 mA	240 mA
2732	40 mA	55 mA
2364	40 mA	55 mA

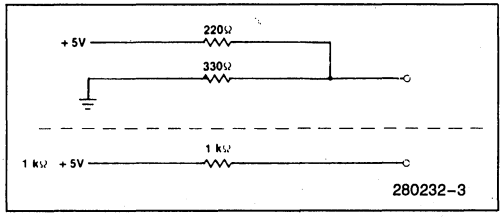
Line Drivers and Terminators

I/O /Drivers—The following line drivers are all compatible with the I/O driver sockets on the iSBC 569 Intelligent Digital Controller.

Driver	Characteristics	Sink Current (mA)
7438	I,OC	48
7437	I	48
7432	NI	16
7426	I,OC	16
7409	NI,OC	16
7408	NI	16
7403	I,OC	16
7400	I	16

NOTE:
I = inverting; NI = non-inverting; OC = open collector.

I/O Terminators—220Ω/330Ω divider or 1 kΩ pull-up (DIP) - user supplied



280232-3

Environmental Characteristics

Operating Temperature: 0° C to 55° C (32° F to 131 °F)

Relative Humidity: To 90% without condensation

Reference Manual

502180—iSBC 569 Intelligent Digital Controller Board Hardware Reference Manual (NOT SUPPLIED)

Reference manuals are shipped with each product only if designated SUPPLIED (see above). Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

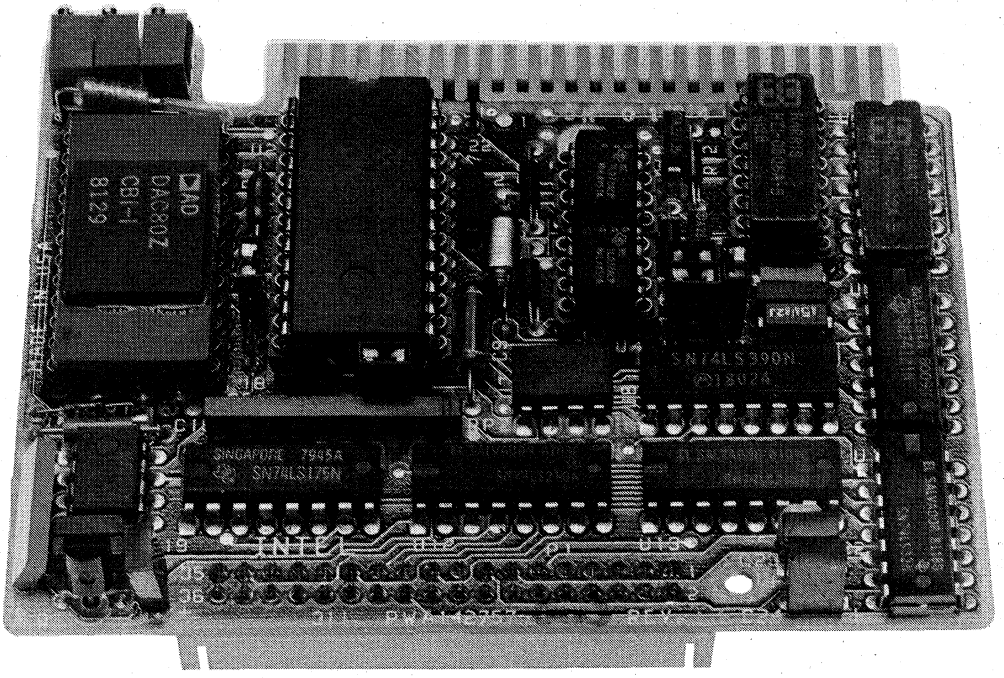
ORDERING INFORMATION

Part Number	Description
SBC 569	Intelligent Digital Controller

iSBX™ 311
ANALOG INPUT MULTIMODULE™ BOARD

- **Low Cost Analog Input Via iSBX™ MULTIMODULE™ Connector**
- **8 Differential/16 Single-Ended, Fault Protected Inputs**
- **20 mV to 5V Full Scale Input Range, Resistor Gain Selectable**
- **Unipolar (0 to +5V) or Bipolar (−5V to +5V) Input, Jumper Selectable**
- **12-Bit Resolution Analog-To-Digital Converter**
- **18 KHz Samples Per Second Throughput to Memory**

The Intel iSBX 311 Analog Input MULTIMODULE board provides simple interfacing of non-isolated analog signals to any iSBC board which has an iSBX compatible bus and connectors. The single-wide iSBX 311 plugs directly onto the iSBC board, providing data acquisition of analog signals from eight differential or sixteen single-ended voltage inputs, jumper selectable. Resistor gain selection is provided for both low level (20 mV full scale range) and high level (5 volt FSR) signals. Incorporating the latest high quality IC components, the iSBX 311 MULTIMODULE board provides 12 bit resolution, 11 bit accuracy, and a simple programming interface, all on a low cost iSBX MULTIMODULE board.



280233-1

October 1986
Order Number: 280233-002

FUNCTIONAL DESCRIPTION

The iSBX 311 Analog Input MULTIMODULE board is a member of Intel's growing family of MULTIMODULE expansion boards, designed to allow quick, easy, and inexpensive expansion for the Intel single board computer product line. The iSBX 311 Analog Input MULTIMODULE Board shown in Figure 1, is designed to operate with a variety of microcomputer modules that contains an iSBX bus connector (P1). The board provides 8 differential or 16 single-ended analog input channels that may be jumper-selected as the application requires. The MULTIMODULE board includes a user-configurable gain, and a user-selectable voltage input range (0 to +5 volts, or −5 to +5 volts). The MULTIMODULE board receives all power and control signals through the iSBX bus connector to initiate channel selection, sample and hold operation, and analog-to-digital conversion.

Input Capacity

Sixteen separate analog signals may be randomly or sequentially sampled in single-ended mode with the sixteen input multiplexers and a common ground. For noisier environments, differential input mode can be configured to achieve 8 separate differential signal inputs, or 16 pseudo-differential inputs.

Resolution

The iSBX 311 MULTIMODULES provide 12-bit resolution with a successive approximation analog-to-digital converter. For bipolar operation (−5 to +5 volts) it provides 11 bits plus sign.

Speed

To A-to-D converter conversion, speed is 35 microseconds (28 KHz samples per second). Combined with the sample and hold, settling times and the programming interface, maximum throughput via the iSBX bus and into memory will be 54 microseconds per sample, or 18 KHz samples per second, for a single channel, a random channel, or a sequential channel scan. A-to-D conversion is initiated via the iSBX connector and programmed command from the iSBC base board. Interrupt on end-of-conversion is a standard feature to ease programming and timing constraints.

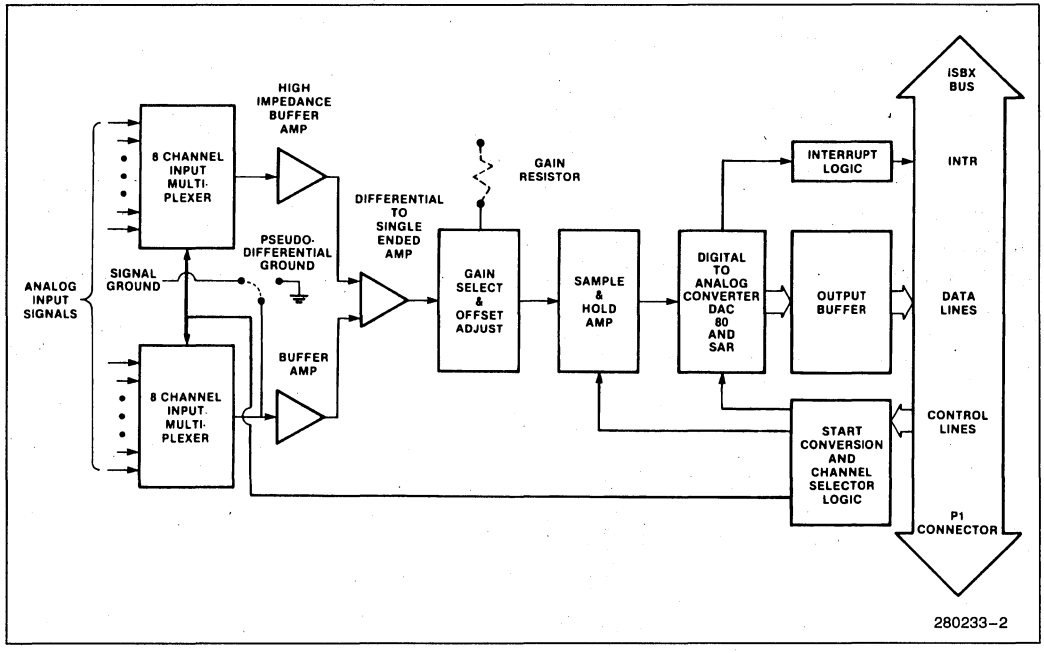


Figure 1. iSBX™ 311 Analog Input MULTIMODULE™ Board

Accuracy

High quality components are used to achieve 12 bits resolution and accuracy of 0.035% full scale range ±½ LSB. Offset and gain are adjustable to ±0.024% FSR ±½ LSB accuracy at any fixed temperature between 0°C (gain = 1). See specifications for other gain accuracies.

Gain

To allow sampling of millivolt level signals such as strain gauges and thermocouples, gain is made configurable via user inserted gain resistors up to 250 x (20 millivolts, full scale input range). User can select any other gain range from 1 to 250 to match his application.

OPERATIONAL DESCRIPTION

The host iSBC microcomputer addresses the iSBX 311 MULTIMODULE board by executing IN or OUT instructions to the iSBX 311 MULTIMODULE as one of the legal port addresses. Analog-to-digital conversions can be programmed in either of two modes: 1. start conversion and poll for end-of-conversion (EOC), or 2. start conversion and wait for interrupt (INTRO/) at end of conversion. When conversion is complete as signaled by one of the above techniques, INput instruction read two bytes (low and high bytes) containing the 12 bit data word plus status information as shown below.

OUTput Command—Select input channel and start conversion.

Bit Position	7	6	5	4	3	2	1	0
Input Channel					C3	C2	C1	C0

INput Data—Read converted data and status (low byte) or Read converted data (high byte). Reads can be with or without reset of interrupt request line (INTRO/).

Bit Position	7	6	5	4	3	2	1	0
Low/Status Byte	D3	D2	D1	D0		start/	busy/	EOC/

High Byte	D11	D10	D9	D8	D7	D6	D5	D4

Fastest data conversion and transfer to memory can be obtained by dedicating the microcomputer to setting the channel address/starting conversion, polling the status byte for EOC/, and when it comes true, read the two bytes of the conversion and send the start conversion/next channel address command. For multitasking situations it may be more convenient to use the interrupt mode, reading in data only after an interrupt signals end of conversion.

SPECIFICATIONS

Inputs—8 differential. 16 single-ended. Jumper selectable.

Full Scale Input
Voltage Range—−5 to +5 volts (bipolar). 0 to +5 volts (unipolar). Jumper selectable.

Gain—User-configurable through installation of two resistors. Factory-configured for gain of X1.

Resolution—12 bits over full scale range (1.22 mV at 0–5V, 5 μV at 0–20 mV).

Accuracy—

Gain	Accuracy at 25°C
1	±0.035% ± ½ LSB
5	±0.035% ± ½ LSB
50	±0.035% ± ½ LSB
250	±0.035% ± ½ LSB

NOTE:
Figures are in percent of full scale reading. At any fixed temperature between 0° and 60°C, the accuracy is adjustable to ±0.035% of full scale.

Dynamic Error—±0.015% FSR for transitions.

Gain TC (at Gain = 1): 30 PPM per degree centigrade (typical); 56 PPM per degree centigrade (max).

Offset TC (in percent of FSR/°C):

Gain	Offset
1	0.0018
5	0.0036
50	0.024
250	0.116

Offset is measured with user-supplied 10 PPM/°C gain resistors installed.

Input Protection—±30 volts.

Input Impedance—20 MΩ (minimum).

Conversion Speed—50 ms (nominal).

Common Mode Rejection Ratio—60 db (minimum).

Sample and hold—sample time 15 ms.

Aperture—hold aperture time: 120 ns.

Connectors—

Interface	Pins (Qty)	Centers in	Centers cm	Mating Connectors
P1 iSBX Bus	36	0.1	0.254	iSBC iSBX connector
J1 8/16 Channels Analog	50	0.1	0.254	3m 3415-000 or T1 H312125 or iCS 910 cable

Physical Characteristics

Width: 9.40 cm (3.7 inches)

Length: 6.35 cm (2.5 inches)

Height: 2.03 cm (0.80 inch) MULTIMODULE board only

2.82 cm (1.13 inches) MULTIMODULE and iSBC board

Weight: 68.05 gm (2.4 ounces)

Electrical Characteristics (from iSBX connector)

V_{cc} = ±5 volts (±0.25V), I_{cc} = 250 mAmax
V_{dd} = +12 volts (±0.6V), I_{dd} = 50 mAmax
V_{ss} = −12 volts (±0.6V), I_{ss} = 55 mAmax

Environmental Characteristics

Operating Temperature: 0° to 60°C (32° to 140°C)

Relative Humidity: to 90% (without condensation)

Reference Manuals

142913— iSBX 311 Analog Input MULTIMODULE Board Hardware Reference Manual (order separately)

Related Literature

230973—Distributed Control Data Book

Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

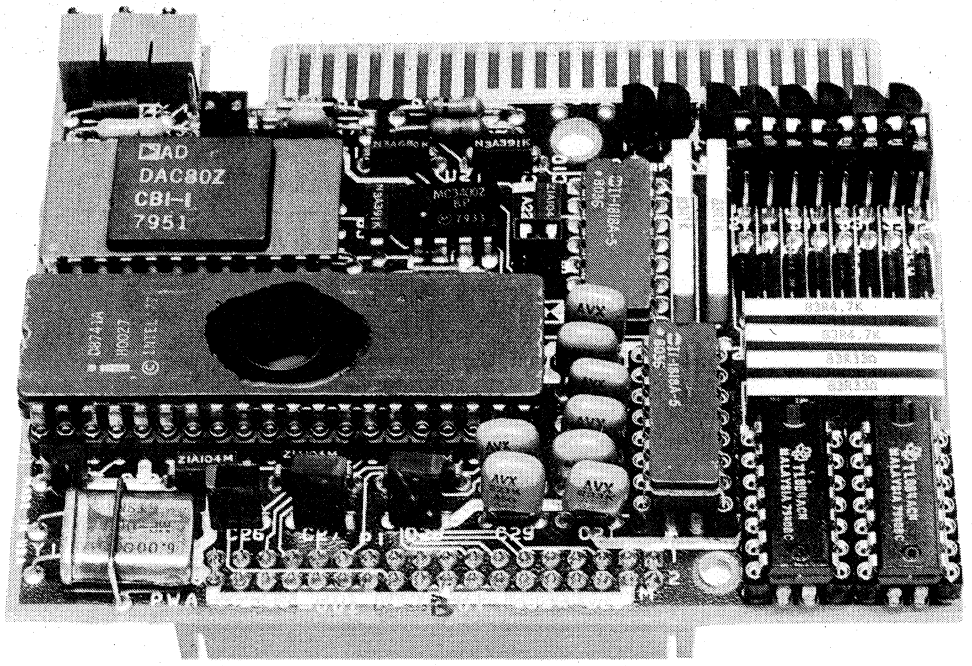
ORDERING INFORMATION

Part Number	Description
SXB 311	Analog Input MULTIMODULE Board

iSBX™ 328
ANALOG OUTPUT MULTIMODULE™ BOARD

- **Low Cost Analog Output Via iSBX™ MULTIMODULE™ Connector**
- **8 Channel Output, Current Loop or Voltage in any Mix**
- **4–20 mA Current Loop; 5V Unipolar or Bipolar Voltage Output**
- **12-Bit Resolution**
- **0.035% Full Scale Voltage Accuracy @ 25°C**
- **Programmable Offset Adjust in Current Loop Mode**

The Intel iSBX 328 MULTIMODULE board provides analog signal output for any intelligent board having an iSBX compatible bus and connector. The single-wide iSBX 328 plugs directly onto the host board, providing eight independent output channels of analog voltage for meters, programmable power supplies, etc. Voltage output can be mixed with current loop output for control of popular 4–20 mA industrial control elements. By using an Intel single chip computer (8041) for refreshing separate sample-hold amplifiers through a single 12 bit DAC, eight channels are contained on a single MULTIMODULE board for high density and low cost per channel. High quality analog components provide 12 bit resolution, and slew rates per channel of 0.1V per microsecond. Maximum channel update rates are 5 KHz on a single channel to 1 KHz on all eight channels.



280234-1

October 1986
Order Number: 280234-001

FUNCTIONAL DESCRIPTION

The iSBX 328 MULTIMODULE board, shown in Figure 1 is designed to plug onto any host iSBC microcomputer that contains an iSBX bus connector. The board uses an Intel 8041 microcontroller to manage eight analog output channels that may be user-configured through jumpers to operate in either bipolar voltage output mode (−5V to +5V), unipolar voltage output mode (0 to +5V), or current loop output mode (4 to 20 mA) applications. Channels may be individually wired for simultaneous operation in both current loop output and voltage output applications. The outputs feed to a 50-pin edge connector (J1) on the iSBX 328 MULTIMODULE board.

Interfacing through the Intel iSBX Bus

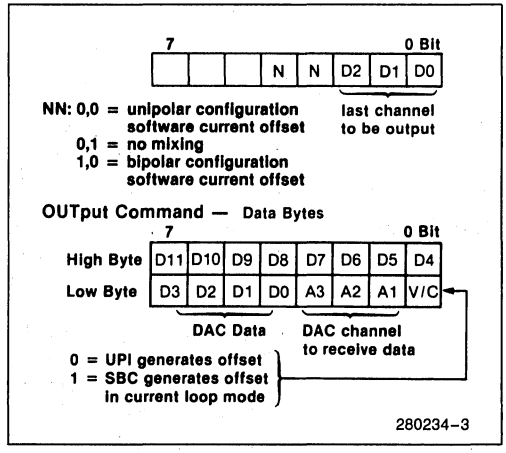
All data to be output through the MULTIMODULE board is transferred from the host microcomputer to the MULTIMODULE board via the iSBX bus connector. The iSBX 328 board accepts the binary digital data and generates a 12-bit data word for the Digital-to-Analog Converter (DAC) and a four bit channel decode/enable for selecting the output channel. The DAC transforms the data into analog signal outputs for either voltage output mode or current loop output mode. Offsetting of the DAC voltage in current output mode may be performed by the UPI software offset routine or by the hardware offset adjustments included on the board. The MULTIMODULE board status is available via the iSBX bus connector, to determine if the UPI is ready to receive updates to analog output channels.

OPERATIONAL DESCRIPTION

The host iSBC microcomputer addresses the MULTIMODULE board by executing IN or OUT instructions specifying the iSBX 328 MULTIMODULE as a port address. The iSBX 328 is initialized to select whether software or hardware offset is to be used and how many channels will be active. Then a 2 byte transfer to each active channel sets the 12 bit output value, the channel selected and the current or voltage mode.

Commands

OUTput Command—Initialization of UPI/iSBX 328



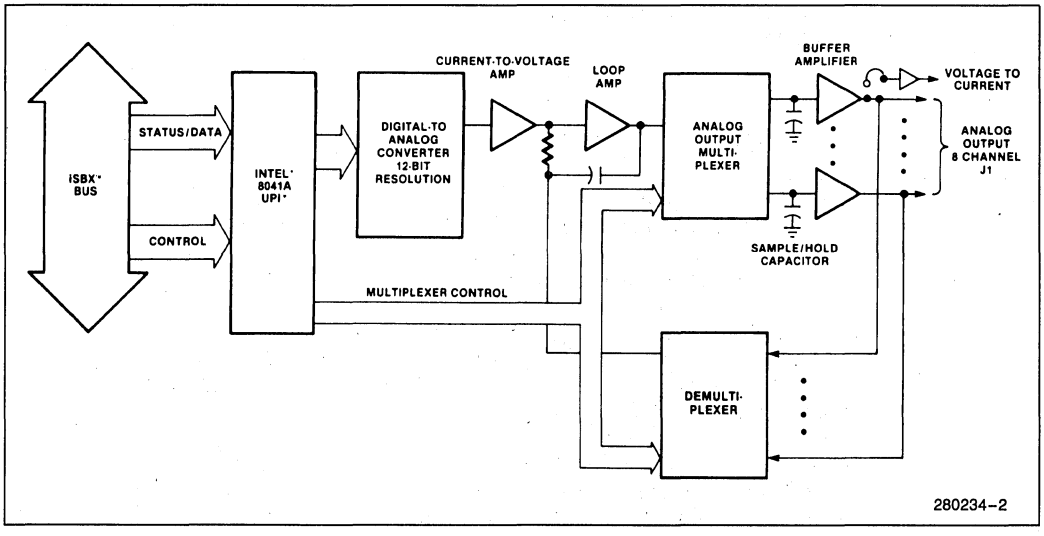
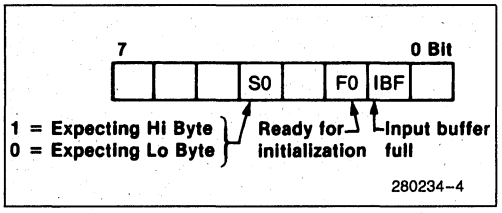


Figure 1. iSBC® 328 Analog Output MULTIMODULE™ Board Block Diagram

INput Command—Status Buffer Read



Interrupts

No interrupts are issued from the iSBX 328 to the host iSBC microcomputer. Data coordination is handled via iSBC software polls of the status buffer.

SPECIFICATIONS

Outputs — 8 non-isolated channels, each independently jumpered for voltage output or current loop output mode.

Voltage Ranges — 0 to +5V (unipolar operation) −5 to +5V (bipolar operation)

Current Loop Range — 4 to 20 mA (unipolar operation only)

Output Current — ±5 mA maximum (voltage mode-bipolar operation)

Load Resistance — 0 to 250Ω with on-board iSBX power. 1000Ω minimum with 30 VDC max. external supply

Compliance Voltage — 12V using on-board iSBX power. If supplied by user, up to 30 VDC max

Resolution — 12 bits bipolar or unipolar

Slew Rate — 0.1V per microsecond minimum

Single Channel Update Rate — 5 KHz

Eight Channel Update Rate — 1 KHz

Output Impedance — 0.1Ω. Drives capacitive loads up to 0.05 microfarads. (approx. 1000 foot cable)

Temperature Coefficient — 0.005%/°C

Refresh and Throughput Rates**	
Refresh 1 channel (no new data):	80 μs
Refresh all 8 channels (no new data):	650 μs
Update and refresh 1 channel with new data: firmware program 2	150 μs
for each additional channel	130 μs
Update and refresh 1 channel with new data: firmware program 1 or 3	200 μs
for each additional channel	155 μs
Update and refresh all 8 channels (all new data): firmware program 2	1,050 ms
per channel of new data	50 μs
Update and refresh all 8 channels (all new data): firmware program 1or 3	1,280 ms
per channel of new data	80 μs

**All times nominal

Accuracy—

Mode	Accuracy	Ambient Temp
Voltage-Unipolar, typical	± 0.025% FSR	@ 25°C
Voltage-Unipolar, maximum	± 0.035% FSR	@ 25°C
Voltage-Unipolar, typical	± 0.08% FSR	@ 0° to 60°C
Voltage-Unipolar, maximum	± 0.19% FSR	@ 0° to 60°C
Voltage-Bipolar, typical	± 0.025% FSR	@ 25°C
Voltage-Bipolar, maximum	± 0.035% FSR	@ 25°C
Voltage-Bipolar, typical	± 0.09% FSR	@ 0° to 60°C
Voltage-Bipolar, maximum	± 0.17% FSR	@ 0° to 60°C
Current Loop, typical	± 0.07% FSR	@ 25°C
Current Loop, maximum	± 0.08% FSR	@ 25°C
Current Loop, typical	± 0.17% FSR	@ 0° to 60°C
Current Loop, maximum	± 0.37% FSR	@ 0° to 60°C

Connectors—

Interface	Pins (Qty)	Centers in	Centers cm	Mating Connectors
P1 iSBX Bus	36	0.1	0.254	iSBC iSBX connector
J1 8/16 channels analog	50	0.1	0.254	3m 3415-000 or T1 H312125 or iCS 910 cable

Physical Characteristics

Width: 9.40 cm (3.7 inches)

Length: 6.35 cm (2.5 inches)

Height: 1.4 cm (0.56 inch) MULTIMODULE board only

2.82 cm (1.13 inches) MULTIMODULE and iSBC board.

Weight: 85.06 gm (3.0 ounces)

Electrical Characteristics

V_{CC} = ±5V (0.25V), I_{CC} = 140 mA max

V_{DD} = ±12V (±0.6V), I_{DD} = 45 mA max (voltage mode)

= 200 mA max (current loop mode

V_{SS} = −12V (±0.6V), I_{SS} = 55 mA max

Environmental Characteristics

Operating Temperature: 0° to 60°C (32° to 140°C)

Relative Humidity: to 90% (without condensation)

Reference Manuals

142914— iSBX 328 Analog Output MULTI-MODULE Board Hardware Reference Manual (Order Separately)

230973— Distributed Control Modules Databook

Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

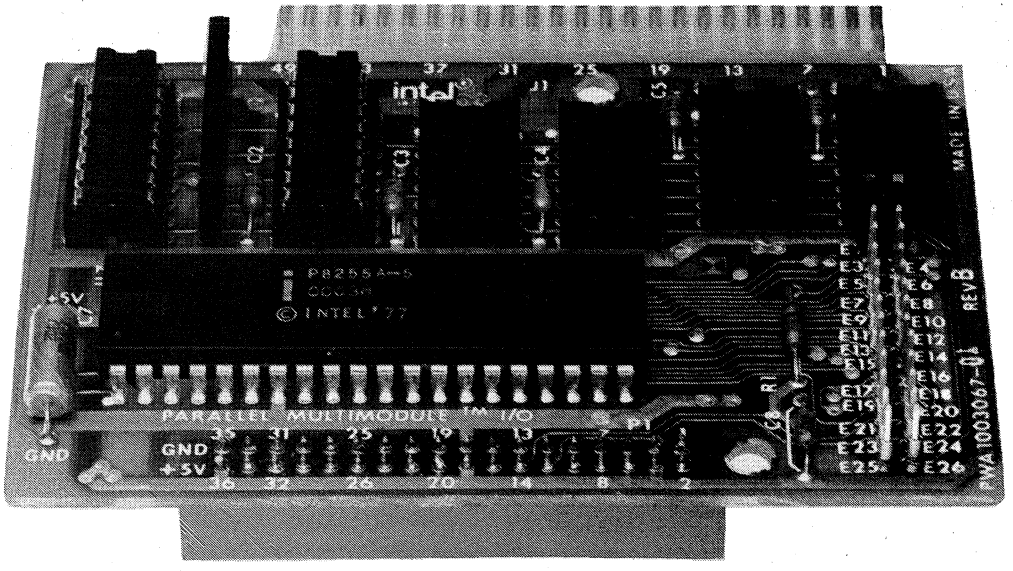
ORDERING INFORMATION

Part Number	Description
SBX 328	Analog Output MULTIMODULE Board

iSBX™ 350
PARALLEL I/O MULTIMODULE™ BOARD

- **iSBX™ Bus Compatible I/O Expansion**
- **24 Programmable I/O Lines with Sockets for Interchangeable Line Drivers and Terminators**
- **Three Jumper Selectable Interrupt Request Sources**
- **Accessed as I/O Port Locations**
- **Single +5V Low Power Requirement**
- **iSBX Bus On-Board Expansion Eliminates MULTIBUS® System Bus Latency and Increases System Throughput**

The Intel iSBX 350 Parallel I/O MULTIMODULE Board is a member of Intel's line of iSBX bus compatible MULTIMODULE products. The iSBX MULTIMODULE board plugs directly into any iSBX bus compatible host board offering incremental on-board expansion. The iSBX 350 module provides 24 programmable I/O lines with sockets for interchangeable line drivers and terminators. The iSBX board is closely coupled to the host board through the iSBX bus, and as such, offers maximum on-board performance and frees MULTIBUS system traffic for other system resources. In addition, incremental power dissipation is minimal requiring only 1.6 watts (not including optional driver/terminators).



280235-1

September 1986
Order Number: 280235-001

FUNCTIONAL DESCRIPTION

Programmable Interface

The iSBX 350 module uses an Intel 8255A-5 Programmable Peripheral Interface (PPI) providing 24 parallel I/O lines. The base-board system software is used to configure the I/O lines in any combination of unidirectional input/output and bidirectional ports indicated in Table 1. Therefore, the I/O interface may be customized to meet specific peripheral requirements. In order to take full advantage of the large number of possible I/O configurations, sockets are provided for interchangeable I/O line drivers and terminators. Hence, the flexibility of the I/O interface is further enhanced by the capability of selecting the appropriate combination of optional line drivers and terminators to provide the required sink current, polarity, and driver/termination characteristics for each application. In addition, inverting bidirectional bus drivers (8226) are provided on sockets to allow convenient optional replacement to non-inverting drivers (8216). The 24 programmable I/O lines, signal ground, and +5 volt power (jumper configurable) are brought to a 50-pin edge connector that mates with flat, woven, or round cable.

Interrupt Request Generation

Interrupt requests may originate from three jumper selectable sources. Two interrupt requests can be automatically generated by the PPI when a byte of information is ready to be transferred to the base board CPU (i.e., input buffer is full) or a byte of information has been transferred to a peripheral device (i.e., output buffer is empty). A third interrupt source may originate directly from the user I/O interface (J1 connector).

Installation

The iSBX 350 module plugs directly into the female iSBX connector on the host board. The module is then secured at one additional point with nylon hardware to insure the mechanical security of the assembly (see Figure 1 and Figure 2).

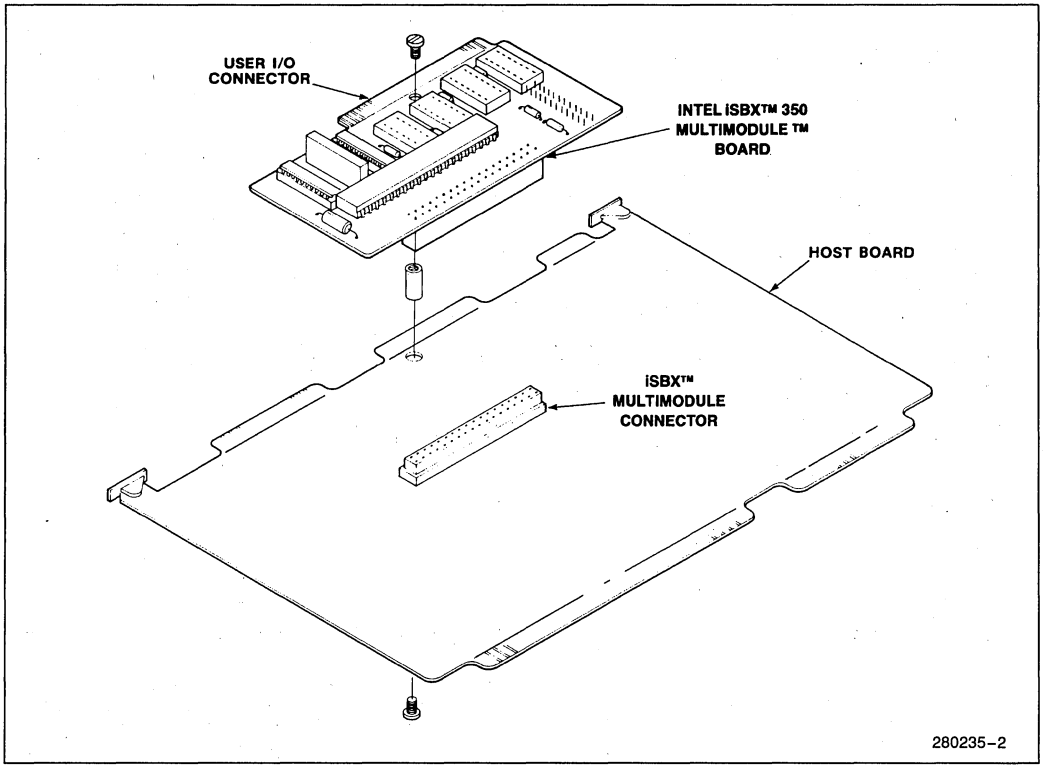


Figure 1. Installation of iSBX™ 350 Module on a Host Board

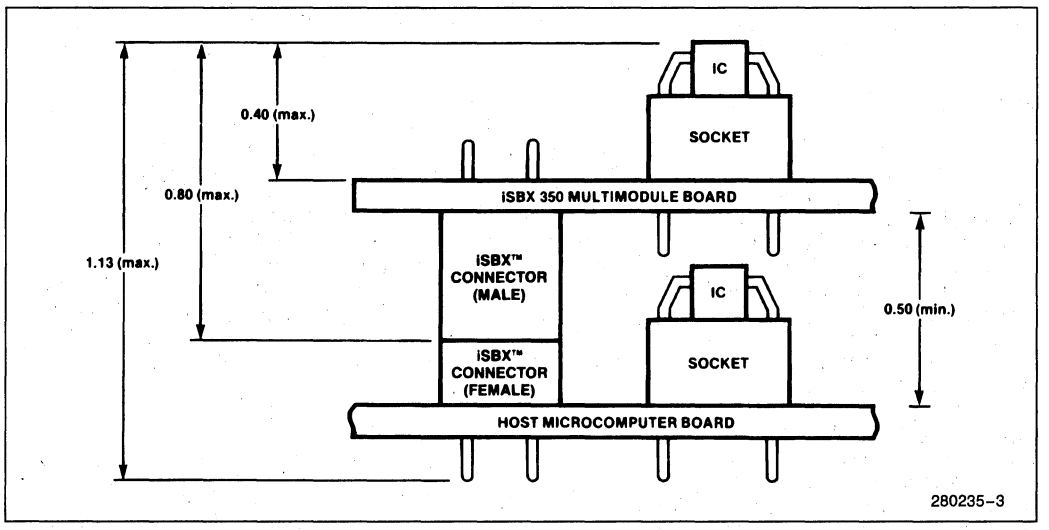


Figure 2. Mounting Clearances (inches)

Table 1. Input/Output Port Modes of Operation

Port	Lines (qty)	Mode of Operation					Control
		Unidirectional				Bidirectional	
		Input		Output			
		Unlatched	Latched & Strobed	Latched	Latched & Strobed		
A	8	X	X	X	X	X	
B	8	X	X	X	X		
C	4	X		X			X(1)
	4	X		X			X(1)

NOTE:
1. Part of Port C must be used as a control port when either Port A or Port B are used as a latched and strobed input or a latched and strobed output port or Port A is used as a bidirectional port.

SPECIFICATIONS

Word Size

Data: 8 Bits

I/O Addressing

8255A-5 Ports	iSBX 350 Address
Port A	X0 or X4
Port B	X1 or X5
Port C	X2 or X6
Control	X3 or X7
Reserved	X8 to XF

NOTE:
The first digit of each port I/O address is listed as "X" since it will change dependent on the type of host iSBC microcomputer used. Refer to the Hardware Reference Manual for your host iSBC microcomputer to determine the first digit of the port address.

I/O Capacity

24 programmable lines (see Table 1)

Access Time

Read: 250 ns max.

Write: 300 ns max.

NOTE:
Actual transfer speed is dependent upon the cycle time of the host microcomputer.

Interrupts

Interrupt requests may originate from the programmable peripheral interface (2) or the user specified I/O (1).

Interfaces

iSBX™ Bus—All signals TTL compatible

Parallel I/O—All signals TTL compatible

Parallel Interface Connectors

Interface	No. of Pairs/ Pins	Centers (in.)	Connector Type	Vendor	Vendor Part No.
Parallel I/O Connector	25/50	0.1	Female	3M	3415-0001 with Ears
Parallel I/O Connector	25/50	0.1	Female Soldered	GTE Sylvania	6AD01251A1DD

NOTE:
Connector compatible with those listed may also be used.

Line Drivers and Teminators

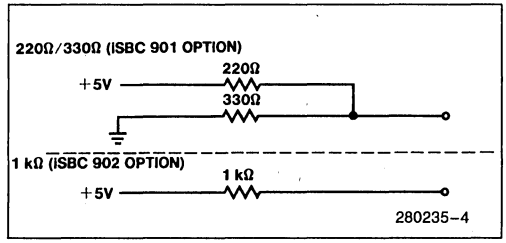
I/O Drivers—The following line drivers and terminators are all compatible with the I/O driver sockets on the iSBX 350.

Driver	Characteristic	Sink Current (mA)
7438	I, OC	48
7437	I	48
7432	NI	16
7426	I, OC	16
7409	NI, OC	16
7408	NI	16
7403	I, OC	16
7400	I	16

NOTE:
I = Inverting, NI = Non-Inverting, OC = Open Collector

Port 1 has 25 mA totem pole drivers and 1 kΩ terminators.

I/O Terminators—220Ω/330Ω divider or 1 kΩ pull up.



Physical Characteristics

Width: 7.24 cm (2.85 in.)

Length: 9.40 cm (3.70 in.)

Height*: 2.04 cm (0.80 in.) iSBX 350 Board
2.86 cm (1.13 in.) iSBX 350 Board + Host Board

Weight: 51 gm (1.79 oz)

*See Figure 2

Electrical Characteristics

DC Power Requirements

Power Requirements	Configuration
+5 @ 320 mA	Sockets XU3, XU4, XU5, and XU6 empty (as shipped).
+5V @ 500 mA	Sockets XU3, XU4, XU5, and XU6 contain 7438 buffers.
+5V @ 620 mA	Sockets XU3, XU4, XU5, and XU6 contain iSBC 901 termination devices.

Environmental

Operating Temperature: 0°C to +55°C

Reference Manual

9803191-01—iSBX 350 Parallel I/O MULTIMODULE Manual (NOT SUPPLIED)

Reference Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Ave., Santa Clara, California 95051.

ORDERING INFORMATION

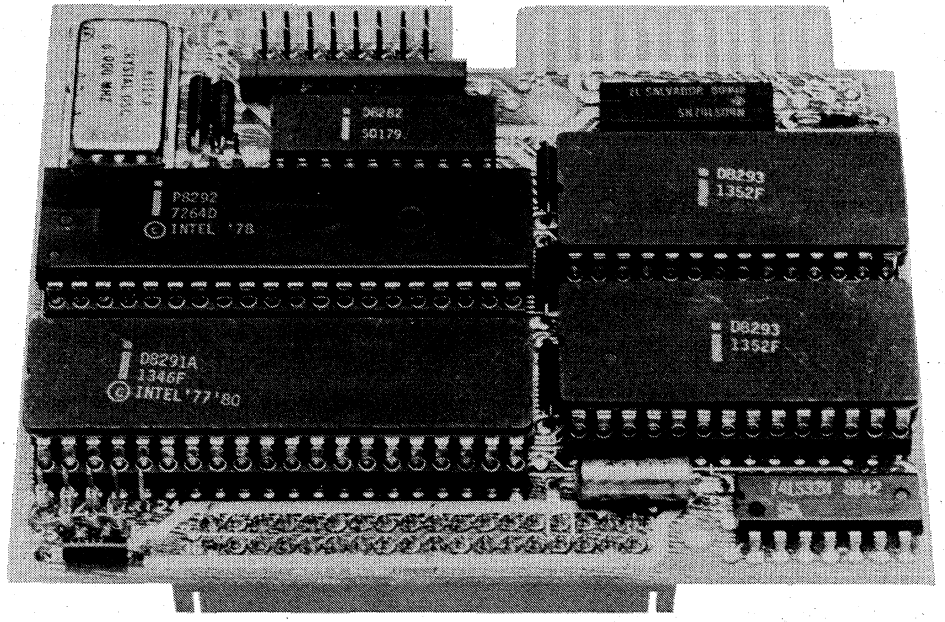
Part Number	Description
SBX 350	Parallel I/O MULTIMODULE Board

iSBX™ 488
GPIB MULTIMODULE™ BOARD

- **Complete IEEE 488-1978 Talker/ Listener Functions Including:**
  - **— Addressing, Handshake Protocol, Service Request, Serial and Parallel Polling Schemes**
- **Complete IEEE 488-1978 Controller Functions Including:**
  - **— Transfer Control, Service Requests and Remote Enable**
- **Simple Read/Write Programming**
- **Software Functions Built into VLSI Hardware for High Performance, Low Cost and Small Size**
- **Standard iSBX Bus Interface for Easy Connection to Intel iSBC™ Boards**
- **IEEE 488-1978 Standard Electrical Interface Transceivers**
- **Five Volt Only Operation**

The Intel iSBX 488 GPIB Talker/Listener/Controller MULTIMODULE board provides a standard interface from any Intel iSBC board equipped with an iSBX connector to over 600 instruments and computer peripherals that use the IEEE 488-1978 General Purpose Interface Bus. By taking full advantage of Intel's VLSI technology the single-wide iSBX 488 MULTIMODULE board implements the complete IEEE 488-1978 Standard Digital Interface for Programmable Instrumentation on a single low cost board. The iSBX 488 MULTIMODULE board includes the 8291A GPIB Talker/Listener, 8292 GPIB Controller and two 8293 GPIB Transceiver devices. This board represents a significant step forward in joining microcomputers and instrumentation using industry standards such as the MULTIBUS® system bus, iSBX bus and IEEE 488-1978. The high performance iSBX 488 MULTIMODULE board mounts easily on Intel iSBX bus compatible single board computers.

A simple user programming interface for easy reading, writing and monitoring of all GPIB functions is provided. This intelligent interface minimizes the impact on host processor bandwidth.



143580-1

October 1986
Order Number: 143580-001

FUNCTIONAL DESCRIPTION

The iSBX 488 MULTIMODULE board is a single-wide iSBX bus compatible I/O expansion board that provides a complete implementation of the IEEE 488-1978 Standard Digital Interface for Programmable Instrumentation. The iSBX 488 MULTIMODULE board may be configured to be a GPIB controller, talker, listener or talker/listener. The hardware implementation of the iSBX 488 board takes full advantage of Intel's VLSI capability by using the Intel 8292 GPIB controller, 8291A talker/listener and two (2) 8293 bus transceivers. All communication between the host iSBC board and the iSBX 488 MULTIMODULE board is executed via the Intel standard iSBX connector. Many of the functions that previously were performed by user software have been incorporated into VLSI hardware for high performance and simple programming. Both the Intel 8291A GPIB Talker/Listener device and the 8292 device can each communicate independently with the host processor on the iSBC board depending on configuration. Communication from the host iSBC board to either device on the iSBX 488 board is flexible and may be either interrupt or poll driven depending on user requirements. Data transfers to or from the GPIB may be executed by the host processor's I/O Read and I/O Write commands or with DMA handshaking techniques for very high speed transfers.

GPIB Talker/Listener Capabilities

The Intel 8291A device on the iSBX 488 MULTIMODULE board handles all talker/listener communications between the host iSBC processor board and the GPIB. Its capabilities include data transfer, bus handshake protocol, talker/listener addressing procedures, device clearing and triggering, service requests, and both serial and parallel polling schemes. In executing most procedures the iSBX 488 board does not interrupt the microprocessor on the iSBC processor board unless a byte of data is waiting on input or a byte is sent to an empty output buffer, thus offloading the host CPU of GPIB overhead chores.

SIMPLE PROGRAMMING INTERFACE

The GPIB talker/listener functions can be easily programmed using the high level commands made available by the Intel 8291A on the iSBX 488 MULTIMODULE board. The 8291A device architecture includes eight registers for input and eight registers for output. One each of these read and write registers is used for direct data transfers. The remaining write registers are used by the programmer to control the various interface features of the Intel 8291A device. The remaining read registers provide the user with a monitor of GPIB states, bus conditions and device status.

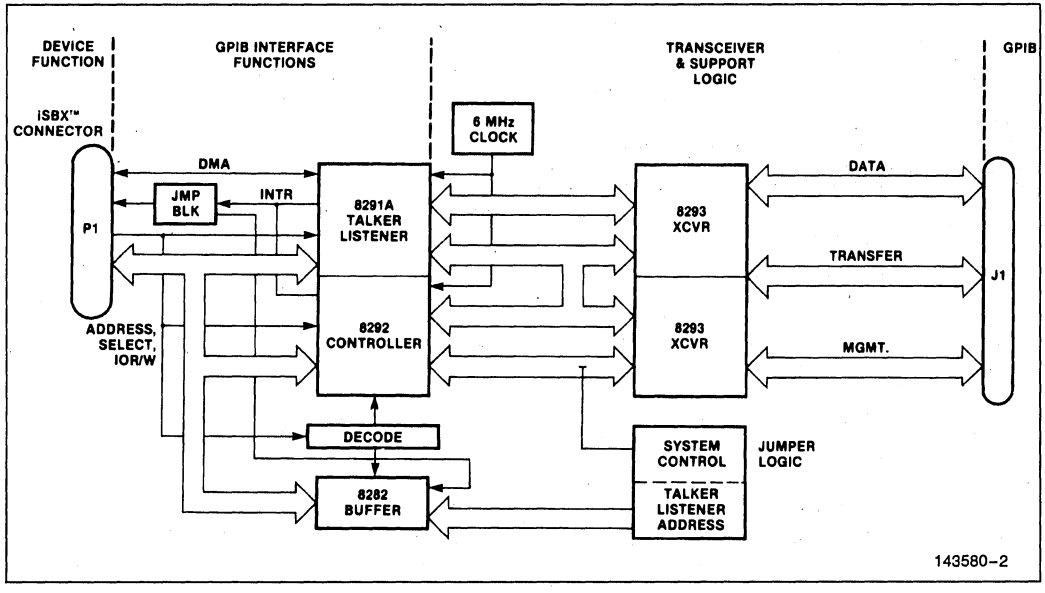


Figure 1. iSBX™ 488 MULTIMODULE™ Board Block Diagram

SOFTWARE FUNCTIONS BUILT INTO VLSI HARDWARE

Additional features that have migrated from discrete logic and software into Intel VLSI include programmable data transfer rate and three addressing modes that allow the iSBX board to be addressed as either a major or a minor talker/listener with primary or secondary addressing. The iSBX 488 MULTIMODULE board can be programmatically configured into almost any bus talker, listener, or talker/listener configuration. Writing software to control these and other iSBX 488 board functions is simply a matter of reading or writing the control registers.

IEEE 488-1978 Functions(1)

Function	ISBX™ 488 Supported IEEE Subsets
Source Handshake (SH)	SH0, SH1
Acceptor Handshake (AH)	AH0, AH1
Talker (T)	T0 through T8
Extended Talker (TE)	TE0 through TE8
Listener (L)	L0 through L4
Extended Listener (LE)	LE0 through LE9
Service Request (SR)	SR0, SR1
Remote Local (RL)	RL0, RL1
Parallel Poll (PP)	PP0, PP1, PP2
Device Clear (DC)	DC0 through DC2
Device Trigger (DT)	DT0, DT1
Controller (C)	C0 through C28

NOTE:
1. For detailed information refer to IEEE Standard Digital Interface for Programmable Instrumentation published by The Institute of Electrical and Electronics Engineers, Inc. 1978.

Controller Capabilities

The GPIB controller functions supplied by the iSBX 488 board are provided by the Intel 8292 GPIB controller device. The 8292 is actually an Intel 8041A eight bit microcomputer that has been preprogrammed to implement all IEEE 488-1978 controller functions. The internal RAM in the 8041A is used as a special purpose register bank for the 8292 GPIB Controller. Just as with the 8291A GPIB Talker/Listener device, these registers are used by the programmer to implement controller monitor, read and write commands on the GPIB.

When configured as a bus controller the iSBX 488 board will respond to Service Requests (SRQ) and will issue Serial Polls. Parallel Polls are also issued to multiple GPIB instrument devices for receiving simultaneous responses. In applications requiring multiple bus controllers, several iSBX 488 boards may each be configured as a controller and pass the active control amongst each other. An iSBX 488 board configured for a System Controller has the capability to send Remote Enable (REN) and Interface Clear (IFC) for initializing the bus to a known state.

GPIB Physical Interface

The iSBX 488 MULTIMODULE board interfaces to the GPIB using two Intel 8293 bidirectional transceivers. The iSBX 488 board meets or exceeds all of the electrical specifications defined in IEEE 488-1978 including bus termination specifications. In addition, for direct connection to the GPIB, the iSBC 988 cable, a 26 conductor 0.5 meter GPIB interface cable is also available from Intel. The cable is terminated with a 26-pin edge connector at the iSBX end and a 24-pin GPIB connector at the other. The cable is also supplied with shield lines for simple grounding in electrically noisy environments.

Installation

The iSBX 488 MULTIMODULE board plugs directly onto the female iSBX connector available on many Intel iSBC boards. The MULTIMODULE board is then secured at one additional point with nylon hardware (supplied) to insure the mechanical security of the assembly.

SPECIFICATIONS

Interface Information

iSBX™ Bus—All signals TTL compatible

26-pin Edge Connector—Electrical levels compatible with IEEE 488-1978.

Physical Characteristics

Width: 3.70 in (0.94 cm)
Length: 2.85 in (7.24 cm)
Height: 0.8 in (2.04 cm)
Weight: 3.1 oz (87.8 gm)

GPIB Data Rate*

300K bytes/sec transfer rate with DMA host iSBC board

50K bytes/s transfer rate using programmed I/O
730 ns Data Accept Time

*Data rates are iSBX board maximum. Data rates will vary and can be slower depending on host iSBC board and user software driver.

Electrical Characteristics

DC Power Requirements: V_{CC} = +5 VDC ±5%

I_{CC} = 600 milliamps maximum

GPIB Electrical and Mechanical Specifications

Conforms to IEEE 488-1978 standard electrical levels and mechanical connector standard when purchased with the iSBC 988 GPIB cable.

Environmental Characteristics

Operating Temperature: 0° to 60°C (32° to 140°F)

Relative Humidity: Up to 90% R.H. without condensation.

Reference Manual

143154-001— iSBX 488 GPIB MULTIMODULE Board Hardware Reference Manual (not supplied).

ORDERING INFORMATION

Part Number	Description
SBX488	GPIB MULTIMODULE
SBC988	0.5 meter GPIB cable for iSBX 488 MULTIMODULE Board

Local Area Network Boards and Software

11

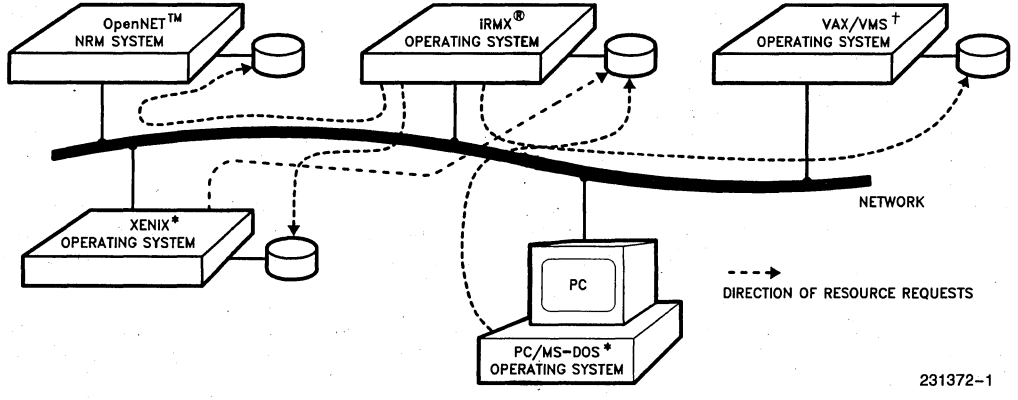
iRMX® NETWORKING SOFTWARE RELEASE 2.0 MEMBER OF THE OpenNET™ PRODUCT FAMILY

- **Provides Transparent Network File Access**
  - **— Remote Files can be Accessed Just Like Local Files**
  - **— Network Communications are Transparent to the User**
- **Provides Network File Protection and User Access Control Mechanisms**
- **Supports File Server and/or File Consumer Applications**
- **Implements a Distributed Name Server to Minimize Administrative Effort**
- **Connects iRMX, DOS, XENIX*, VAX/VMS†, and OpenNET™ NRM Systems on the LAN**
  - **— Runs Under the iRMX® 86 R7 and iRMX® 286 R2 Operating Systems**
  - **— Interoperates with XENIX Networking Software (XENIX-NET), Intel OpenNET PC Link with Microsoft Networks (MS-NET), VAX/VMS OpenNET, and iNDX OpenNET Software**
- **Supports OpenNET IEEE 802.3 Compatible Hardware and ISO 8073 Software**
  - **— iSXM™ 552/552A COMMengine Boards**
  - **— iSBC® 186/51 COMMputer™ Board**
  - **— iNA 960/961 Transport Software**

The Intel iRMX® Networking Software (iRMX-NET) implements the Network File Access (NFA) protocols to provide transparent access to files on other systems that are attached to the same Local Area Network (LAN) and that are running the appropriate Network File Access software. Transparent file access means that remote files can be accessed as if they were local because the OpenNET™ software does the necessary network communications for the user.

A seven layer OSI communication system solution is established on an iRMX system when the iRMX Networking Software is used in conjunction with the Intel iNA 960/961 Transport Software plus hardware such as the iSXM™ 552A or the iSBC® 186/51 communication processor boards. Networked iRMX systems can serve in a wide range of applications including real time transaction processing, automated testing, data collection, communications switching, and process control.

*XENIX and MS-DOS are trademarks of Microsoft Corp.
†VAX and VMS are trademarks of Digital Equipment Corp.



April 1987
Order Number: 231372-003

iRMX®-NET FUNCTIONAL OVERVIEW

iRMX-NET provides transparent network file access by implementing the Network File Access protocols. The Network File Access protocols provide the ability for local application programs to access remote files by attaching the remote system as a local file system device. Then remote files can be accessed by simply using the remote system's name as part of the file pathname.

The Network File Access protocols were developed jointly by IBM, Microsoft, and Intel to provide a powerful set of network file access capabilities among a variety of heterogeneous operating systems. The Network File Access protocols have been implemented on iRMX with iRMX-NET, on PC/MS-DOS* with MS-NET, on XENIX* with XENIX-NET, on VAX/VMS† with VAX/VMS OpenNET, and on the NRM (Network Resource Manager for Intel microprocessor development systems) with iNDX OpenNET software.

iRMX-NET provides the transparent network file access capability through file consumer and file server software functions. The file consumer software intercepts file commands from the local application program and transmits them across the LAN to the file server node where the target file resides. The file server software receives, interprets, and executes commands received over the LAN from remote file consumers. When iRMX-NET is initially installed, the user has the option of configuring the system to include either or both of the file consumer and file server functions.

The iRMX-NET Network File Access service provides functionality for layers 5 through 7 of the OSI 7-layer communications model. The layer 1 through 4 services are provided by iNA 960/961 Transport Software and IEEE 802.3 compatible controller boards such as the iSXM 552A or the iSBC 186/51.

iRMX-NET capabilities can be installed in a variety of hardware configurations to meet differing system requirements. For example, a "COMMengine" configuration consists of a host processor board executing iRMX-NET R2.0 under either iRMX 86 or iRMX 286 and an intelligent network controller board executing iNA 961 Transport Software. Figure 1 shows an example of a COMMengine configuration with an iSBC 286/12 host board and an iSXM 552A COMMengine controller board. Also, a single board COMMputer™ system can be implemented with an iSBC 186/51 board executing both iRMX-NET software and iNA 960 Transport Software under iRMX 86. See Figure 2.

iRMX-NET is included at iRMX configuration time as a user job if the Extended I/O System (EIOS) is not present or as an I/O job if the EIOS is present. iRMX-NET contains a number of user-defined parameters which must be set up when configuring the system. These parameters include the number of file consumers served concurrently, the identification of which directories are public, and the specification of various time-out values.

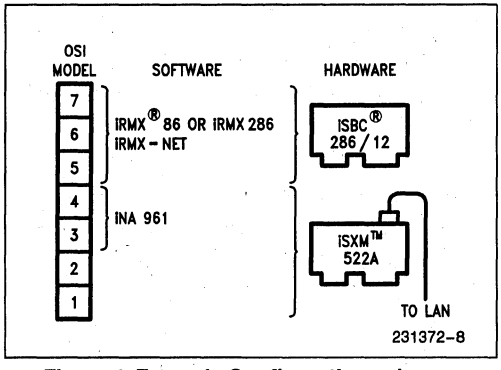


Figure 1. Example Configuration using an iSXM™ 552A COMMengine as an Intelligent Front-End Processor

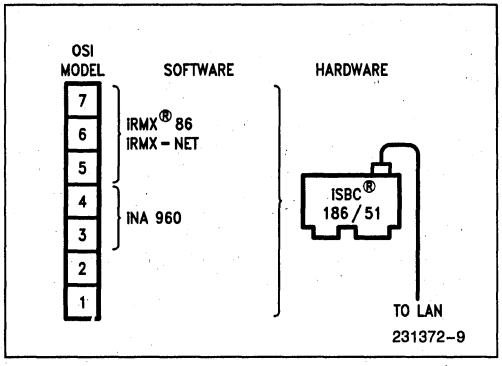


Figure 2. Example Configuration using an iSBC® 186/51 COMMputer™

iRMX® FILE SYSTEM OVERVIEW

The iRMX Operating System provides a flexible structure for managing directories of files on several different devices. To illustrate some of the capabilities, refer to the example system configuration shown in Figure 3.

In this example, disk A is the system device. The system device is the storage device from which the

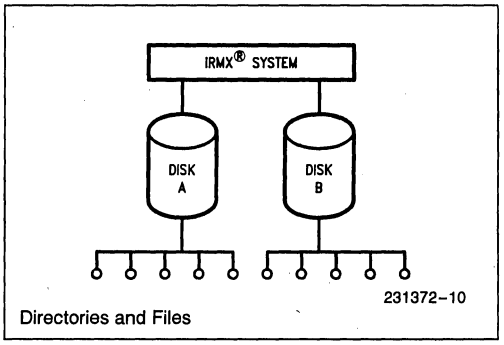


Figure 3. iRMX® File System

system is bootstrapped and it is also the default device to which file references are directed. When the system is initialized, application programs can access directories and files on device A with a hierarchical directory structure. Files on the system device are accessed with the following iRMX naming convention:

/directory/filename

The system device "A" is the default device and therefore it doesn't have to be specifically identified in the pathname. If the user wishes to access files on another device, for example "B", that device can be attached to the file system with the iRMX command:

ATTACHDEVICE B AS logicalname

Then files can be directly accessed on the B device with this naming convention:

:logicalname:directory/filename

TRANSPARENT NETWORK FILE ACCESS

Transparent network file access enables the user application to manipulate and use remote files as if they were local. In contrast, a less-sophisticated file transfer capability typically requires a multi-step process with the application program having to find the address of the remote system, to move the file to the local system, to process it, and then to restore it to the remote system when processing is completed.

The benefit transparent network file access provides is user access to remote files without the need to transfer the file back and forth from the remote to the local system. The network communications required to access the remote file are managed by the iRMX-NET software in a way that is transparent to the user application.

To access a remote file, the user first attaches the remote network node as a file system device. Then remote files can be accessed by designating the remote node logical device name as part of the file pathname.

For example, Figure 4 illustrates two systems on a local area network, both equipped with iRMX-NET software. System S1 would access its local files on disk A with the following iRMX naming convention:

/directory/filename

The user on S1 can access files on the remote network node, System S2, by first attaching S2 to the file system with the augmented iRMX command:

ATTACHDEVICE S2 AS nodename REMOTE

This allows user on system S1 to access the remote files on System S2 with the simple naming convention:

:nodename:directory/filename

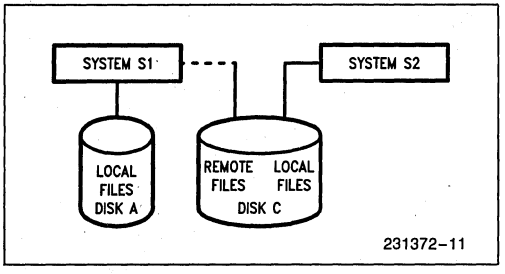


Figure 4. iRMX®-NET Network File Access

iRMX-NET provides transparent network file access at the BIOS, EIOS and Human Interface levels of the iRMX Operating System. This means that all iRMX user applications that use the BIOS, EIOS, or Human Interface file access commands can be used in a networked environment where the referenced files may reside at other network nodes on the local area network.

NETWORK FILE PROTECTION AND USER ACCESS CONTROL

The iRMX-NET Network File Access software also adds the benefits of extensive file security mechanisms across the network.

The file accessing capabilities implemented by the iRMX-NET OpenNET Network File Access software extends the file systems of the individual network nodes into a network hierarchical file system. Within

the network, any user with appropriate access permissions can access each of the public files on other network nodes through a unique path of the network directory. iRMX-NET allows directories to be designated as public (accessible from other network nodes) or private (accessible only locally) when configuring the file server.

In addition, the iRMX Operating System itself offers the ability to define protection rights for individual directories and files. The iRMX-NET software provides the ability to extend these file protection privileges to accesses over the local area network. Local iRMX files and directories can be specified to be "read only" or "writable." Within the network file system, these access rights apply to remote files as well.

iRMX-NET also defines two types of user access control that allows the network administrator a trade-off between performance and level of security. The first type of protection is called "consumer-based" protection and offers the highest performance for accessing remote files. The second type is called "server-based" protection and offers the highest level of security. The two types of user protection rely on an iRMX-NET concept called the "Administrative Unit." The Administrative Unit (AU) is a collection of network nodes that have the same set of users defined. The Administration Unit can contain only one network node if desired.

The consumer-based mechanism applies to network nodes within one Administrative Unit. In this case, a user is checked for valid username and password by the local system, and once this access is gained, public files on other nodes within the Administrative Unit can be accessed without further user verification by the destination node. Because of the minimum of administrative overhead, consumer-based protection is the best performer. However, this mechanism offers the least protection against malicious users and therefore is best suited for collections of users that are trustworthy and where performance is of particular value.

Server-based protection comes into play for accesses that cross Administrative Unit boundaries. For these accesses, the remote system whose file is being accessed checks the user identification to confirm authorization before granting access to the public files in its file system. This mechanism offers the highest level of security.

An example of the Administrative Unit concept and its use in setting up consumer-based protection and server-based protection network nodes is shown in Figure 5. In this example, the networked systems S1, S2, and S3 are all within Administrative Unit #1 and can access each others files with the consumer-based mechanism. However, if system S2 wishes to access files on a system in another Administrative Unit (such as system S4), the server-based mechanism takes effect and the destination system (S4) checks user authorization before granting access to its public files.

FILE SERVER AND FILE CONSUMER IMPLEMENTATION

iRMX-NET implements file access across the network through introducing a new file type, the "remote file." The iRMX Operating System normally supports physical, stream, and named files through the respective file drivers contained within the Basic I/O System (BIOS). The iRMX-NET file consumer software adds a new file driver called the Remote File Driver (RFD). All local commands that reference remote files are intercepted at the BIOS level and

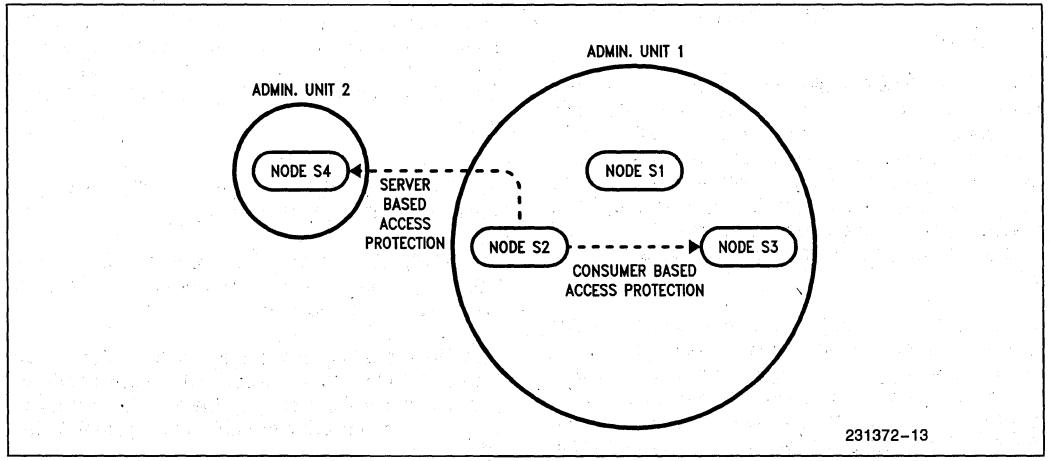


Figure 5. Example of iRMX®-NET File Protection Administration

are redirected through the RFD to the appropriate remote node on the network. At the remote node, the iRMX-NET file server software receives commands from the network and forwards them to the local operating system which then executes the commands on the remote node's local file system.

Figure 6 shows the implementation of both the file consumer and file server software in a COMMengine environment. In a COMMengine environment, the Multibus Interprocessor Protocol (MIP) Software provides the interface between the iRMX-NET Software executing on the host processor board and the iNA 961 Transport Software executing on the intelligent network controller board.

When a request for a remote file is made, the Remote File Driver routes the request to the iRMX-NET File Consumer Software. The File Consumer Software translates the remote network node name into a network address and then formats network communication messages that are sent by the MIP Software to the iNA 961 Transport Software and then to the remote network node.

When a file access request is received from the network, the iNA 961 Transport Software routes the request via the MIP Software to the iRMX-NET File Server Software. The File Server Software in turn accesses the file system through an iRMX Operating System dependent software module called the Apex File Access (AFA) Software. The AFA Software receives requests from the File Server Software and, acting as the remote user, executes the necessary file operations corresponding to the requests.

The User Administration (UA) module maintains the files used when making additions and deletions of authorized users and consumer systems within an Administrative Unit on the network.

DISTRIBUTED NAME SERVER

The Name Server Software provides name-to-network-address mapping for the network node on which it is installed. iRMX-NET implements a distributed or "protocol based" name server scheme in which every node "knows" its own name and address. The named network node responds with identification of its address to any name server request for its name (See Figure 7). The file consumer uses this mechanism to translate a remote network node name to a network address when a remote file is accessed. As a result, network management is simplified since there is no need to maintain a master directory file within the network.

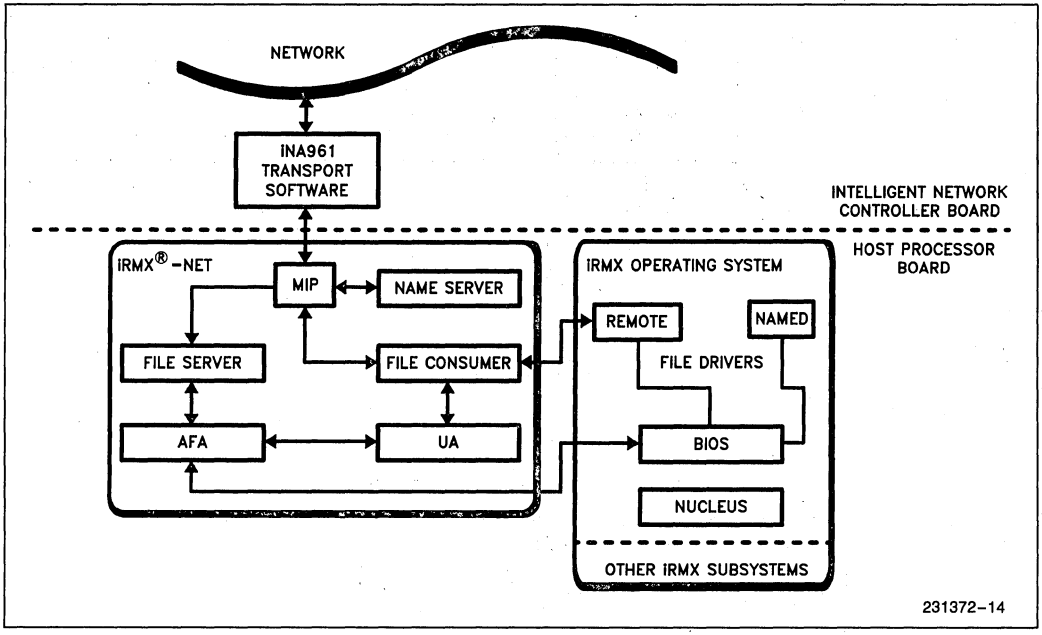


Figure 6. iRMX®-NET Software Modules in a COMMengine Environment

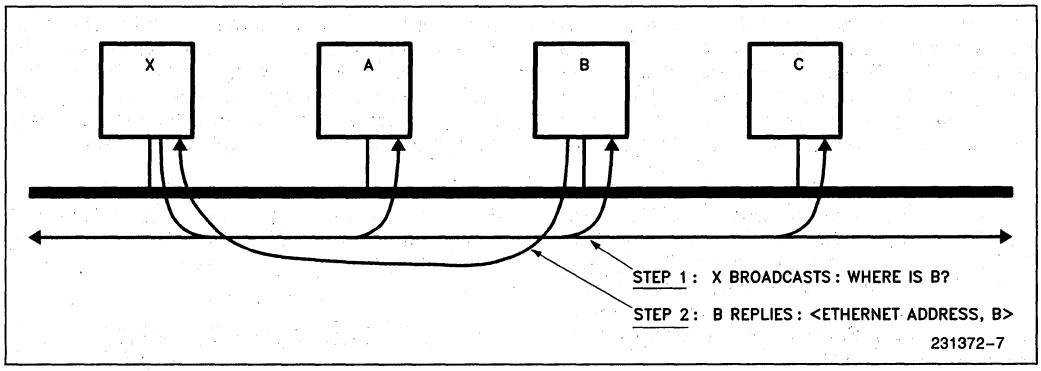
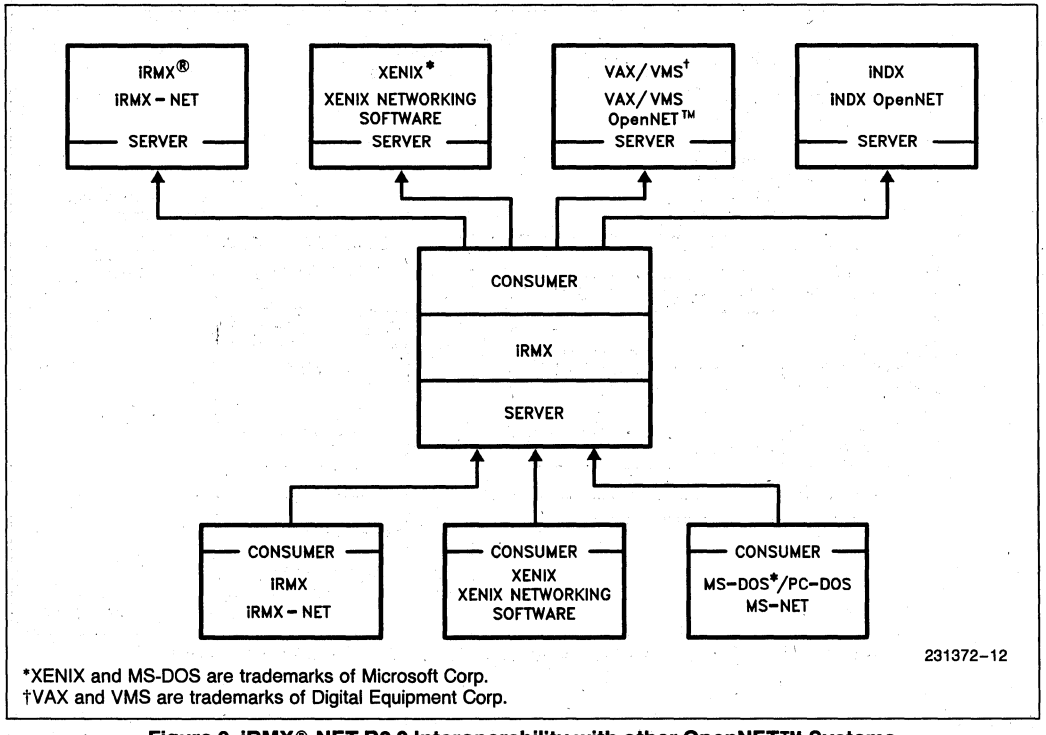


Figure 7. Distributed Name Server Scheme

INTEROPERABILITIES

An iRMX-NET system can transparently access files resident at remote systems that are configured with OpenNET Network File Access file server software. iRMX-NET, XENIX-NET, VAX/VMS OpenNET, and iNDX OpenNET equipped network nodes can act as file servers. Likewise, an iRMX-NET equipped network node can act as a file server to other network nodes that are equipped with OpenNET Network File Access file consumer software. iRMX-NET, XENIX-NET, and Microsoft Networks (MS-NET) equipped nodes can act as file consumers. See Figure 8 for an illustration of these interoperation capabilities. The arrows in the diagram indicate the direction of resource requests. Table 1 lists the operating systems and the required networking software that interoperate with iRMX-NET R2.0 when installed with either the iRMX 86 R7 or iRMX 286 R2 Operating Systems.



*XENIX and MS-DOS are trademarks of Microsoft Corp.
†VAX and VMS are trademarks of Digital Equipment Corp.

Figure 8. iRMX®-NET R2.0 Interoperability with other OpenNET™ Systems

Table 1. Interoperable Software

Operating System	Networking Software
XENIX* R3.4	XENIX Networking Software R2.0
MS-DOS* V3.1–3.2	MS-NET V1.0–1.01
iNDX R3.2	NDS II R3.2 OpenNET™ File Servers
VAX/VMS† V4.2–4.4	VAX/VMS OpenNET R1.0
iRMX® 86 R7 iRMX 286 R2	iRMX-NET R2.0
iRMX 86 R6	iRMX-NET R1.0A

*XENIX and MS-DOS are trademarks of Microsoft Corp.
†VAX and VMS are trademarks of Digital Equipment Corp.

SYSTEM COMPATIBILITIES

iRMX-NET R2.0 is supported by the iRMX 86 R7 and the iRMX 286 R2 Operating Systems.

iRMX-NET R2.0 operates with the iNA 960 R1.1 or iNA 961 R1.3 Transport Software and runs in either COMMputer mode or COMMengine mode.

iRMX-NET R2.0 operates in a COMMengine environment with a variety of host iSBC boards along with the iSXM 552 and iSXM 552A LAN controllers.

iRMX-NET R2.0 operates in a COMMputer environment with the iSBC 186/51.

SYSTEM INCOMPATIBILITIES

iRMX-NET R2.0 is NOT supported by the iRMX 86 R6 or iRMX 286 R1 Operating Systems.

iRMX-NET R2.0 does NOT operate with iNA 961 R1.1 or iNA 960/961 R2.0 Transport Software.

iRMX-NET R2.0 does NOT operate with the iSBC 186/530 LAN Controller board or with the iSBX™ 586 MULTIMODULE™.

The compatible combinations of COMMengine and COMMputer hardware and software are shown in Tables 2, 3, and 4.

Table 2. Valid iRMX®-NET R2.0 Compatible COMMengine Host Boards and Software

COMMengine Host iSBC® Boards:	Host Operating System			
	iRMX® 86		iRMX® 286	
	R7	R6	R2	R1
86/30	Yes	No	No	No
86/35	Yes	No	No	No
286/10 (A)	Yes	No	Yes	No
286/12	Yes	No	Yes	No
286/20	Yes	No	Yes	No
386/20	No	No	Yes	No

Table 3. iRMX®-NET R2.0 Compatible COMMengine LAN Controller Boards and Software

COMMengine Transport Software:	COMMengine Hardware		
	iSXM™ 552A	iSXM 552	iSBC® 186/530
iNA 961 R1.3	Yes	Yes	No
iNA 961 R2.0	No	No	No

Table 4. iRMX®-NET R2.0 Compatible COMMputer™ Boards and Software

COMMputer™ Software:		COMMputer Hardware	
		iSBC® 186/51	iSBC 286/12 with iSBX™ 586
iRMX® 86	R7	Yes	No
	R6	No	No
iRMX 286	R2	No	No
	R1	No	No
iNA 960	R1.1	Yes	No
	R2.0	No	No

MEMORY REQUIREMENTS

iRMX-NET R2.0 typically requires from 90K to 145K bytes of memory depending on the particular hardware and software configuration.

ORDERING INFORMATION

Order Code	Description
RMXNETJSU	Development license. No pass-through allowed.
RMXNETJRO	OEM license allowing pass-through of iRMX-NET Software with payment of appropriate incorporation fee.
RMXNETRF	Incorporation fee for iRMX-NET.
RMXNT961KITJSU	Development license kit bundling iRMX-NET Software with the iNA 961 Transport Software. No pass-through allowed.
RMXNETKITJRI	iRMX-NET Software bundled with the iNA 961 Transport Software and the iSXM 552A LAN controller to provide a complete IEEE 802.3 LAN connection for an iRMX Multibus system.

An Intel Software License Agreement (SLA) is required to order iRMX-NET Software products.

Please consult the current Intel Product Catalog for complete order code descriptions and licensing information.

RELATED LITERATURE

Title	Order No.
iRMX Networking Software Release 2.0 User's Guide	460255
iRMX Networking Software Users' Guide [for iRMX-NET R1.0A]	122323
iNA 960 Programmer's Reference Manual [for iNA 960 R1.1]	122193
iNA 960 Architecture Reference Manual [for iNA 960 R1.1]	122194
iNA 961 Programmer's Reference Manual [for iNA 961 R1.3]	122274
iNA 960 Release 2.0 Programmer's Reference Manual	149231
iNA 960 Release 2.0 Configuration Guide	149230
iSBC/iSXM 552A IEEE 802.3 Communication Controller User's Guide [Hardware Reference Manual]	149228
iSBC 552 Ethernet Communications Controller Hardware Reference Manual	122141
iSBC 186/51 COMMputer Board Hardware Reference Manual	122330
iSBX 586 MULTIMODULE Ethernet Communication Controller Hardware Reference Manual	122290
iSBC 186/530 Ethernet COMMengine User's Guide	149226
OpenNET PC Link User's Guide	166664
VAX/VMS OpenNET Hardware and Transport Software Installation Guide	480070
VAX/VMS OpenNET Networking Software User's Guide	480071
XENIX Networking Software User's Guide [for XENIX-NET R2]	135147
XENIX Networking Software Installation and Configuration Guide [for XENIX-NET R2]	135146
iNDX OpenNET User's Guide	135848
OpenNET NRM Installation Manual	136883
OpenNET NRM User's Guide	136882
OpenNET Planning and Design Guide	138444

To order Intel Literature, contact your local Intel sales office or write or call:

Intel Literature Sales
P.O. Box 58130
Santa Clara, CA 95052-8130
(800) 548-4725

MAP-NET™ COMMUNICATIONS SOFTWARE (MAPNET2.1 AND MAP2.1SXMSW) MEMBER OF THE OpenNET™ PRODUCT FAMILY

- **Supported by OpenNET™-Map Hardware and Software:**
  - **— iSBC®554 Token Bus Board**
  - **— iNA 960 Communication Software**
- **MAPNET2.1 Implements ISO/OSI Layers 5–7, as Specified by Map Version 2.1**
- **Designed to Interface with iNA 960 Rel 2.0—Intel's Transport and Network Software for Layers 3–4.**
- **MAPNET2.1, iNA 960 Rel 2.0 and the iSBC®554 Map Board Provide a Seven Layer, Modular and Configurable MAP Solution Based on Intel's OpenNET Architecture.**
- **Provides MAP 2.1 ISO FTAM, Session, CASE, Network Management/Directory Services**
- **Pre-Configured to Run on Intel's iSBC 554 MAP Board**
- **Preconfigured Software Provides Layers 3–7 of the MAP 2.1 Specifications.**
- **Preconfigured Map Software with the iSBC 554 Board Provides a Seven Layer Turnkey Solution.**

MAPNET2.1, iNA 960 Rel 2.0 and the iSBC 554 Map Board are ready-to-use building blocks for OEM suppliers of networked systems to implement ISO/OSI layers 1–7, as specified by MAP version 2.1. The Intel iSBC 554 board provides the data link and the IEEE 802.4 based physical layer for MULTIBUS® based systems. MAP-NET is designed to use the services and interface provided by Intel's iNA 960 Rel 2.0 Software package. iNA 960 Rel 2.0 provides the ISO 8473 network and ISO 8073 transport layers 3 and 4 of MAP 2.1. MAPNET2.1 provides layers 5–7 of the MAP 2.1 specifications and is designed to run on top of iNA 960 Rel 2.0 on the iSBC 554 board. Together the board and software modules provide a complete, seven layer configurable MAP solution for OEM's. The MAP-NET software is also available preconfigured with iNA 960 Rel 2.0 to run on the Intel iSBC 554 board. This preconfigured software with the board provides a complete 7 layer turnkey solution for MAP 2.1.

Figure 1. below indicates how Intel's OpenNET/MAP software and hardware products fit in the ISO/OSI reference model for MAP.

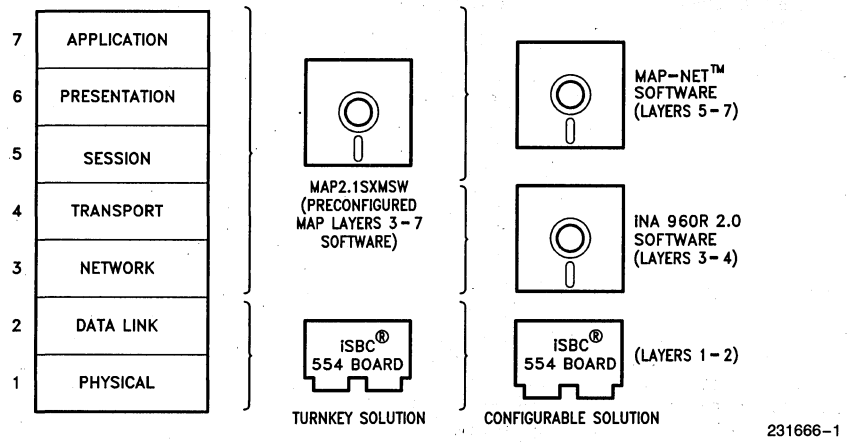


Figure 1. ISO/OSI Reference Model

September 1986
Order Number: 231666-002

FUNCTIONAL OVERVIEW

The Intel MAPNET2.1 software provides the following services specified by MAP 2.1; the session service, directory services, network management, FTAM and CASE. These services fit into the upper 3 layers of the ISO/OSI 7 layer model.

Using the Services of MAP-NET, users can initiate communications with other users on a MAP LAN, access information regarding resources available on a LAN, transfer files across a LAN and address other users on the LAN by logical names rather than numbered addresses.

MAP-NET is designed to interface with iNA 960 Rel 2.0. iNA 960 Rel 2.0 provides the network and transport protocol that is required by the map specification. Please refer to the iNA 960 data sheet for more information. The configurable software packages MAP-NET and iNA 960 Rel 2.0 are designed to run on the iSBC 554 for a complete, on-board, seven layer map COMMengine.

MAP2.1SXMSW is a preconfigured software package that incorporates the functions of MAP-NET and iNA 960 Rel 2.0. This package provides layers 3–7 and is designed to run on the iSBC 554 for a complete, on-board, seven layer, turnkey MAP COMMengine.

MAP-NET™ SESSION SERVICES

The MAPNET2.1 software implementation provides the Session services specified in the MAP version 2.1 specification. The session service is built on top of the iNA 960 Rel 2.0 transport service. iNA 960 Rel 2.0 provides the class 4 services of the ISO 8073 transport specification and the ISO 8473 network specification. The Session service supports all of the services provided by the underlying transport layer. Besides, the session layer also provides a 'graceful close' service. This service enables a user to release a session connection without the loss of any outstanding requests. The 'graceful close' feature is in addition to the 'abort' method of close provided by transport.

MAP-NET™ DIRECTORY SERVICES

The MAPNET2.1 Directory Services software maintains a database of network objects such as node names, user names, etc..., and related properties. For example, the directory services can be used to store the name of a network user and his network addresses as the properties associated with his name. A network user or application can query the directory service to retrieve information from this database. Users can also add or delete objects and properties from this database.

The Directory Services provided in MAPNET2.1 does the following:

— Runs on top of CASE

— Performs name to address conversion

— Maintains a local cache of resolved names

— Provides two forms of Directory Service—Client Service Agent for Local Data Base and Directory Service Agent for Remote/Master Data Base. (Can be configured to utilize the host memory pool)

MAP-NET™ CASE

The MAPNET2.1 Common Application Service Elements (CASE) is built on top of the MAPNET2.1 Session Service.

CASE is designed to support all the services provided by the lower ISO layers. In addition, MAP 2.1 CASE provides name-to-address translation for the user. By the use of the CASE service, a process can make a connection request to a remote process by using only the names of the processes. CASE takes these process names supplied by the user and resolves these names into network addresses and identification utilizing the services provided by the MAPNET2.1 Directory Service.

This greatly increases the ease-of-use of network Services provided by the underlying layers.

MAP-NET™ FILE TRANSFER, ACCESS AND MANAGEMENT (FTAM)

The FTAM Software in MAPNET2.1 provides remote file transfer capability. This capability is provided by the implementation of file request 'Initiator' module and a file request 'Responder' module. The Initiator intercepts file commands from the local user and transmits them across the LAN to the Responder at the node where the target file resides. The Responder receives, interprets, and executes the command acting as a user on its local node. File transfer between nodes is made possible by the implementation of a common set of file transfer protocols defined by the ISO FTAM Specification.

MAP-NET™ NETWORK MANAGEMENT FUNCTIONS (NMF)

The NMF meets or exceeds the MAP2.1 functionality for net management of each layer. The NMF interfaces to CASE, Session, Transport, Network, and Data Link layers. It provides three basic services:

— Read Net Management Object

— Set Net Management Object

— Event Notification

The NMF can be configured as a Net Manager for managing local or remote Net Agents or Net Agent for use by a remote Network Manager.

MAPNET2.1 FTAM allows a user to:

1) Create files on a remote node.
2) Write into files on a remote node.
3) Read files on a remote node.
4) Delete files on a remote node.
5) Get file attibutes on a remote node.

To perform the above functions the Initiator module should be configured in the user's node and the Responder should be configured in the remote target node. MAP-NET FTAM implementation allows a node to be 1) a file Initiator only, 2) a file Responder only and 3) both an Initiator and Responder.

MAP-NET™ and iNA 960 Software

MAPNET2.1 is designed to interface with iNA 960 Rel 2.0. iNA 960 Rel 2.0 provides the transport and network layers as required by the MAP specifications. Table 1 shows some examples of functions provided by MAPNET2.1 and iNA 960 Rel 2.0.

MAP2.1SXMSW—PROCONFIGURED LAYERS 3-7 MAP 2.1 SOFTWARE

MAP2.1SXMSW preconfigured 7 layer solution supports all seven layers on the iSBC 554 MULTIBUS® based commengine board. The services that are supplied by this preconfigured software package are FTAM, Directory Services, CASE, Session, Transport and Network layers. In order to provide maximum flexibility in interfacing user applications, the network management facility has been added. The preconfigured MAP software product is supplied with iRMX®86 device drivers, user interface utilities and the 7 layer conformance tested software.

OPERATING SYSTEM ENVIRONMENT

Figure 2 is a layout of the complete seven layer commengine. The preconfigured MAP software is downloaded on the iSBC 554 board. The user utilities can communicate with the seven layer commengine via the MULTIBUS Interface Protocol (MIP).

MIP is an Intel reliable process to process message delivery protocol between MULTIBUS processors. An implementation of the MIP protocol is provided on the iSBC 554 for communication with the host. The corresponding MIP/File Access Interface will have to be provided on the host side for communication with the iSBC 554. The user utilities include Directory Services, File Transfer and Net Management. The MIP/File Access Interface is available from Intel for the iRMX 86 Operating System and can be easily ported to other operating system environments.

Table 1. MAP2.1SXMSW and MAP-NET™/iNA 960 Rel 2.0 Services

Application	File Transfer, Access and Management (FTAM) provides remote operations on files (create, read, write, delete, get file attributes) Common Application Service Elements (CASE) supports all the services provided by the lower ISO layers provides name to address translation support Directory Services performs name to address conversion maintains local cache of resolved names two forms of Directory Service—client Service Agent for local data base and directory Service Agent for remote (master) data base
Presentation	Null
Session	Implements subset of ISO session 8327 specified by the MAP 2.1 specifications. Provides 'Graceful Close' 'graceful Close' allows the closing of a connection without any loss of queued requests it enhances the transport provided 'Close' which aborts a connection
Transport	Virtual circuit open: establish a virtual circuit database send connect: actively try to establish a virtual connection await connect: passively awaits the arrival of a connection request send: send a message receive: post a buffer to receive a message close: close a virtual circuit Datagram send: send a datagram message receive: post a buffer to receive a datagram message
Network	Internetworking routing between multiple lans segmentation/reassembly user defined routing tables Multiple subnets supported user supplied 802.3, 802.4
Data Link	Transmit: transmit a data link packet Receive: post a buffer to receive a data link packet Connect: make a data link logical connection (link service access point. IEEE802.4) Disconnect: disconnect a data link logical connection Change token bus address Add multicast address Delete multicast address Configure TBH
Network Management	Read/Clear/Set network objects (local/remote): read/clear/set local or remote MAP-NET/iNA 960 network parameters Read/Set network memory (local/remote): read/set memory of the local or a remote station useful in network debug process Boot consumer: requests a network boot server to load a boot file into this station Echo: Echo a packet between this station and another remote station on the network

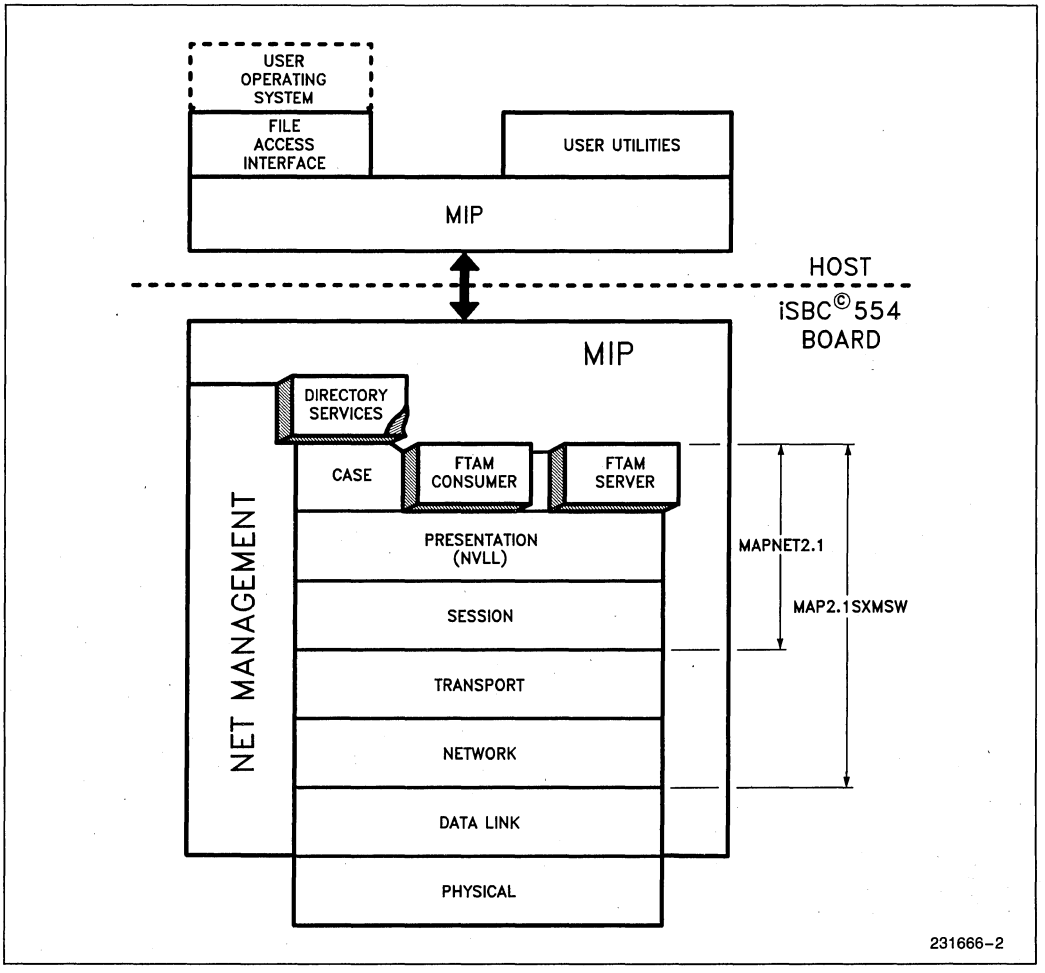


Figure 2. MAP-NET™/MAP2.1SXMSW User Interface

Available Literature

- iNA 960 Release 2.0 Programmers Reference Manual.
- iNA 960 Release 2.0 Configuration Guide
- iNA 960/MAP-NET Installation Guide
- iSBC 186/51 Hardware Reference Manual
- iSBC/iSXM 552 Hardware Reference Manual
- iSBC/iSXM 552A Hardware Reference Manual
- iSBC 554 Hardware Reference Manual
- MAP-NET Programmers Reference Manual
- RMX-NET Programmers Reference Manual
- iNA 960/961 Rel 2.0 Data Sheet
- iSBC 554 Data Sheet
- iSBC 552A Data Sheet

ORDERING INFORMATION

Hardware

Part Number	Modem Frequencies/Channel Pairs
iSBC 554-1	Transmit: 59.75 to 71.75 MHz/Ch. 3 and 4
	Receive: 252 to 264 MHz/Ch. P and Q
iSBC 554-2	Transmit: 71.75 to 83.75 MHz/Ch. 4A and 5
	Receive: 264 to 276 MHz/Ch. R and S
iSBC 554-3	Transmit: 83.75 to 95.75 MHz/Ch. 6 and FM1
	Receive: 276 to 288 MHz/Ch. T and U

Software

Code	Description
MAP21SXMSWRO	License for preconfigured MAP 2.1 layers 3–7 software.
MAP32SXMSWRF	Incorporation fee for preconfigured MAP 2.1 layers 3–7 software (License required).
MAPNET21RO	License for configurable MAP 2.1 layers 5–7 software.
MAPNET21RF	Incorporation fee for configurable MAP 2.1 layers 5–7 software (License required).
iNA 961 R2	Preconfigured transport and internet software for a IEEE 802.3 to IEEE 802.4 router.
iNA 960 R2	Configurable MAP 2.1 layers 3–4 software.

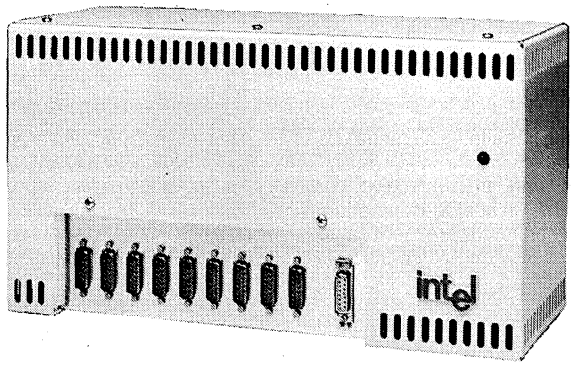
Hardware/Software Packages

Code	Description
MAP554NODEKIT-X	Package consists of:
(X = 1, 2 or 3)	One iSBC 554-X (X = 1, 2 or 3) and
	One MAP21SXMSWRF.
	This kit requires the prior purchase of MAP2.1SXMSWRO—the software license.

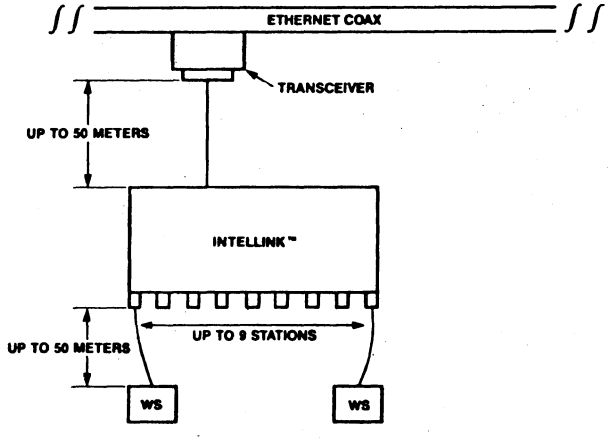
iDCM 911-1 INTELLINK™ ETHERNET* CLUSTER MODULE

- **Eliminates Need for Transceivers and Ethernet Coaxial Cable for a Local Cluster of Workstations**
- **Enables Local Cluster of Nine Workstations to Connect to Main Ethernet Cable with Only One Transceiver**
- **Permits Clustering of up to Nine Workstations in a Smaller Area**
- **Enables Workstations to be up to 100M from Main Ethernet Cable**
- **IEEE 802.3/Ethernet Compatible**

The Intellink™ Ethernet Cluster Module is a device used as a means of interconnecting up to nine Ethernet devices without the need for Ethernet coaxial cable and transceivers. The Intellink module forms a standalone Ethernet local area network with "interconnection" communication capability. The Intellink module (and attached devices) can optionally be connected to the Ethernet coaxial cable through a single transceiver.



210508-1



210508-2

Figure 1. Intellink™ Configuration

*Ethernet is a trademark of Xerox Corporation.

September 1987
Order Number: 210508-003

FUNCTIONAL DESCRIPTION

Intellink module performs the same functions as a standard Ethernet transceiver. It buffers receive and transmit data, detects attempts by two or more stations to gain access to the line simultaneously, signals the presence of a collision to the transmitting stations, and transmits the jam signal prior to initiation of the random back-off algorithm.

Ethernet Work Station to Intellink™ Interface (WI) Connectors

There are nine WI interface connectors into which Ethernet-based systems can be connected. Each connector has the same signal pairs as does the equivalent connector on a standard Ethernet transceiver.

Intellink™ Module to Transceiver Interface (IT) Connector

The IT interface connector on the Intellink module is used to connect the local cluster to the "main" Ethernet cable through a standard transceiver, or can be left unconnected for standalone operation. The characteristics of this connector are identical to an Ethernet system to transceiver cable connector.

Topology

The Intellink module can function in standalone operation in which case it appears as a "zero length Ethernet segment" for up to nine Ethernet-based systems, or optionally can be connected to the "main" Ethernet coaxial cable through a single transceiver. When connected to the "main" Ethernet coaxial cable, it extends the Ethernet system interface to the transceiver from 50 meters to 100 meters. (Figure 1).

Physical Characteristics

Width: 14 in. (35.56 cm)
Height: 7.8 in. (19.81 cm)
Depth: 5.5 in. (13.97 cm)
Weight: 10 lb. (4.52 kg)

ELECTRICAL CHARACTERISTICS

Input Voltage Range

(Voltages AC RMS)

Voltage (15%)
100V ±15%
120V ±15%
220V ±15%
240V ±15%

NOTE:
The frequency range is 47 to 64 Hz, single phase.

ENVIRONMENTAL CHARACTERISTICS

Temperature: 10°C to 40°C Operating
−40°C to 70°C Non-Operating
Humidity: 10% to 85% Operating
5% to 95% Non-Operating

ORDERING INFORMATION

Part Number	Description
iDCM 911-1	Intellink, IEEE 802.3/Ethernet compatible

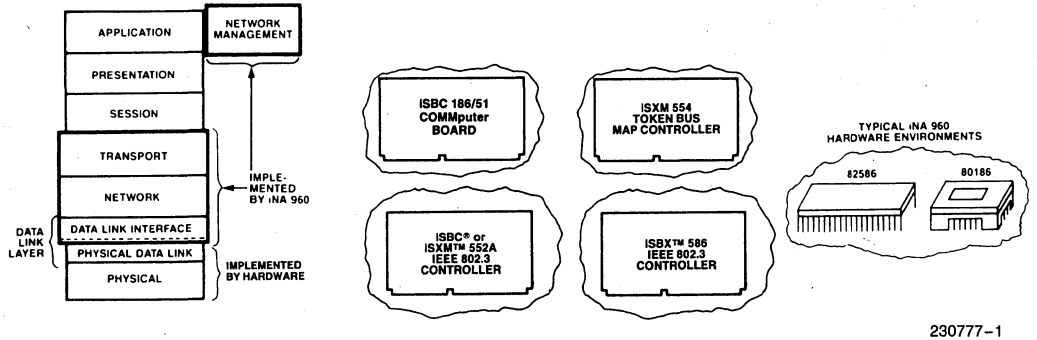
iNA 960/961 RELEASE 2.0 TRANSPORT AND NETWORK SOFTWARE MEMBER OF THE OpenNET™ PRODUCT FAMILY

- **Certified ISO Standard Transport and Network Layer Software**
- **ISO 8073 Transport Class 4 Services**
  - **Multiple Virtual Circuit Connection Capability**
  - **Guaranteed Message Integrity**
  - **Data Rate Matching (Flow Control)**
  - **Variable Length Messages**
  - **Expedited Delivery**
- **ISO 8473 Network Class 3 Services**
  - **Connectionless Internetworking Capability**
  - **Supports End-Node Systems**
  - **Supports Internetwork Routers**
- **Highly Configurable for Multiple System Environments**
  - **As an iRMX® 86 Job**
  - **As a Stand-Alone Communications Processor System**
  - **Supports Other Host Operating System Independent Designs**
- **Connectionless Transport (Datagram) Services**
- **Data Link Drivers Support Many Hardware Environments**
  - **IEEE 802.3 Hardware Such as the iSBC® 186/51, iSXM™ 552(A), and iSBX™ 586 Boards and Various Designs Based on the 8086, 8088, or 80186 Processors and the 82586 LAN Coprocessor**
  - **IEEE 802.4 Hardware such as the iSBC® 554 Board**
  - **Others Definable by the User**
- **Comprehensive Network Management Services**
  - **Collection of Network Usage Statistics**
  - **Setting and Inspecting of Transport and Data Link Parameters**
  - **Fault Isolation and Detection**
  - **Boot Server**

iNA 960 is a complete transport and network software system plus a comprehensive set of network management functions, data link drivers, and system environment features. It is highly configurable to allow optimized selection of features, parameters, data link drivers, and memory buffers for a variety of system environments.

iNA 961 is derived from iNA 960. It consists of preconfigured subsets of iNA 960 that are designed to operate with several specific COMMengine hardware environments. iNA 961 contains preconfigured load files ready for download to the hardware. Load files are included to support the iSXM 552 and iSXM 552A IEEE 802.3 COMMengines, and the iSBC 554 IEEE 802.4 (MAP) COMMengine.

iNA 960/961 is a mature, flexible, and ready-to-use software building block for OEM suppliers of networked systems for both technical and commercial applications. Using the iNA 960 software the OEM can minimize development cost and time while achieving compatibility with a growing number of equipment suppliers adopting the ISO and IEEE standards.



230777-1

September 1987
Order Number: 230777-004

FUNCTIONAL OVERVIEW

Using the ISO seven layer model for network communications, iNA 960 provides the services of layers four and three, the transport and network layers. The iNA 960 design is an implementation of the Class 4 services of the ISO standard 8073 connection oriented transport protocol. The iNA 960 transport layer provides a reliable full-duplex message delivery service on top of the internetworking capability offered by the network layer. The iNA 960 network layer is an implementation of the Class 3 services of the ISO standard 8473 connectionless network protocol. The network layer allows routing of information packets between different networks (each network is called a subnetwork). The network layer directs information packets to the packet delivery services of the IEEE 802.3 or IEEE 802.4 data link and physical layer functions.

Consisting of linkable object modules, the iNA 960 software can be configured to implement a range of capabilities and interface protocols. In addition to reliable process-to-process message delivery services, iNA 960 includes a datagram service, internetworking end-node capabilities, internetworking router node capabilities, boot server capabilities, a direct user access to the data link layer, and a comprehensive network management facility.

iNA 960 also contains a variety of client program interfaces, data link drivers, and a stand-alone operating system executive. As a result, iNA 960 is highly configurable to run under the iRMX 86 operating system, to run under its own operating system executive on an Intel iSXM IEEE 802.3 or IEEE 802.4 network board, or to run on a custom designed controller with an 8086, 8088, or 80186 processor coupled with an 82586 data link coprocessor.

The iNA 960 software also includes a comprehensive network management service. This facility enables the user to monitor and adjust the network's operation in order to optimize its performance.

For a conceptual block diagram of iNA 960, refer to Figure 2.

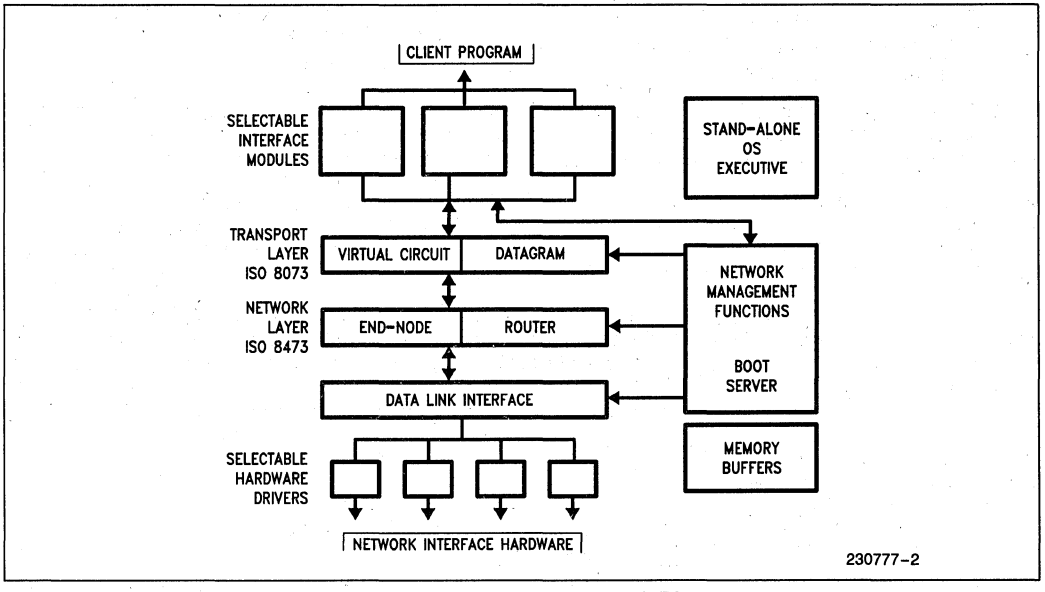


Figure 2. iNA 960 Conceptual Block Diagram

TRANSPORT LAYER

The Transport Layer provides message delivery services between client processes running on computers (network "nodes") anywhere in the network. Communicating client processes within the network are identified by a transport address that is a combination of a network address defining the network node and a transport service access point defining the interface point through which the client accesses the transport services. The transport address is supplied by the iNA 960 user for both the local and the remote client processes that are to be connected.

The iNA 960 transport layer implements two kinds of message delivery services: virtual circuit and datagram. The virtual circuit services provide a reliable point-to-point message delivery capability that ensures maximum data integrity and is fully compatible with the ISO 8073 Class 4 protocol standard. The datagram service provides a best-effort message delivery between client processes requiring less overhead and therefore allows higher throughput than virtual circuits.

Both the datagram and the virtual circuit services are optional and can be included when configuring iNA 960.

Virtual Circuit Services

Reliable Delivery: Data is delivered to the destination in the exact order it was sent by the source with no errors, duplications or losses, regardless of the quality of service available from the underlying network service.

Data Rate Matching (flow control): The Transport Layer attempts to maximize throughput while conserving communication subsystem resources by controlling the rate at which messages are sent. That rate is based on the availability of receive buffers at the destination and its own resources.

Multiple Connection Capability (Process Multiplexing): Several Processes can be simultaneously using the Transport Layer with no risk that progress or lack of progress by one process will interfere with others.

Variable Length Messages: The client software can submit arbitrarily short or long messages for transmittal without regard for the minimum or maximum network service data unit (NSDU) lengths supported by the underlying network services.

Expedited Delivery (optional): With this service the client can transmit up to 16 bytes of urgent data bypassing the normal flow control. The expedited data is guaranteed to arrive before any normal data submitted afterward.

Connectionless Transport (Datagram) Service

The datagram service transfers data between client processes without establishing a virtual circuit connection. The service is a "best effort" capability and data may be lost or misordered. Data can be transferred at one time to a single destination or to several destinations (multicast). The iNA 960 datagram service conforms to the ISO draft standard DIS 8602.

NETWORK LAYER

The network layer of iNA 960 provides the Class 3 connectionless network services specified by the ISO standard 8473 protocols.

The iNA 960 network layer provides the capability of connecting multiple different networks (called subnetworks) together and having information packets from one subnetwork routed to a destination on any other subnetwork. The network layer thus provides for two major capabilities:

- Internetworking
- Multiple subnets attached to one node

The iNA 960 network layer allows the user a variety of configurations. A node can be configured as:

- An internet end node belonging to a single subnetwork which is in turn connected to other subnetworks. In this configuration, the end node has the capability to address other nodes anywhere on the entire system of subnetworks.
- An internetwork router belonging to two or more subnetworks. In this case, only the ISO 8473 standard connectionless internetworking layer is configured on the node. The user can select the addressing and routing algorithms to be used. The iNA 960 network layer provides a routing algorithm with user changeable routing tables. The network layer also permits the future addition of address passing and routing algorithms as standards emerge. A router node can be configured with a variety of subnet data link and physical layers of mixed media types. The transport layer and above are not needed by this node.

- A multi-homed end system which is connected to two or more subnets. The network layer can provide routing between these subnets. In this case the transport layer is included and applications can run on this system and communicate on all subnetworks connected to it.
- A single network end node which can address nodes on one subnetwork only. This gives iNA 960 the transport layer functionality and a null network layer. The program interface to iNA 960 can be set up to accept the network address format of the ISO 8473 standard or of the previous draft ISO standard.

Data Link Drivers

The iNA 960 network layer has a variety of data link drivers for both IEEE 802.3 and IEEE 802.4 data link and physical layers. Specifically, IEEE 802.3 hardware drivers are included for the iSBC 186/51 COMMputer, the iSBC/iSXM 552 and 552A COMMengines, the iSBX 586 module, and 82586-based custom designed systems. An IEEE 802.4 data link driver is also included for the iSBC 554 token-bus MAP board. In addition, a user can add up to two user written subnetworks (when operating under the iRMX 86 operating system). Communication between the subnetwork drivers and the network layer is via request blocks and is based on the programmatic interface specified by iNA 960.

Router Capabilities

Since iNA 960 includes a wide variety of data link drivers and a flexible internetworking capability, a wide variety of internetworking configurations are supportable.

- With the iSBC 554 board and the iSBX 586 module, an IEEE 802.4 MAP token-bus to IEEE 802.3 Ethernet CSMA/CD router is supported. iNA 961 includes a preconfigured load file for this hardware configuration.
- With the iSBC 186/51 board and the iSBX 586 module, an IEEE 802.3 to IEEE 802.3 router is supported.
- With the iSBC 186/51 board (which has both an IEEE 802.3 port and a serial port), the user can link a separate serial data link driver (such as for X.25) to the iNA 960 network layer and produce an IEEE 802.3 to serial link router.

For full internetworking configurations, the user can set up the routing tables which are used for routing information packets between subnetworks. The routing tables can be changed during operation via a routing management facility. Information packets follow the routing path fixed by the routing table information.

NETWORK MANAGEMENT FACILITY

The Network Management Facility provides the user of iNA 960 with planning, operation, maintenance, and initialization services described below:

- Planning: This service captures network usage statistics on the various layers to observe network traffic and to help plan network expansion. Statistics are maintained by the layers themselves and are made available to users via a program interface with the NMF.
- Operation: This service allows the user to monitor network functions and to inspect and adjust network parameters. The goal is to provide the tools for performance optimization on the network.
- Maintenance: This service deals with detecting, isolating, and correcting network faults. It also provides the capability to determine the presence of other nodes on the network and the viability of their connection to the network.
- Initialization: NMF provides initialization and remote loading facilities for remote nodes on the network.

Network management provides distributed management of the network. The user can request any of the services to be performed on a remote as well as a local node. The NMF interfaces to every other network layer both to utilize their services and to access their internal data bases.

In support of the above services, the NMF capabilities include layer management, echo testing, limited debugging facilities, and the ability to down line load and dump a remote system.

The NMF software provides a routing management facility which can be used to change the internetworking routing tables. The routing tables are used by the network layer to route information packets between subnetworks.

The NMF provides the hooks for MAP-NET software (which provides layers 5 through 7 support for MAP networks) to support the network management functions in the MAP 2.1 specification. Thus, the MAP-NET user has a choice of selecting the Intel NMF network management functions or the MAP network management functions.

Layer management deals with manipulating the internal database of a layer. The elements of these data bases are termed objects. Some examples for objects are the number of collisions, the retransmission timeout limit, the number of packets sent, and the list of nodes to boot. NMF can examine and modify objects in a layer's data base.

An echo facility is provided. Using this facility, one node can determine if another node is present on the network or not, test the communication path to that node, and determine whether the remote node is functional.

NMF enables the user to read or write memory in any node present on the network. This feature is provided as an aid to debugging.

NMF can down line load any system present on the network. A simple Data Link protocol is used to ensure reliability. This facility can be used to load databases, to boot systems without local mass storage, or to boot a set of nodes remotely, thus ensuring that they have the same version of software, etc.

Dumping is an operation equivalent to memory read from the user's standpoint. However, dumping uses the Data Link facilities while memory read uses the transport facilities.

EXTERNAL DATA LINK (EDL)

The External Data Link option allows the user to access the Data Link Layer directly instead of having to go through the network and transport layers. This flexibility is useful when the user needs custom higher layer software or does not need the Network Layer and Transport Layer services (e.g. when sending "best effort" messages or running customer diagnostics).

Through the EDL, the capabilities supporting the lower layers in iNA 960 are made directly available to the user. EDL enables the user to establish and delete data link connections, transmit packets to individual and multiple receivers, and configure the data link software to meet the requirements of the given network environment.

SYSTEM ENVIRONMENT

iNA 960 is designed to run on hardware based on the 8086, 8088, or 80186 microprocessors and the 82586 LAN Coprocessor. The software can be configured to run under the iRMX 86 operating system or on a dedicated 8086, 8088, or 80186 processor separately from the host. The following section describes these two operating environments.

iRMX® 86 Operating System Environment

In this configuration, both the user program and iNA 960 are running under the iRMX 86 operating system. The communications software is implemented as an iRMX 86 job requiring only the iRMX nucleus for most operations. The only exception is the boot server option which also needs the iRMX 86 Basic IO System. The iSBX 586 IEEE 802.3 module is supported when iNA 960 runs under the iRMX 86 operating system. Also, the two user defined data link drivers are supported when iNA 960 runs under the iRMX 86 operating system. Figures 3 and 4 show two example hardware configurations supported by iNA 960 running under the iRMX 86 operating system.

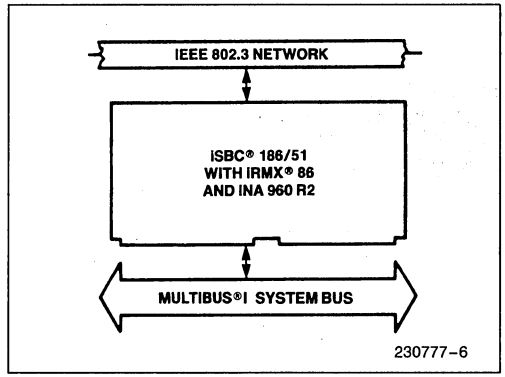


Figure 3. Configuration using iSBC® 186/51, iRMX® 86 and iNA 960

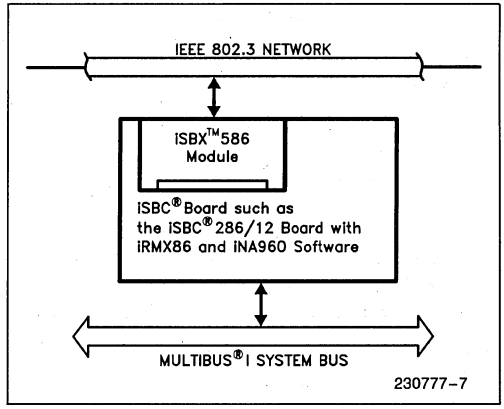


Figure 4. Configuration using an iSBC® Board and iSBX™ 586 Controller Module

Operating System Processor Independent Implementation

iNA 960 is also capable of operating in a standalone system environment under its own operating system executive. This mode of operation is appropriate in those systems where the iRMX operating system is not the primary operating system, where off-loading the host of the communications tasks is necessary for performance reasons, or where a cus-

tom designed communications front end processor configuration is being used. iNA 960 can be configured to support such implementations by providing network services on an 8086, 8088, or 80186 processor that in turn controls an 82586 LAN coprocessor. Figure 5 depicts the conceptual block diagram of this configuration. The iSBC/iSXM 552, the iSBC/iSXM 552A, and the iSBC 554 boards are MULTIBUS® I implementations of this architecture. Figures 6 and 7 depict examples of these implementations.

This approach provides the component and system designer with an ISO standard communications software building block that can be adapted to their system needs with a minimum development effort. For added flexibility, iNA 960 provides the user with the alternative of using the iNA 960 interface module or of writing their own module if necessary.

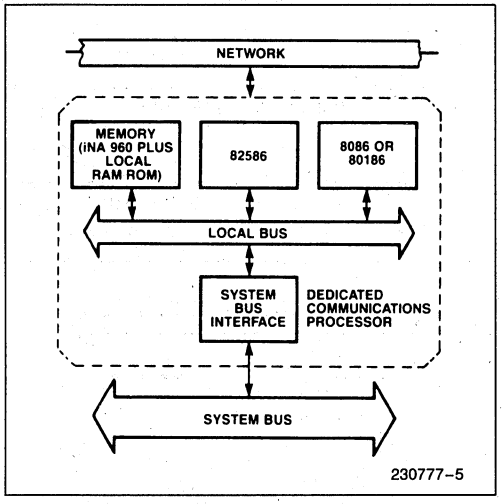


Figure 5. In the operating system/processor independent implementation iNA 960 is running on a dedicated 8086, 8088 or 80186 processor.

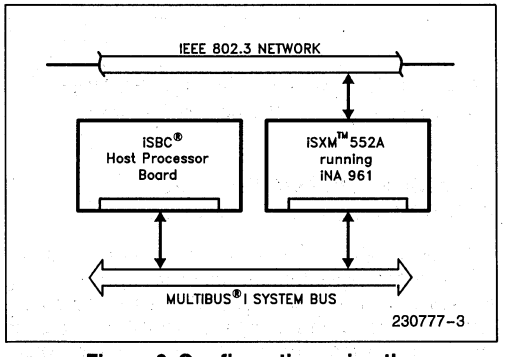


Figure 6. Configuration using the iSXM™ 552A and iNA 961

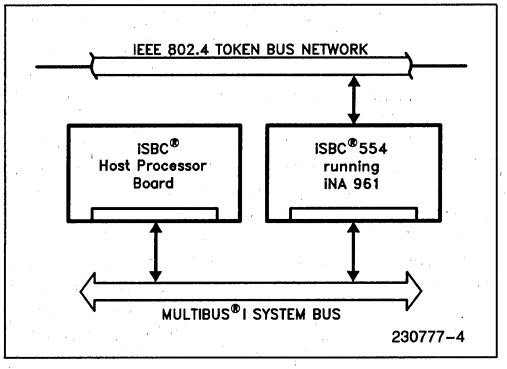


Figure 7. Configuration using the iSBC® 554 and iNA 961

USER INTERFACE

iNA 960 is designed to run both under the iRMX 86 operating system or on a dedicated communications front end processor separate from the host. In both environments, the user interface is based on exchanging memory segments called request blocks between iNA 960 and the client. The format and contents of the request blocks remain the same in both configurations with only the request block delivery mechanism changing.

Request blocks are memory segments containing the data to be passed from the user to iNA 960 (commands) or from iNA 960 to the user (responses). The iNA 960 request blocks consist of fixed format fields identical across all user commands and argument fields unique to the individual commands. Refer to Figure 8 for the standard request block format.

Issuing an iNA 960 command consists of filling in the request block fields and transferring the block to iNA 960 for execution. After processing the command, iNA 960 returns the request block with one of the pre-defined response codes placed in the response code field of the request block. The response code indicates whether the command was executed successfully or whether an error occurred. By examining the response code, the user can take appropriate action for that command.

The request block delivery mechanism is the means by which the host processor and the communications processor running iNA 960 software exchange the request blocks. iNA 960 provides three such mechanisms: the MIP (Multibus Inter-process Protocol), the BCB (Base Control Block), and a user-defined mechanism. The MIP interface is included for use in systems already supporting this protocol, the BCB is a simple interface for single host environments, and the user-defined interface accommodates unique application requirements.

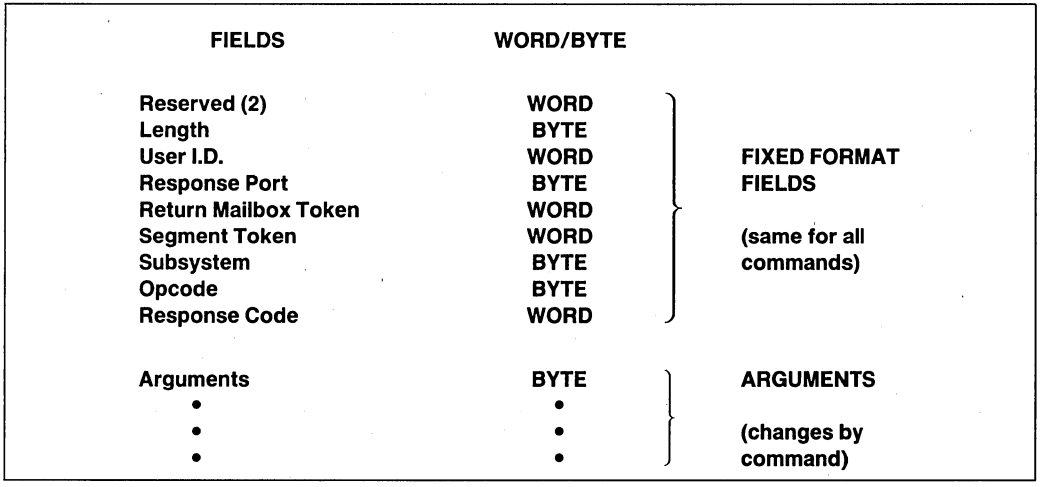


Figure 8. iNA 960 Request Block Format

Transport Layer User Interface

The following table summarizes the user commands and the corresponding transport layer responses:

Command	Function
OPEN	Allocates memory for the connection database of a virtual circuit for connection to be established. The connection database contains data concerning the connection.
SEND CONNECT REQUEST	Requests connection to a fully specified remote transport address using specified ISO connection negotiation options.
AWAIT CONNECT REQUEST TRAN	Indicates that the transport client is willing to consider incoming connection requests based on pre-established acceptance criteria.
AWAIT CONNECT REQUEST USER	Indicates that the transport client is willing to consider incoming connection requests if the request meets the address and negotiation option criteria it passed to the client for further consideration.
ACCEPT CONNECT REQUEST	Indicates that the connection requested by a remote transport service is accepted by the client.
SEND DATA or SEND EOM DATA	With this command the client requests the transmission of the data in the buffers using the normal delivery service of the specified connection.
RECEIVE DATA	Posts normal receive data buffers for a specific connection or for a buffer pool used by a class of connections.
WITHDRAW RECEIVE BUFFER	Returns a previously posted receive buffer for use.
SEND EXPEDITED DATA	Transmits up to 16 bytes of data using the expedited delivery service. The expedited data is guaranteed to arrive at the destination before any normal data submitted afterward.
RECEIVE EXPEDITED DATA	Posts receive data buffers for expedited delivery for a specific connection or for a pool of buffers used by a class of connections.

Transport Layer User Interface (Continued)

Command	Function
WITHDRAW EXPEDITED BUFFER	Returns a previously posted expedited delivery receive buffer for use.
CLOSE	Terminates an existing connection or rejects an incoming connection request. Any normal or expedited data queued up to be sent will not be sent.
AWAIT CLOSE	Requests notification from the client of the termination of a specified connection.
STATUS	Returns status of the transport service connections.
SEND DATAGRAM	Requests transmission of the data in the buffers using the transport datagram service.
RECEIVE DATAGRAM	Posts a receive buffer for a specific receiver or a class of receivers to receive data from a transport datagram.
WITHDRAW DATAGRAM BUFFER	Returns a previously posted datagram buffer for use.
ADD DATAGRAM MULTICAST ID	Allows a client to belong to a group and receive datagrams sent to this group in addition to receiving datagrams specifically addressed to the client.
DELETE DATAGRAM	Allows a client to remove themselves from a multicast group.

Network Management Layer User Interface

Command	Function
READ OBJECT	Returns the value of the specified object to the client.
SET OBJECT	Sets the value of an object as specified by the client.
READ AND CLEAR OBJECT	Returns the value of the specified object to the client then clears the object.
ECHO	This function is used to determine the presence of a node to test the communication path to that node and to ascertain the viability and functionality of the remote host addressed.
UP LINE DUMP	Requests a remote node to dump a specified memory area.
READ MEMORY	Reads memory of the specified network node.
SET MEMORY	Sets memory of the specified network node.
FORCE LOAD	Causes a node to attempt a remote load from another node.

External Data Link Interface

Command	Function
CONNECT	With this command the client establishes a data link connection.
DISCONNECT	Eliminates a previously established connection.
TRANSMIT	Transmits data contained in buffers specified by the client.
POST RECEIVE PACKET DESCRIPTOR	Allocates memory for maintaining records on receive data buffers. Also may be used to allocate memory for buffering receive data.
ADD MULTICAST	Adds an address to the list of data link multicast addresses.
REMOVE MULTICAST ADDRESS	Removes an address from the list of data link multicast addresses.
SET DATA LINK ID	Sets up a unique data link ID for the node.

CONFIGURING iNA 960

iNA 961 contains preconfigured subsets of iNA 960 that are designed to execute on specific hardware configurations such as the iSXM 552A and the iSBC 554 boards. The preconfigured load files in iNA 961 are ready for downloading to the hardware and therefore require no software configuration effort by the customer.

iNA 960 is highly configurable for a variety of system environments, and it therefore allows configuration and optimization by the customer. iNA 960 is configurable at the object code level.

In order to adapt iNA 960 to a specific system environment, the user must configure the software to define the desired functions, to select the appropriate user interface, to set the layer parameters, and to set up for the specific hardware configuration.

There are a number of capability combinations the user may elect to implement in their application. At the transport layer level, the options are virtual circuit service with or without expedited delivery, or datagram service, or both. At the network layer level, the options are to use the ISO 8473 internet layer or to use a null network layer. At the data link level, the user may include or exclude the External Data Link interface.

The Network Management Facility is also optional. When it is configured in, the user may also include the boot server module. These capabilities can be made available simply by linking in the corresponding software modules. The interface options are also implemented in a modular fashion. The user links in the desired module to set up for the iRMX 86 operating system or the operating system independent configurations.

Layer parameters and configuration options are first edited into layer configuration files, then assembled and linked into iNA 960. Layer parameters adjust the network's operation to match the usage pattern and the available resources. For example, within the Transport Layer, the flow control parameters, the retransmission timer parameters, the transport data base parameters, etc. can be set via this process.

During the configuration process, the user also sets up for the required hardware configuration, such as port addresses, interrupt levels, number of memory buffers, etc. For the flow diagram of configuring iNA 960, refer to Figure 9.

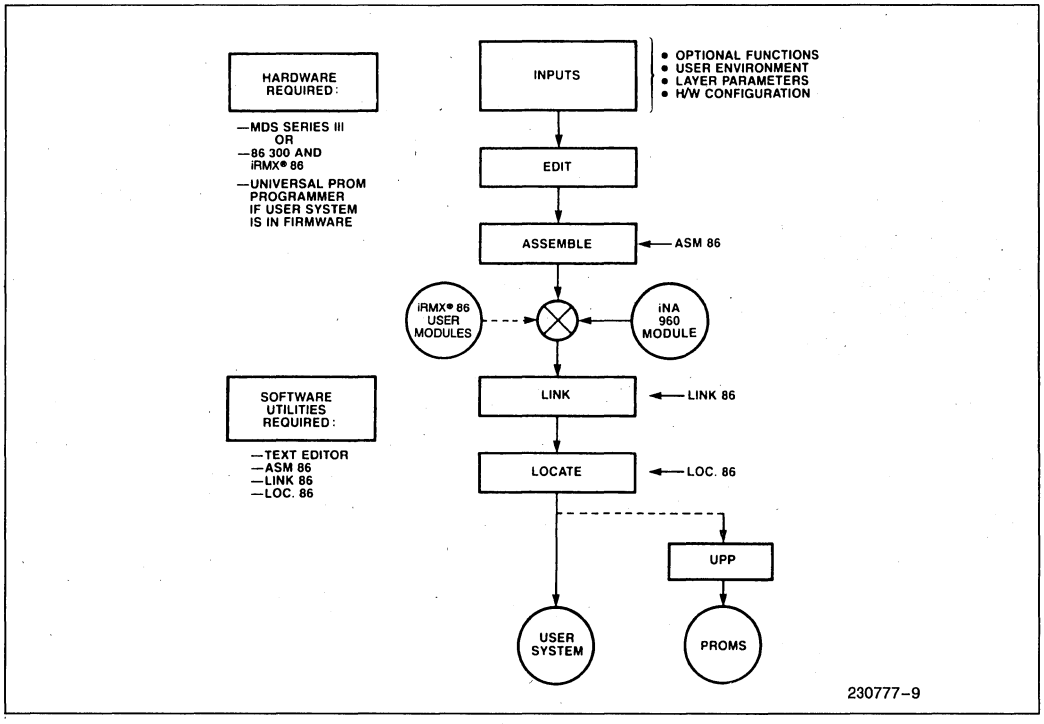


Figure 9. The Configuration Process for iNA 960

SPECIFICATIONS

Hardware Supported

— iSBC 186/51 Communication Computer

— iSBC/iSXM 552 and 552A Ethernet COMMengines

— iSBC 554 Token Bus (MAP) COMMengine

— iSBX 586 Ethernet Data Link Engine when configured with a supporting iSBC or iSXM board.

Typical Throughput at Transport

Environments:

186/51 and iRMX 86 Operations System	50k to 200k bytes/sec
Dedicated 80186/82586 COMMengine	100k to 300k bytes/sec

Memory Requirements (in bytes):

Base System	12k plus configurable buffer memory
Normal Virtual Circuit Option	18k plus configurable buffer memory
Expedited Delivery Option	2k
Datagram Option	3k plus data base memory
ISO 8473 Internet Layer	20k
Null Network Layer	2k
NMF Option	1k to 5k
External Data Link Option	5k
Boot Server Option	5k

Available Literature:

— iNA 960 Release 2.0 Programmers Reference Manual (149231-001)

— iNA 960 Release 2.0 Configuration Guide (149230-001)

— iSBC 186/51 Hardware Reference Manual (122136-002)

— iSBC/iSXM 552 Hardware Reference Manual (122141-002)

— iSBC/iSXM 552A Hardware Reference Manual (149228-001)

— iSBC 554 Hardware Reference Manual (149229-001)

— MAP—NET Programmers Reference Manual (149227-001)

— RMX—NET Programmers Reference Manual (122323-002)

ORDERING INFORMATION

iNA 960 is the order code for the fully configurable version of iNA 960 with the full ISO standard transport and network services. Licenses are available for both the object and the source code.

iNA 961 is the order code for a preconfigured version of iNA 960 for the following hardware configurations:

Hardware	Network Layer	# of Virtual Circuits
— iSXM 552 Board	null	30
— iSXM 552A Board	null	100
— iSXM 552A Board	internet	100
— iSBC 554 Board	internet	100
— iSBC 554/iSBX 586 Boards	internet (router)	(no transport)

iNA 960 release 1 is the former version (available since 1984) of fully configurable iNA 960 software that conformed with the draft ISO transport standard (DIS 8073). The network layer is null. Release 1 will be supported by Intel until all operating system products such as iXNX and iRMX convert to iNA 960 Release 2 transport services.

iNA 961 Release 1 includes preconfigured subsets of iNA 960 Release 1 for the following hardware configurations:

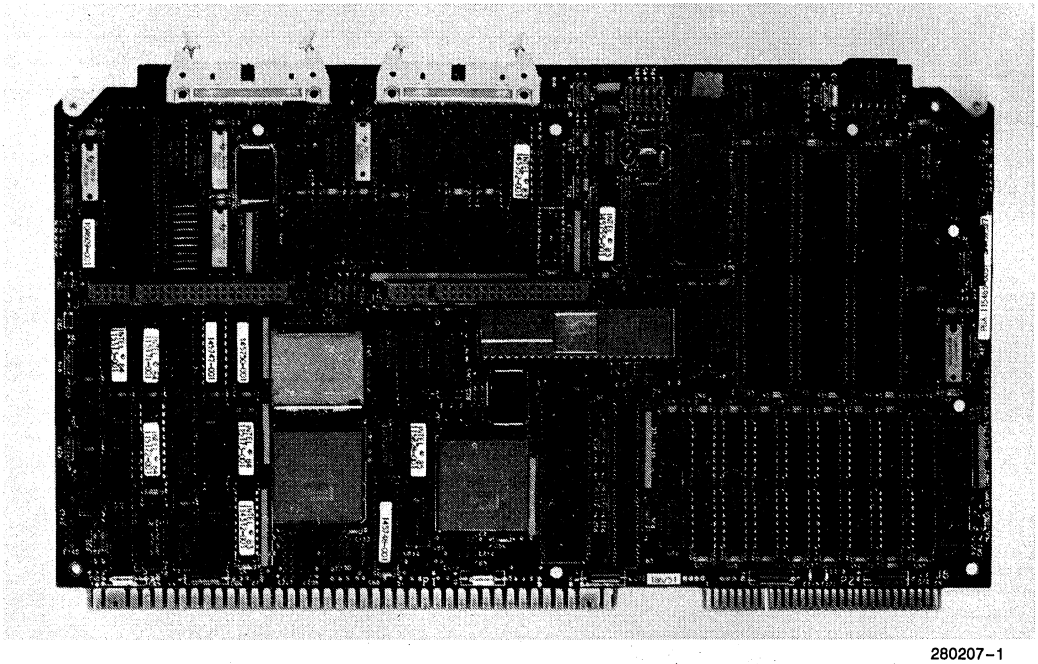
Hardware	# of Virtual Circuits
— iSXM 552 Board	30
— iSXM 552A Board	100

Order Code	Product
iNA960ESR	Machine Readable Source Code
iNA960LST	Human Readable Source Code
iNA960YRO	Object Code License—Configurable
iNA961ZRO	Object Code License—Preconfigured
iNA960RF	Incorporation fee per unit.

iSBC® 186/51
COMMUNICATING COMPUTER
MEMBER OF THE OpenNET™ PRODUCT FAMILY

- **6 MHz 80186 Microprocessor**
- **128K Bytes of Dual-Ported RAM Expandable On-Board to 256K Bytes**
- **82586 Local Area Network Coprocessor for Ethernet/IEEE 802.3 Specifications**
- **Two Serial Interfaces, RS-232C and RS-422A/RS-449 Compatible**
- **Supports Transport Layer Software (iNA 960) and Higher Layer Communications Software (such as iRMX®-NET)**
- **Sockets for up to 192K Bytes of JEDEC 28 Pin Standard Memory Devices**
- **Two iSBX™ Bus Connectors**
- **16M Bytes Address Range of MULTIBUS® Memory**
- **MULTIBUS Interface for Multimaster Configurations and System Expansion**
- **Supported by a Complete Family of Single Board Computers, Peripheral Controllers, Digital and Analog I/O, Memory, Packaging and Software**

The iSBC® 186/51 COMMUNICATING COMPUTER, THE COMMputer™, is a member of Intel's OpenNET™ family of products, and supports Intel's network software. The COMMputer utilizes Intel's VLSI technology to provide an economical self-contained computer for applications in processing and local area network control. The combination of the 80186 Central Processing Unit and the 82586 Local Area Network Coprocessor makes it ideal for applications which require both communication and processing capabilities such as networked workstations, factory automation, office automation, communications servers, and many others. The CPU, Ethernet interface, serial communications interface, 128K Bytes of RAM, up to 192K Bytes of ROM, I/O ports and drivers and the MULTIBUS interface all reside on a single 6.75″ x 12.00″ printed circuit board.



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Order Number: 280207-002

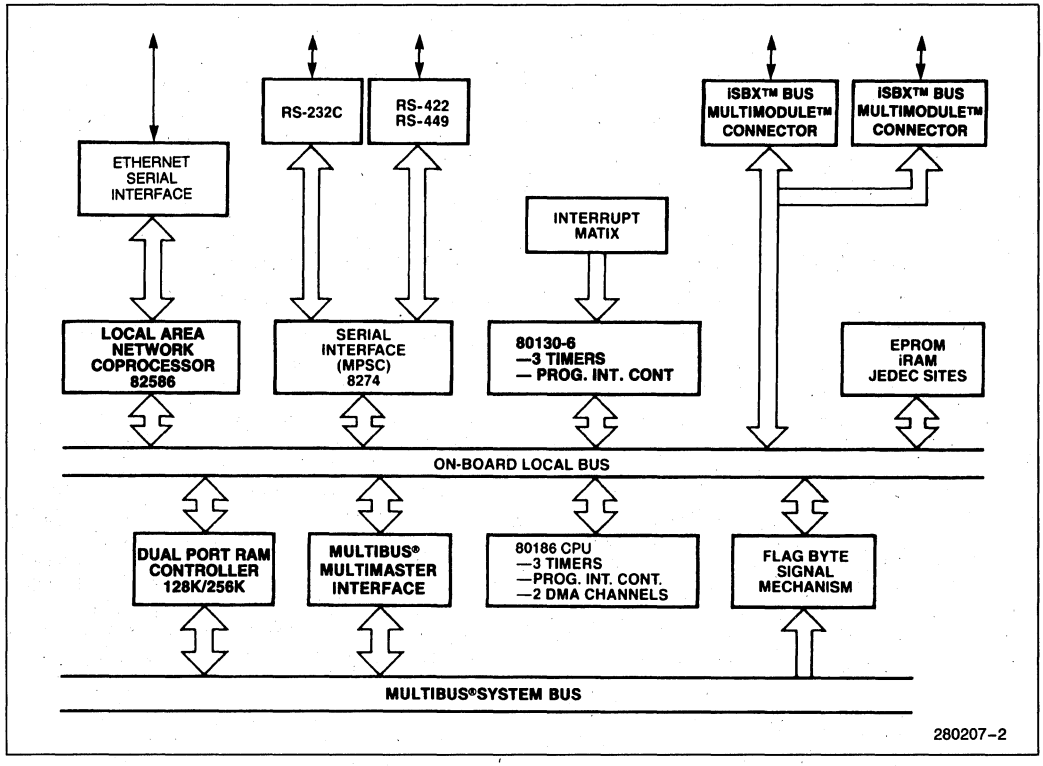


Figure 1. iSBC® 186/51 Block Diagram

FUNCTIONAL DESCRIPTION

Communicating Computer

Intel's OpenNET strategy provides the user with building blocks to implement all seven layers of the International Standards Organization's (ISO) Open Systems Interconnect (OSI) model (see Figure 2.) The iSBC 186/51 is a part of the OpenNET product family. The iSBC 186/51 can host iNA 960 transport layer software to provide ISO 8073 class 4 standard protocol on IEEE 802.3 LAN. In conjunction with the transparent file access software, iRMX-NET, the iSBC 186/51 and iNA 960 provide a complete seven layer communications solution.

The iSBC 186/51 board integrates a programmable processor and communications capability onto one board, serving both computational and networking capacities as dictated by the application. The communications coprocessor (82586) aids in this task by accomplishing as much of the communications task as possible before the processor intervenes (thus reducing the overhead load of the 80186 processor).

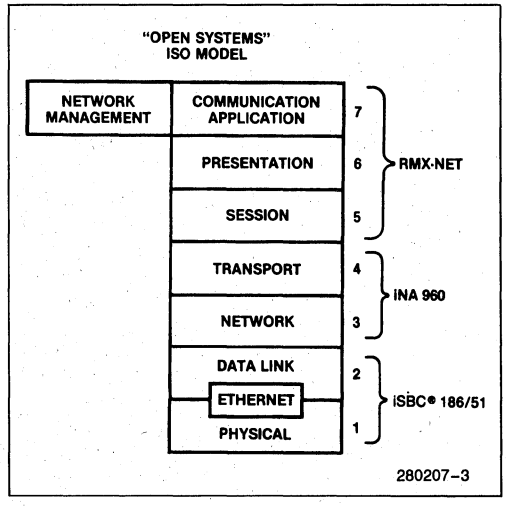


Figure 2. iSBC® 186/51 Implementation of ISO Standard Model

The dual capabilities of the iSBC 186/51 board are useful in three types of applications: (1) as a single board communicating computer running both user applications and communications tasks; (2) as one bus master of a multiple processor board solution running a portion of the overall user application and the communications tasks; and (3) as an "intelligent bus slave" that performs communications related tasks as a peripheral processor to one or more bus masters in a communications intensive environment.

Architecture

The iSBC 186/51 board is functionally partitioned into three major sections: central computer, I/O including LAN interconnect and memory including shared dual port RAM (Figure 1).

The central computer, an 80186 CPU, provides powerful processing capability. The microprocessor, together with the on-board PROM/EPROM sites, programmable timers/counters, and programmable interrupt control provide the intelligence to manage sophisticated communications operations on-board the iSBC 186/51. The timers/counters and interrupt control are also common to the I/O area providing programmable baud rates to USARTs and prioritizing interrupts generated from the USARTs. The central computer functions are protected for access by the on-board 80186 only.

The I/O is centered around the Ethernet access provided by the 82586. All 10 Mbps CSMA/CD protocols can be supported. Included here as well are two serial interfaces, both of which are fully programmable. In support of the single board computer, two iSBX connectors are provided for further customer expansion of I/O capabilities. The I/O is under full control of the on-board CPU and is protected from access by other system bus masters.

The third major segment, dual-port RAM memory, is the key link between the 80186, the Ethernet controller, and bus masters (if any) managing the system functions. The dual-port concept allows a common block of dynamic memory to be accessed by the on-board 80186 CPU, the on-board Ethernet controller and off-board bus masters. The system program can, therefore, utilize the shared dual-port RAM to pass command and status information between the bus masters and on-board CPU and Ethernet controllers. In addition, the dual-port concept permits blocks of data transmitted or received to accummulate in the on-board shared RAM, minimizing the need for a dedicated memory board.

CENTRAL COMPUTER FUNCTIONALITY

Central Processing Unit

The central processor for the iSBC 186/51 is Intel's 80186 CPU. The 80186 is a high integration 16-bit microprocessor. It combines several of the most common system components onto the chip (i.e., Direct Memory Access, Interval Timers, Clock generator, and Programmable Interrupt Controller). The CPU architecture includes four 16-bit Byte addressable data registers, two 16-bit index registers and two 16-bit memory base pointer registers. These are accessible by a total of 24 operand addressing modes for (1) comprehensive memory addressing, and (2) support of the data structures required for today's structured, high level languages—as well as assembly language.

Instruction Set

The 80186 instruction set is a superset of the 8086. It maintains object code compatibility while adding 10 new instructions to the existing 8086 instruction set. The 80186 retains the variable length instruction format (including double operand instructions), 8-bit and 16-bit signed and unsigned arithmetic operators for binary, BCD and unpacked ASCII data, and iterative word and byte string manipulations. Added instructions include: Block I/O, Enter and Leave subroutines, Push Immediate, Multiply Quick, Array Bounds Checking, Shift and Rotate by Immediate, and Pop and Push All.

Architectural Features

A six-byte instruction queue provides prefetching of sequential instructions and can reduce the 1000 ns minimum instruction cycle to 333 ns for queued instructions. The stack oriented architecture readily supports modular programming by facilitating fast, simple intermodule communication, and other programming constructs needed for asynchronous real-time systems. Using a windowing technique and external logic, the full 16M Bytes addressing range of the IEEE-796 MULTIBUS Standard is available to the user. The dynamic relocation scheme allows ease in segmentation of pure procedure and data for efficient memory utilization. Four segment registers (code, stack, data, extra) contain program loaded offset values which are used to map 16-bit addresses to 20-bit addresses. Each register maps 64K

Bytes at a time and activation of a specific register is controlled both explicitly by program control, and implicitly by specific functions and instructions. A flag byte signaling mechanism aids in creating an interprocessor communication scheme. This includes (1) the ability to set/reset interrupts with MULTIBUS commands and (2) board reset.

Programmable Timers

The 80186 provides three internal 16-bit programmable timers. Two of these are highly flexible and are connected to four external pins (two per timer). They can be used to count external events, time external events, generate nonrepetitive waveforms, etc. The third timer is not connected to any external pins, and is useful for real-time coding and time delay applications. In addition, this third timer can be used as a prescaler to the other two, or as a DMA request source. The factory default configuration for timer 0 is baud rate generator.

The 80130-6 provides three more programmable timers. One is a factory default baud rate generator and outputs an 8254 compatible square wave to the RS232 Channel B. The other two timers are assigned to the use of the Operating System and should not be altered by the user.

The system software configures each timer independently to select the desired function. Examples of available functions are shown in Table 1. The contents of each counter may be read at any time during system operation.

Interrupt Capability

The iSBC 186/51 has two programmable interrupt controllers (PICs): one in the 80186 component and one in the 80130-6 component. In the iRMX mode, the 80186 interrupt controller acts as a slave to the 80130-6. The 80186 interrupt controller in this mode uses all of its external interrupt pins. It therefore services only internally generated interrupts (i.e., three timers, two DMA channels). The 80130-6 interrupt controller operates in the master mode and has eight prioritized inputs that can be programmed either edge or level sensitive.

The iSBC 186/51 board provides 9 vectored interrupt levels. The highest level is the NMI (Non-Maskable Interrupt) line which is directly tied to the 80186 CPU. This interrupt is typically used for signaling catastrophic events (e.g., power failure). The Programmable Interrupt Controllers (PIC) provide control and vectoring for the next eight interrupt levels. As shown in Table 2, a selection of four priority proc-

Table 1. 80186 Programmable Timer Functions

Function	Operation
Interrupt on Terminal Count	When terminal count is reached, an interrupt request is generated. This function is extremely useful for generation of real-time clocks.
Programmable One-Shot	Output goes low upon receipt of an external trigger edge or software command and returns high when terminal count is reached. This function is retriggerable.
Rate Generator	Divide by N counter. The output will go low for one input clock cycle, and the period from one low going pulse to the next is N times the input clock period.
Square-Wave Rate Generator	Output will remain high until ½ the count has been completed, and go low for the other half of the count.
Software Triggered Strobe	Output remains high until software loads count (N). N periods after count is loaded, output goes low for one input clock period.
Hardware Triggered Strobe	Output goes low for one clock period N counts after rising edge counter trigger input. The counter is retriggerable.
Event Counter	On a jumper selectable basis, the clock input becomes an input from the external system. CPU may read the number of events occurring after the counter "window" has been enabled or an interrupt may be generated after N events occur in the system.

essing modes is available for use in designing request processing configurations to match system requirements for efficient interrupt servicing with minimal latencies. Operating modes and priority assignments may be reconfigured dynamically via software at any time during system operation. The PIC accepts interrupt requests from all on-board I/O resources and from the MULTIBUS system bus. The PIC then resolves requests according to the selected mode and, if appropriate, issues an interrupt to the CPU.

Interrupt Request Generation

iSBC 186/51 Interrupt Service requests may originate from 25 sources. Table 3 contains a list of devices and functions supported by interrupts. All interrupts are jumper configurable with either suitcase or wire wrap to the desired interrupt request level.

I/O FUNCTIONALITY

Local Area Network Coprocessor

The 82586 is a local communications controller designed to relieve the 80186 of many of the tasks associated with controlling a local network. The 82586 provides most of the functions normally associated with the data link and physical link layers of a local network architecture. In particular, it performs framing (frame boundary delineation, addressing, and bit error detection), link management, and data modulation. It also supports a network management interface.

The 80186 and the 82586 communicate entirely through a shared memory space. To the user, the 82586 appears as two independent but communicat-

Table 2. iSBC® 186/51 Programmable Interrupt Modes

Mode	Operation
Fully Nested	Interrupt request line priorities fixed at 0 as highest, 7 as lowest
Special Fully Nested	Allows multiple interrupts from slave PICs to the master PIC. Used in the case of cascading where the priority has to be conserved within each slave
Specific Priority	System software assigns lowest priority level. Priority of all other levels based in sequence numerically on this assignment
Polled	System software examines priority-encoded system interrupt status via interrupt status register

Table 3. Interrupt Request Sources

Device	Function	Number of Interrupts
MULTIBUS® Interface	Requests from MULTIBUS resident peripherals or other CPU	2
8274	Transmit buffer empty, receive buffer full and channel errors	8
Internal 80186 PIC	Timer 0, 1, 2 outputs (function determined by timer mode) and 2 DMA channel interrupts	5
82586	Communications processor needs attention	1
Flag Byte Interrupt	Flag byte interrupt set by MULTIBUS master	1
Systick	80130-6, iRMX® system timer	1
Edge to Level Trigger	Converts EDGE interrupts to level interrupts	1
iSBX® Connectors MULTIMODULE®	Function determined by iSBX	4 (2 per iSBX connector)
Bus Fail Safe Timer	Indicates addressed MULTIBUS resident device has not responded to command within 6 ms	1
OR-Gate Matrix	Outputs of OR-gates on-board for multiple interrupts	1

ing units: the Command Unit (CU) and the Receive Unit (RU). The CU executes the commands given by the 80186 to the 82586. The RU handles all activities related to packet reception, address recognition, CRC checking, etc. The two are controlled and monitored by the CPU via a shared memory structure called the System Control Block (SCB). Commands for the CU and RU are placed into the SCB by the host processor. Status information is placed into the SCB by the CU and RU (via the CU). The Channel Attention and Interrupt lines are used by the CPU and the 82586 to get the other to look into the SCB. See Figure 3. The 82586 features a high level diagnostic or maintenance capability. It automatically gathers statistics on CRC errors, frame alignment errors, overrun errors, and frames lost due to lack of reception resources. In addition, the user can output the status of all internal registers to facilitate system design.

Upon initialization, the 82586 obtains the address of its System Control Block through the Initialization Root which begins at location 0FFFFF6H. See Figure 4. The SCB contains control commands, status register, pointers to the Command Block List (CBL) and Receive Frame Area (RFA), and tallies for CRC, Alignment, DMA Overrun and No Resource errors. Through the SCB, the 82586 is able to provide status and error counts for the 8086, execute "programs" contained in the CBL and receive incoming frames in the Receive Frame Area (RFA).

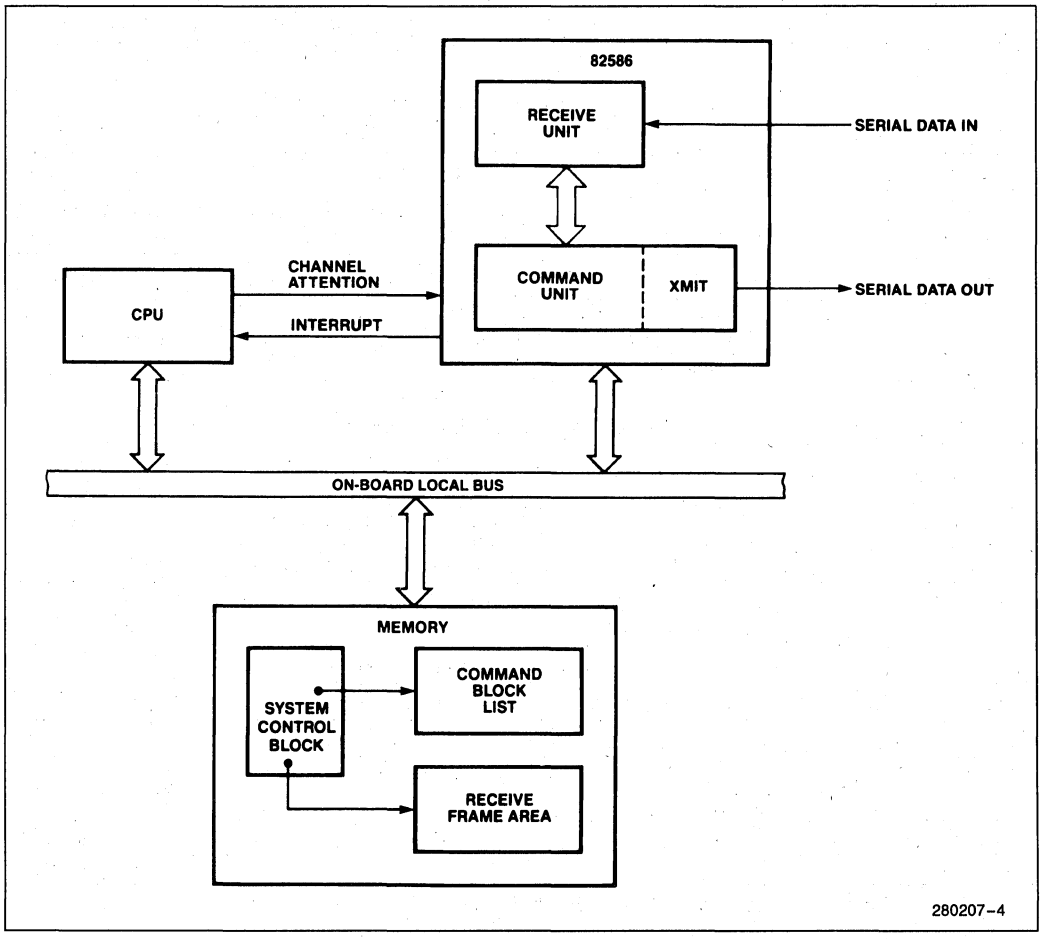


Figure 3. System Overview

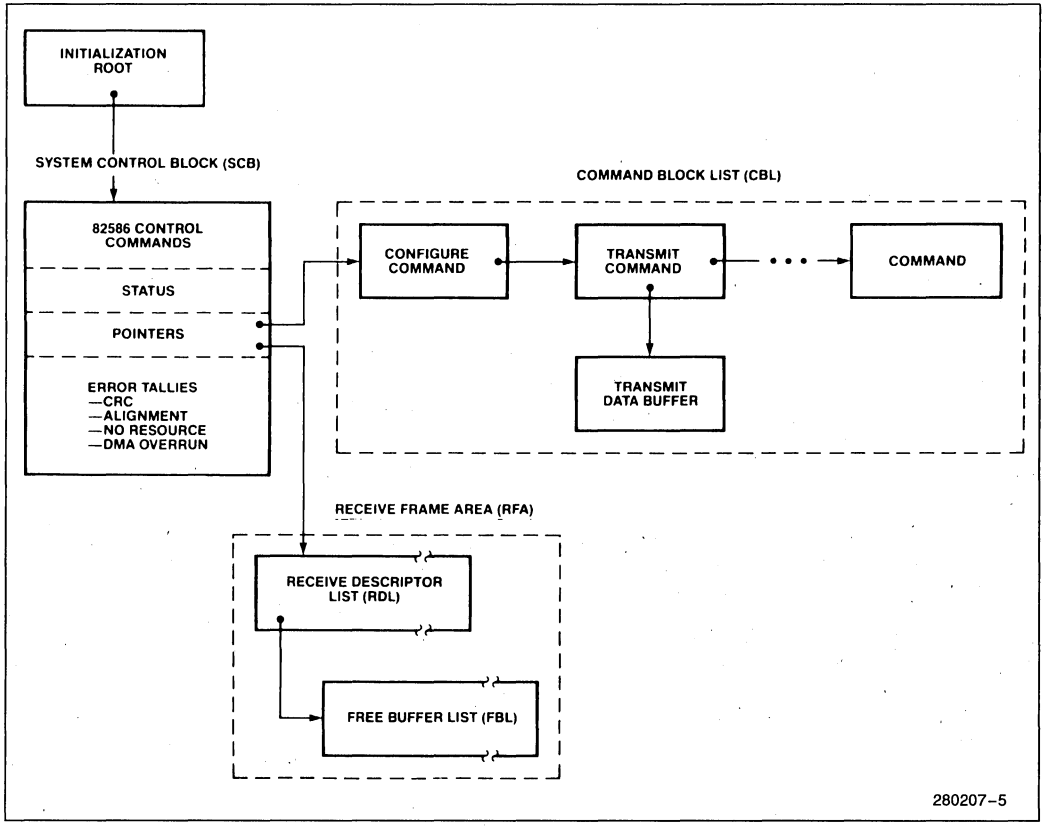


Figure 4. 82586 Memory Structures

Serial I/O

Two programmable communications interfaces using the Intel 8274 Multi-Protocol Serial Controller (MPSC) are contained on the iSBC 186/51. Two independent software selectable BAUD rate generators provide the channels with all the common communications frequencies. The mode of operation (for example, Asynchronous, Byte Synchronous or Bi-synchronous protocols), data format, control character format, parity, and baud rate are all under program control. The 8274 provides full duplex, double buffered transmit and receive capability. Parity, overrun, and framing error detection are all incorporated in the MSPC. The iSBC 186/51 supports operation in the polled, interrupt and DMA driven interfaces through jumper options. The board is delivered previously configured with channel A in RS-422/RS-449. Channel B in RS-232C. Channel A may be configured to support RS-232C.

iSBX™ MULTIMODULE™ On-Board Expansion

Two 8/16-bit iSBX MULTIMODULE connectors are provided in the iSBC 186/51 microcomputer. Through these connectors, additional on-board I/O functions may be added. iSBX MULTIMODULE boards optimally support functions provided by VLSI peripheral components such as additional parallel and serial I/O, analog I/O, small mass storage device controllers (e.g., cassettes and floppy disks), and other custom interfaces to meet specific needs. By mounting directly on the single board computer, less interface logic, less power, simpler packaging, higher performance, and lower cost results when compared to other alternatives such as MULTIBUS form factor compatible boards. The iSBX connectors on the iSBC 186/51 boards provide all signals necessary to interface to the local on-board bus, including 16 data lines for maximum data transfer rates.

iSBC MULTIMODULE boards designed with 8-bit data paths and using the 8-bit iSBX connector are also supported on the iSBC 186/51 microcomputers. A broad range of iSBX MULTIMODULE options are available in this family from Intel. Custom iSBX modules may also be designed for use on the iSBC 186/51 boards. An iSBX bus interface specification and iSBX connectors are available from Intel.

MEMORY FUNCTIONALITY

RAM Capabilities

The iSBC 186/51 COMMputer board contains 128K Bytes of dual-port dynamic RAM. The on-board RAM may be expanded to 256K Bytes with the iSBC 304 MULTIMODULE board mounted onto the iSBC 186/51 board. The dual-port controller allows access to the on-board RAM (including RAM MULTIMODULE options) from the iSBC 186/51 board and from any other MULTIBUS master via the system bus. Segments of on-board RAM may be configured as a private resource, protected from MULTIBUS system access. The amount of memory allocated as a private resource may be configured in increments of 25% of the total on-board memory ranging from 0% to 100% (optional RAM MULTIMODULE board doubles the increment size). These features allow the multiprocessor systems to establish local memory for each processor and shared system memory configurations where the total system memory size (including local on-board memory) can exceed one megabyte without addressing conflicts.

Universal Memory Sites for Local Memory

Six 28-pin sockets are provided for the use of Intel's 2732, 2764, 27128, 27256 EPROMs and their respective ROMs. When using the 27256s, the on-board EPROM capacity is 192K Bytes. Other JEDEC standard pinout devices are also supported, including byte-wide static RAMs and iRAMs.

MULTIBUS® SYSTEM BUS AND MULTIMASTER CAPABILITIES

Overview

The MULTIBUS system bus is Intel's industry standard microcomputer bus structure. Both 8- and 16-bit single board computers are supported on the MULTIBUS structure with 24 address and 16 data lines. In its simplest application, the MULTIBUS system bus allows expansion of functions already contained on a single board computer (e.g., memory and digital I/O). However, the MULTIBUS structure also allows very powerful distributed processing configurations with multiple processors and intelligent slave I/O, and peripheral boards capable of solving the most demanding microcomputer applications. The MULTIBUS system bus is supported with a broad array of board level products, LSI interface components, detailed published specifications and application notes.

Expansion Capabilities

Memory and I/O capacity may be expanded and additional functions added using Intel MULTIBUS compatible expansion boards. Memory may be expanded by adding user specified combinations of RAM boards, EPROM boards, or combination boards. Input/output capacity may be added with digital I/O and analog I/O expansion boards. Mass storage capability may be achieved by adding single or double density diskette controllers, or hard disk controllers. Modular expandable backplanes and cardcages are available to support multiboard systems.

Multimaster Capabilities

For those applications requiring additional processing capacity and the benefits of multiprocessing (i.e., several CPU's and/or controllers logically sharing system tasks through communication of the system bus), the iSBC 186/51 boards provide full MULTIBUS arbitration control logic. This control logic allows up to three iSBC 186/51 boards or other bus master, including iSBC 80XX family MULTIBUS compatible 8-bit single board computers, to share the system bus using a serial (daisy chain) priority scheme. This allows up to 16 masters to share the MULTIBUS system bus with an external parallel priority decoder. In addition to the multiprocessing configurations made possible with multimaster capability, it also provides a very efficient mechanism for all forms of DMA (Direct Memory Access) transfers.

MISCELLANEOUS FUNCTIONALITY

Power-Fail Control and Auxiliary Power

An active-low TTL compatible memory protect signal is brought out on the auxiliary connector which, when asserted, disables read/write access to RAM memory on the board. This input is provided for the

protection of RAM contents during system power-down sequences. An auxiliary power bus is also provided to allow separate power to RAM for systems requiring battery back-up of read/write memory. Selection of this auxiliary RAM power bus is made via jumpers on the board.

System Development Capabilities

The development cycle of iSBC 186/51 products can be significantly reduced and simplified by using either the System 3XX or the Intellec Series Microcomputer Development Systems. The Assembler, Locating Linker, Library Manager, Text Editor and System Monitor are all supported by the ISIS-II disk-based operating system. To facilitate conversion of the 8080A/8085A assembly language programs to run on the iSBC 186/51 boards, CONV-86 is available under the ISIS-II operating system.

In-Circuit Emulator

The Integrated Instrumentation In-Circuit Emulator (I^2ICE) provides the necessary link between the software development environment provided by the Intellec system and the "target" iSBC 186/51 execution system. In addition to providing the mechanism for loading excutable code and data into the iSBC 186/51 boards, the I^2ICE-186 provides a sophisticated command set to assist in debugging software and final integration of the user hardware and software.

PL/M-86 and C-86

PL/M-86 provides the capability to program in algorithmic language and eliminates the need to manage register usage or allocate memory while still allowing explicit control of the system's resources when needed. C-86 is especially appropriate in applications requiring portability and code density. FORTRAN 86 and PASCAL 86 are also available on Intellec or 3XX systems.

Run-Time Support

The iRMX 86 Operating System is a highly functional operating system with a very rich set of features and options based on an object-oriented architecture. In addition to being modular and configurable, functions beyond the nucleus include a sophisticated file management and I/O system, and a powerful human interface.

SPECIFICATIONS

Word Size

Instruction: 8, 16, 24, or 32 bits
Data: 8, 16 bits

System Clock

6.00 MHz ± 0.1%

Cycle Time

Basic Instruction Cycle

6 MHz— 1000 ns
333 ns (assumes instruction in the queue)

NOTE:
Basic instruction cycle is defined as the fastest instruction time (i.e., two clock cycles.)

Memory Capacity/Addressing

Six Universal Memory Sites support JEDEC 24/28 pin EPROM, PROM, iRAM and static RAM.

Example for EPROM:

Device	Total Capacity	Address Range
2732	24K Bytes	$F8000-FFFFF_H$
2764	48K Bytes	$F0000-FFFFF_H$
27128	96K Bytes	$E0000-FFFFF_H$
27256	192K Bytes	$C0000-FFFFF_H$

On-Board RAM

Board	Total Capacity	Address Range
iSBC 186/51	128K Bytes	$0-1FFFF_H$

With MULTIMODULE™ RAM

Board	Total Capacity	Address Range
iSBC 304	256K Bytes	$0-3FFFF_H$

I/O Capacity

Serial—two programmable channels using one 8274. iSBX MULTIMODULE—two 8/16-bit iSBX connectors allow use of up to 2 single-wide modules or 1 single-wide module and 1 double-wide iSBX module.

Serial Communications Characteristics

Synchronous — 5–8 bit characters; internal or external character synchronization; automatic sync insertion

Asynchronous — 5–8 bit characters; break character after generation; 1, ½, or 2 stop bits; false start bit detection

Baud Rates

Frequency (KHz) (S/W Selectable)	Baud Rate (Hz)		
	Synchronous	Asynchronous	
	÷1	÷16	÷64
153.6	—	9600	2400
76.8	—	4800	1200
38.4	38,400	2400	600
19.2	19,200	1200	300
9.6	9,600	600	150
4.8	4,800	300	75
2.4	2,400	150	—
1.76	1,760	110	2400

NOTE:
Frequency selected by I/O write of appropriate 16-bit frequency factor to baud rate register (80186 timer 0 and 80130 baud timer).

Timers

Input Frequencies

Reference 1.5 MHz ±0.1% (0.5 μs period nominal)
Event Rate: 1.5 MHz max.

80186 Output Frequencies/Timing Intervals

Function	Single Timer/Counter		Dual (Cascaded) Timer/Counter	
	Min	Max	Min	Max
Real-Time Interrupt	667 ns	43.69 ms	667 ns	47.72 minutes
Programmable One-Shot	1000 ns	43.69 ms	1000 ns	47.72 minutes
Rate Generator	22.889 Hz	1.5 MHz	0.0003492 Hz	1.5 MHz
Square-Wave Rate Generator	22.889 Hz	1.5 MHz	0.0003492 Hz	1.5 MHz
Software Triggered Strobe	1000 ns	43.69 ms	1000 ns	47.72 minutes
Event Counter	—	1.5 MHz	—	—

Interfaces

Ethernet— IEEE 802.3 compatible

MULTIBUS®— IEEE 796 compatible

MULTIBUS®— Master D16 M24 I16 V0 EL

Compliance

iSBX™ Bus— IEEE P959 compatible

Serial I/O— RS-232C compatible, configurable as a data set or data terminal, RS-422A/RS-449

Connectors

Interface	Double-Sided Pins	Centers (in.)	Mating Connectors
Ethernet	10	0.1	AMP87531-5
MULTIBUS SYSTEM	86 (P1)	0.156	Viking 3KH43/9AMK12 Wire Wrap
	60 (P2)	0.1	Viking 3KH30/9JNK
iSBX Bus 8-Bit Data	36	0.1	iSBX 960-5
16-Bit Data	44	0.1	iSBX 960-5
Serial I/O	26	0.1	3M 3452-0001 Flat or AMP88106-1 Flat

Physical Characteristics

Width: 12.00 in. (30.48 cm)

Height: 6.75 in. (17.15 cm)

Depth: 0.70 in. (1.78 cm)

Weight: 18.7 ounces (531 g.)

Environmental Characteristics

Operating Temperature: 0°C to 55°C

Relative Humidity: 10% to 90% (without condensation)

Electrical Characteristics

DC Power Supply Requirements

Configuration	Maximum Current (All Voltages ±5%)		
	+5	+12	−12
SBC 186/51 as shipped:			
Board Total	7.45A	40 mA	40 mA
With separate battery back-up	6.30A	40 mA	40 mA
Battery back-up	1.15A	—	—
With SBC-304 Memory Module Installed:			
Board Total	7.55A	40 mA	40 mA
With separate battery back-up	6.30A	40 mA	40 mA
Battery back-up	1.25A	—	—

NOTES:

1. Add 150 mA to 5V current for each device installed in the 6 available Universal Memory Sites.
2. Add 500 mA to 12V current if Ethernet transceiver is connected.
3. Add additional currents for any SBX modules installed.

Reference Manual

122330-001—iSBC 186/51 Hardware Reference Manual (NOT SUPPLIED)

Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

Ordering Information

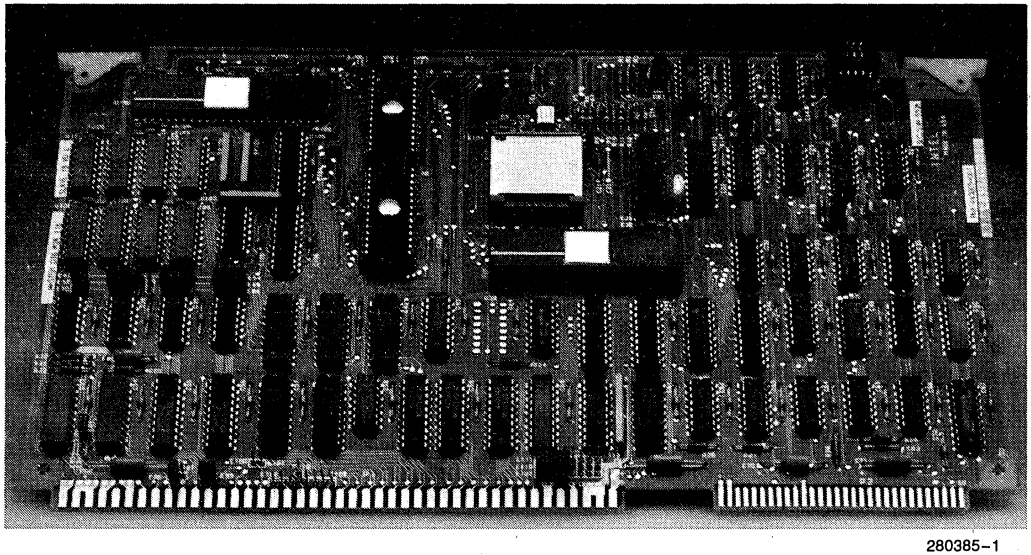
Part Number	Description
SBC 186/51	Communicating Computer

iSBC® 552A AND iSXM™ 552A IEEE 802.3 COMPATIBLE COMMUNICATIONS ENGINE PRODUCTS MEMBER OF THE OpenNET™ PRODUCT FAMILY

- **Provides High-Performance Network Front-End Processing for All MULTIBUS® I Systems Regardless of the Operating System of the Host**
  - **— Intelligent Controller with an 8 MHz 80186 Processor and 256K of DRAM Memory**
  - **— IEEE 802.3 Network Port Driven by the 82586 LAN Coprocessor**
- **Can Execute On-Board the Intel iNA 960/961 Software, an Implementation of Industry Standard ISO 8073 Transport and ISO 8473 Network Protocols**
- **Resident Network Software Can be Down-Loaded Over the Bus or the LAN**
- **On-Board Diagnostic and Boot Firmware**
- **Supported by XNX-NET and RMX-NET Network File Service Software Products**
- **Available in Two Versions**
  - **— iSBC 552A is a Flexible, Intelligent Communications Controller for IEEE 802.3 LANs**
  - **— iSXM™ 552A is a Preconfigured Controller for Executing iNA 961 Transport and Network Software as a Fully Qualified System Extension Module for the System 310 Family Products**

The iSBC 552A and iSXM 552A COMMengine products are designed for communications front end processor applications connecting MULTIBUS I systems onto IEEE 802.3 compatible LANs. COMMengines are dedicated to the communications tasks within a system allowing the host to spend more time processing user applications. A major advantage of COMMengines is that they can be used to network existing systems and established designs without forcing the redesign of the entire system architecture.

The iSBC and iSXM 552A boards can be used with any operating system because they require only a high level interface to communicate with the host (eg. transport commands in the case of the iSXM 552A board). The result is a powerful system building block which enables the OEM to network MULTIBUS I based systems with different operating systems. Applications for the 552A products include networked multiuser XENIX 286 based systems for the office and laboratory, iRMX-based systems for real-time applications, or many other system applications.



280385-1

September 1986
Order Number: 280385-001

THE iSBC® BOARD vs THE iSXM™ BOARD

The iSBC 552A version is a board that offers the hardware necessary for the user to construct an IEEE 802.3 front-end processor for custom requirements. The Intel iNA 960 ISO standard transport and network software can be configured and optimized to run on the iSBC 552A board.

The iSXM 552A version is a product that is preconfigured for Intel's family of System 310 products, includes the necessary internal system cabling, and is fully qualified to run in System 310 products. The iSXM 552A board supports the iNA 961 ISO standard transport and network software with no configuration activities required of the customer. iSXM 552A board customers receive the iNA 961 software through a separate purchase of a software license.

ARCHITECTURE DESCRIPTION

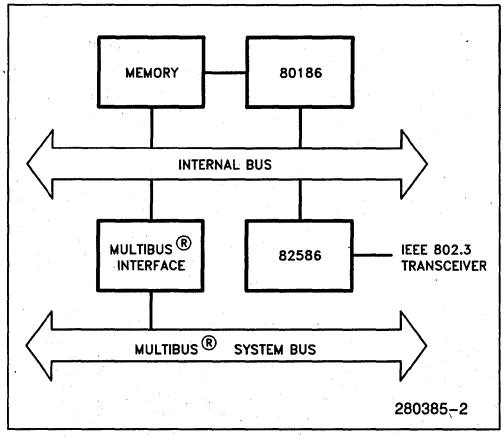


Figure 1. iSBC®/iSXM™ 552A Architecture

The iSBC and iSXM 552A boards consist of the following major architectural blocks (see Figure 1): an 80186 processor running at 8 MHz, the IEEE 802.3 I/O channel based on the 82586 LAN coprocessor, the on-board memory consisting of ROMs and 256K of zero wait state dynamic RAM, and the MULTIBUS I interface.

Processor

The iSBC 552A board contains an 80186 processor operating at 8 MHz. It is responsible for implement ing the intelligent interface between the iSBC 552A board and a host processor. The 80186 processor runs the iNA 960/961 transport software and delivers data between user buffers in MULTIBUS I memory and iNA 960/961 buffers on the iSBC and iSXM 552A boards. iNA 960/961 software is responsible for the reliable transfer of information across the IEEE 802.3 compatible network.

The 80186 and 82586 use both synchronous and asynchronous ready logic. The 80186 chip select lines are used to select memory mapped I/O locations.

The 80186 supplies the timers and the interrupt controller on the iSBC 552A board. The interrupt controller is used in the fully nested mode. The inputs and the outputs of the 80186 timers are not connected to external sources and destinations. Timer clocking and timer interrupts are generated internally in the 80186.

Memory

The iSBC/iSXM 552A board is equipped with 256K Bytes of zero wait state dynamic RAM and 16K Bytes of EPROM. The EPROM parts (Type 2764) are in two 28-pin sockets (JEDEC 27256 or 27572). The user can substitute parts (Type 27512) to provide 128K Bytes of EPROM.

The one megabyte address space of the 80186 is divided into four quadrants (see Figure 2). The first quadrant (0–256K Byte) is reserved for local EPROM memory and the last quadrant (768–1000K Byte) is reserved for local DRAM memory. The second quadrant (256–512K Byte) is used for memory mapped I/O. The iSBC/iSXM 552A board is totally memory mapped. The third quadrant (512–768K Byte) maps into a 256K Byte MULTIBUS I window. This window allows the iSBC/iSXM 552A board to access a total of 16M Byte of MULTIBUS I memory in 256K Byte segments. The iSBC/iSXM 552A board does not contain any memory which is accessible by other boards over the MULTIBUS I system bus.

The 256K Byte MULTIBUS I window starts on 64K Byte boundaries anywhere in the 16M Byte MULTIBUS I memory. The starting location of this window is determined by a memory mapped I/O latch described in the "iSBC 552A User Interface" section.

Memory mapped I/O locations are selected by the PCS and the MCS control lines of the 80186 processor. Functions controlled by memory mapped I/O are discussed in the "iSBC 552A User Interface" section.

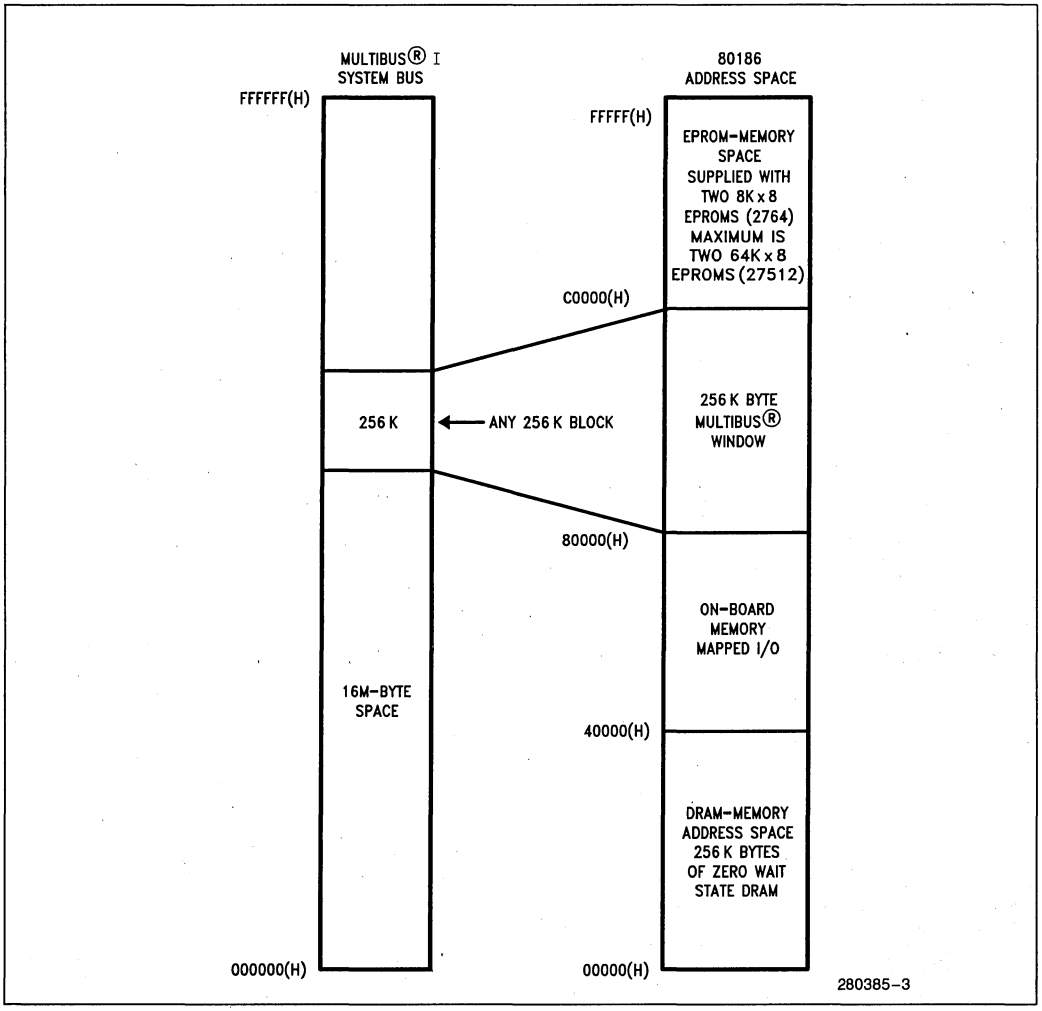


Figure 2. iSBC® iSXM™ 552A Memory Configuration

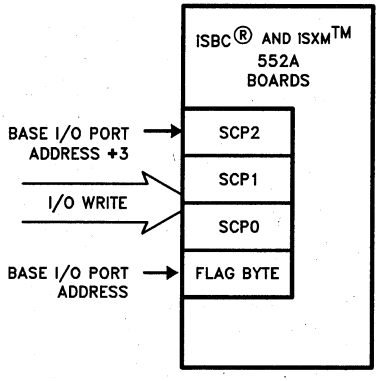
IEEE 802.3 Interface

The IEEE 802.3 Interface on the iSBC/iSXM 552A board is based on the 82586 LAN controller. Data is transferred between the on-board memory of the iSBC/iSXM 552A board and the 82586 controller by 82586 initiated DMA. The 82586 initiates the DMA cycles by activating the HOLD signal to the 80186 processor. The DMA cycle begins when the 80186 processor activates the HOLD ACKNOWLEDGE signal.

Each iSBC/iSXM 552A board is manufactured with a unique default 48-bit IEEE 802.3/Ethernet network address stored in an address PROM. This address PROM is protected by checksum and can be read by utilizing the on-board memory mapped I/O. The 82586 can be programmed to have this or any other Ethernet address.

MULTIBUS® I Interface

The iSBC/iSXM 552A board can access the MULTIBUS I with an 8- or 16- bit data path and can support up to 24-address bits. An I/O operation by the 80186 on the iSBC/iSXM 552A board normally accesses the I/O ports on the 80186 that controls the processor's interrupt controller and timers. MULTIBUS I/O is disabled in this normal operation. iSBC/iSXM 552A MULTIBUS I/O operations can be enabled or disabled by writing to memory mapped I/O control locations (Table 2). When the MULTIBUS I/O is enabled, the iSBC/iSXM 552A board can write or read the complete 64K Bytes of I/O space locations.



Base I/O port address = configurable. If 8-bit I/O is used, base port address is configurable from 0-OFCH. If 16-bit I/O is used, base port address is configurable from 0-OFFFCH.
Flag byte: see Table 1.
SCP0–SCP2: I/O written by host processor and read by 80186 on iSBC and iSXM 552A SCP0 can be jumper preset.

Figure 3. iSBC® 552A MULTIBUS® I Communication Interface

Table 1

Value Written to Flag Byte Port	Action
1	Resets iSBC 552A Board
2	Interrupts 80186 on Interrupt Level 1
4	Clears a MULTIBUS Interrupt Previously Generated by the iSBC 552A Board

A host processor in a system communicates with the iSBC/iSXM 552A board via a flag byte port and three other byte registers in the MULTIBUS interface. These registers are called the "System Configuration Pointer" registers (SCP0–SCP2). The flag byte port and the SCP registers are presented as 4 consecutive MULTIBUS I/O ports to the host processor. The locations of these I/O ports on the MULTIBUS are configurable on the iSBC 552A (Figure 3). To the 80186 processor on the iSBC/iSXM 552A board, the three SCP registers are memory mapped locations.

The flag byte port is used by the host processor to reset the iSBC/iSXM 552A board, to interrupt the 80186 processor, and to reset a MULTIBUS I interrupt generated by the iSBC/iSXM 552A board (Table 1). SCP0–SCP2 are general purpose registers that the host processor can I/O write to and the iSBC/iSXM 552A board can read from. SCP0 can also be preset by hardware jumpers.

iSBC® 552A FUNCTIONAL DESCRIPTION

The iSBC 552A board is a high performance general purpose IEEE 802.3 compatible COMMengine designed to offload a host processor in a system from transport layer and network layer communication processing. The board supports user written communications software for unique applications or it can run Intel's iNA 960/961 transport and network software in standard applications. When running iNA 960 software, the iSBC 552A board provides the host processor with reliable process to process message delivery. User messages to be sent are copied by iNA 960 software into iSBC 552A board local memory for transmission. Packets received from the network are first buffered and reassembled into messages on the iSBC 552A board. These received messages are then delivered to the user.

The iSBC 552A board makes use of the functions on the 82586 controller to implement a number of network functions. These functions include reprogramming the iSBC 552A station address, Multicast packet reception filtering, and loopback diagnostics. The 82586 also records a set of network statistics information. Information stored includes the number of CRC and alignment errors, the number of occurrences of no receive buffer resources and the number of DMA overruns/underruns.

The iSBC 552A can be configured to have a range of EPROM memory configurations up to 128K Bytes using 27512's.

The iSBC 552A board and iNA 960 software combination offers a flexible and configurable transport

COMMengine, and allows a user to optimally configure the system for highest performance. The iSXM 552A and iNA 961 combination offers a preconfigured turn-key solution. In both cases, iNA 960/961 software and the 552A significantly reduce the design cycle involved in designing and implementing a transport COMMengine.

For additional information about iNA 960/961, please refer to the iNA 960/961 data sheet.

iSBC® 552A User Interface

The iSBC 552A board communicates with a host processor through a handshake of interrupts. The host processor can generate flag byte interrupts to the 80186 on the iSBC 552A and the iSBC 552A can generate MULTIBUS I interrupts to the host processor. The host processor and the iSBC 552A board can also communicate through shared MULTIBUS I system memory. None of the on-board buffer on the iSBC 552A board is accessible to the host processor but the iSBC 552A can read and write all of the 16M Byte of MULTIBUS I system memory.

The host processor and the iSBC 552A board further communicate through the SCP registers. These byte registers can be I/O written by the host and can be read through memory mapped I/O by the iSBC 552A processor.

The 80186 processor controls the iSBC 552A through memory mapped I/O. Functions that are controlled are listed in Table 2.

OPERATING ENVIRONMENTS

The iSBC/iSXM 552A is designed to function in any MULTIBUS I system as a communications processor. It can function as both a MULTIBUS I bus master or a slave. As a MULTIBUS I master, it can access up to 16M Byte of host memory and 64K Byte of I/O address. As a MULTIBUS I slave, it occupies four consecutive I/O locations on the MULTIBUS I system memory. These locations are reserved for the flag byte and the three SCP registers.

iSXM™ 552A FUNCTIONAL DESCRIPTION

The iSXM 552A board is offered to operate specifically with the iNA 961 transport and network layer software. The iSXM 552A firmware provides the capabilities to load iNA 961 onto the 552A from either a buffer in the local host or remotely from another IEEE 802.3 network station. It also performs a variety of IEEE 802.3 and on-board diagnostics (see sections on iNA 961 User Interfaces and Operating Systems Environment).

iNA 961 software and the iSXM 552A board together provide the functionality of a preconfigured operating system independent transport engine. In addition to transport services, iNA 961 software also includes extensive data link, internetworking, and network management services. Figure 4 shows the distribution of network seven layer functions between iNA 961/iSXM 552A and the host processor. Table 3 shows some examples of functions provided by iNA 961. Refer to the iNA 960/961 data sheet for more iNA 961 information.

Table 2. iSBC® 552A Memory Mapped Functions

80186 Chip Select Lines	Read/Write by 80186	Functions
MCS	R	MULTIBUS I Interface registers (System Configuration Pointer Registers, see "MULTIBUS Interface" Section)
PCS	W	Channel Attention to 82586
	R	Reading iSBC 552A Ethernet Address PROMS
	W	Controlling Loopback of the Serial Interface
	W	Disabling and Enabling MULTIBUS I/O
	W	Generating and Clearing iSBC 552A Interrupts to the MULTIBUS System Bus
	W	Controlling the On-Board LED
	W	Latches the MULTIBUS Window Segment (8 most Significant Bits of 24-Bit Address)

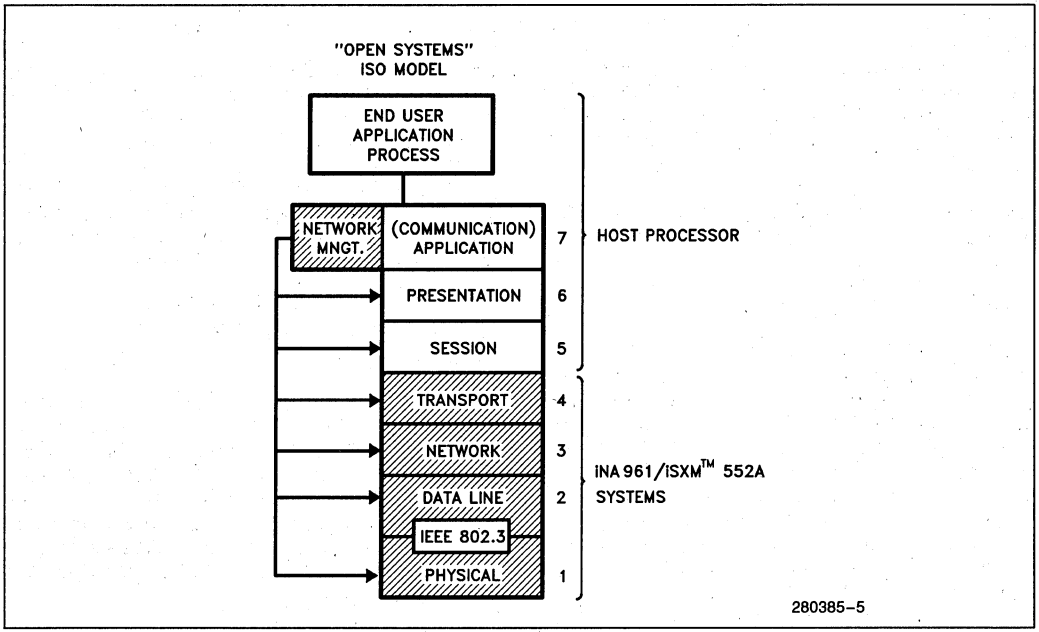


Figure 4. iNA 961 Configuration on iSXM™ 552A Board

Table 3. iNA 961 Services

Transport	Virtual Circuit Open: Establish a Virtual Circuit Database Send Connect: Actively Try to Establish a Virtual Connection Await Connect: Passively Awaits the Arrival of a Connection Request Send: Send a Message Receive: Post a Buffer to Receive a Message Close: Close a Virtual Circuit Datagram Send: Send a Datagram Message Receive: Post a Buffer to Receive a Datagram Message
Data Link	Transmit: Transmit a Data Link Packet Receive: Post a Buffer to Receive a Data Link Packet Connect: Make a Data Link Logical Connection (Link Service Access Point, IEEE802.3/802.2) Disconnect: Disconnect a Data Link Logical Connection Change Ethernet Address: Change the Ethernet Address Add Multicast Address: Add a Multicast Address Delete Multicast Address: Remove a Multicast Address Configure 82586: Configure the 82586 Controller
Network Management	Read/Clear/Set Network Objects (Local/Remote): Read/Clear/Set Local or Remote iNA 960 Network Parameters Read/Set Network Memory (Local/Remote) Read/Set Memory of the Local or a Remote Station Useful in Network Debug Process. Boot Consumer: Requests a Network Boot Server to Load a Boot File into this Station Echo: Echo a Packet between this Station and Another Remote Station on the Network

iSBC®/iSXM™ 552A Boot Firmware User Interface

The iSBC/iSXM 552A boot firmware is used to load iNA 961 or other software onto the 552A board from either local MULTIBUS I memory or a remote network station. The firmware performs a number of local and network diagnostics. Table 4 describes the functions of the boot firmware.

The iSBC/iSXM 552A boot firmware interfaces with the host processor through a configurable command buffer location in MULTIBUS I memory. This location can be either jumper or program configured. The host processor updates the command byte in the command buffer and expects the firmware to update the response byte when the command is done. The host processor signals to the firmware to examine this command buffer by writing a 2 to the flag byte port. The firmware will update the response byte when the command is completed.

The iSBC/iSXM 552A boot firmware commands fully support the initialization of the MIP interface. The MIP interface is used by the host processor to communicate with the iNA 961 once it is loaded and started. See section "iNA 961 User Interfaces" for details.

iNA 961 User Interfaces

User programs give iNA 960 commands to the iNA 961 software on the iSBC/iSXM 552A board via the MULTIBUS I Interface Protocol (MIP). MIP is an Intel reliable message delivery protocol between MULTIBUS I processors. Figure 5 illustrates how this message delivery functions. Commands are passed between the iSBC/iSXM 552A board and the host processor in the form of request blocks. A request block is a buffer that contains a command specification and the command parameters. Each request block (or equivalently, each command) is reliably delivered from the host processor to iNA 961 via the MIP facility. iNA 961 will extract the command information and carry out the command. After the command is done, iNA 961 will use the MIP facility to return the command result to the user program.

Table 4. iSXM™ 552A Boot Firmware Commands

Command	Function
Presence	This command will indicate that the boot firmware is functional by returning the version number of the firmware, the power on diagnostic result, and the default Ethernet address of the iSXM 552A board.
Load	Load a program from MULTIBUS memory into a designated location in the iSBC 552A memory.
Load and Go	Load a program from MULTIBUS bus memory into a designated location in the iSXM 552A memory. Proceed to start this program once it is loaded. This command also initializes the MIP interface on the iSXM 552A board.
Echo	Echo a packet between this iSXM 552A board and another station on the network.
Remote Boot	This command requests a remote boot server station to download software onto the iSXM 552A board.
MIP Initialize and Start	Used after a remote boot. This command initializes the MIP interface on the iSXM552A board and then start the software loaded by the remote boot command.

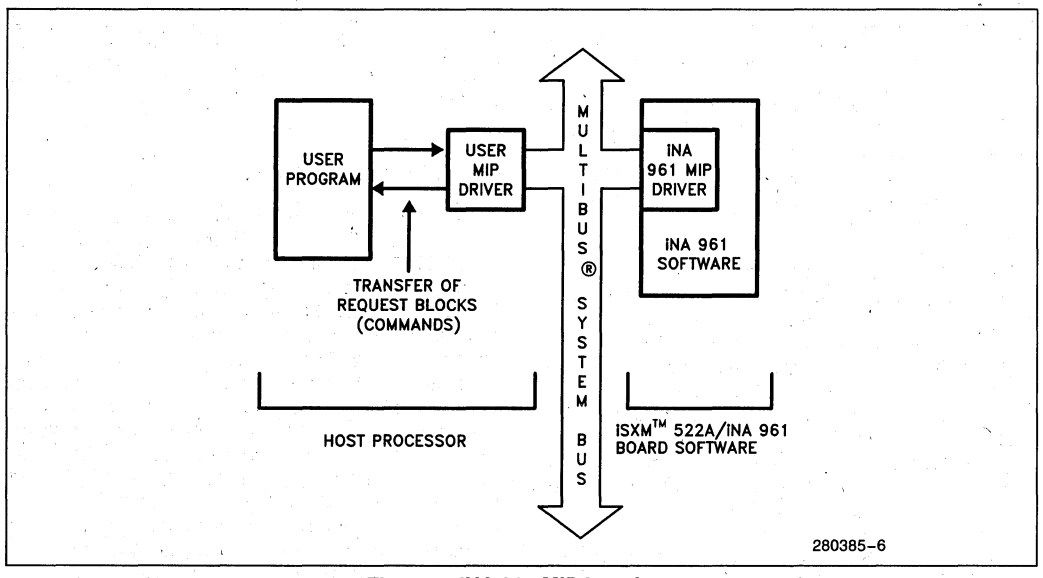


Figure 5. iNA 961 MIP Interface

iNA 961 request blocks are in the same formats as iNA 960 commands. Refer to the iNA 960/961 data sheet and reference manuals for more details on iNA 960/961 software.

Operating Systems Environment

The iSBC/iSXM 552A board and iNA 960/961 software can function in any MULTIBUS I environment. The communication between the iSBC/iSXM 552A and the host processor is entirely independent of any host operating systems. iNA 960/961 uses the MIP protocol to interface with the host processor. The MIP is a reliable, host operating system independent, process to process communication scheme between any processors on the MULTIBUS I System Bus. iNA 960/961 can service multiple processes utilizing its services at the same time.

A host processor passes iNA 960/961 commands and buffers in the MULTIBUS I system memory to the iNA 960/961 software. This software is responsible for updating the response fields of these commands. It is responsible for copying the user send buffer in MULTIBUS I system memory into its onboard buffers for transmission and for copying received messages to user buffers in MULTIBUS I system memory.

Diagnostics

The iSBC/iSXM 552A board offers a range of power up diagnostics designed to ensure that the 80186 processor, the memory, and the IEEE 802.3 interface are functioning properly. Table 5 describes these diagnostics.

Table 5. Functions Checked by iSXM™ 552A Diagnostics

1. Insufficient RAM
2. RAM March Pattern Test
3. Ram Ripple Data Test
4. Boot Firmware PROM Checksum
5. Address PROM Checksum
6. 80186 Interrupt Controller
7. 80186 Timer Controller
8. 82586 Initialization
9. 82586 CRC Check
10. 82586 Broadcast Packet Recognition
11. 82586 External Loopback
12. 82586 Individual Address Recognition
13. 82586 Multicast Address Recognition
14. 82586 Reset
15. 82586 Diagnose Check

DEVELOPMENT ENVIRONMENT

The iSXM 552A board is a complete system product that allows a user to emphasize the development of high level software, such as a network file server. The iSXM 552A board and the iNA 961 software together form a transport COMMengine that integrates into any MULTIBUS I system. iNA 961 is supplied in a boot loadable file format. This file can be loaded into the iSXM 552A by a host processor or through a remote boot server network node. The boot firmware on the iSXM 552A supports both functions. In order to remote boot the host system, appropriate host processor firmware and software is required.

The iSBC 552A allows a user to fine tune iNA 960 and to put the software on the board. Both iNA 960 and the iSBC 552A can be flexibly configured to best meet the users' requirements. An Intel development system, together with the Intel I2ICE™ system or equivalent product can be used if the user desires to do extensive development work on the iSBC 552A. Intel also supplies a wide range of host processor boards and systems (such as the iSBC 286/12 and system 310) that will function well both with the iSBC 552A or the iSXM 552A board.

SPECIFICATIONS

Data Transfer: 8 or 16 bits

Average Raw MULTIBUS I Transfer Rate:

8.7M bits/second (450 ns., 16-bit system memory and no MULTIBUS I contention)

Transceiver Interface

Transmit Data Rate: 10M bits/second

Signal Levels: Series 10,000 ECL-compatible

Host Interrupts: One MULTIBUS I non-vector interrupt for use in system/host handshaking

MULTIBUS Interface: The iSBC/iSXM 552A board conforms to all AC and DC requirements outlined in Intel MULTIBUS I Specification. Order Number 142686-022m except for the following signals:

Signal DAT0–DAT7

Signal Specification:
IIL = 180 μA IIH = 125 μA

DC Power Required: All voltages supplied by the MULTIBUS I interface

+5.0V ±5%, 6.2A maximum

+12.0V ±5%, 0.5A maximum

Environmental

Temperature: 0°C to +55°C Operating
−40°C to −65°C Non-Operating

Humidity: 5% to 90% Operating
5% to 95% Non-Operating

ORDERING INFORMATION

Part Number	Description
SBC552A	IEEE 802.3 COMMengine
SXM552A	IEEE 802.3 Transport Engine for iNA961 and SYP310 systems
iNA960	Configurable transport software usable with the SBC552A
iNA961	Preconfigured transport software for the SXM552A

iSBC® 554
MAP COMMUNICATIONS ENGINE

- **Provides IEEE 802.4 Networking Capability for MULTIBUS® Based Systems Running Under any Operating System**
- **Serves as a Complete Front End Communication Engine With the Capacity to Provide MAP Layers 1 Through 7 Capability for MULTIBUS® Based Hosts**
- **Runs on Board Intel's Proven iNA 960 Rel 2.0 Providing the ISO 8073 Transport Software and ISO 8473 Network Software as Required by the Map Specifications**
- **Runs on Board Intel's MAP-NET™ Software for Layers 5–7 of the Map Protocol**
- **Preconfigured Software Available for Seven Layer Map Engine, Four Layer Transport Engine or IEEE 802.4 to IEEE 802.3 Router**
- **8 MHz 80186 Processor**
- **256K Bytes of RAM of Which 128K Bytes Provide Dual Port Window Support**
- **10 Mbps IEEE 802.4/Token Bus Modem Interface**
- **Sockets for up to 4 JEDEC 28 Pin Memory Devices, up to Maximum of 160K Bytes EPROM Storage**
- **One iSBX™ Bus Connector for I/O Expansion Capability**
- **Can Be Configured as Either a Master or a Slave in MULTIBUS**
- **On Board Diagnostic and Boot Firmware**
- **Available in Three Different Modem Frequencies/Channel Pairs**

The iSBC 554 COMMengine product is designed to fit into front end LAN Communication processor applications. It allows the connection of MULTIBUS I based systems onto a MAP/IEEE 802.4 (Token Bus) LAN. COMMengines are dedicated communication processor boards. They allow the host processor board to offload LAN communication related tasks onto the front end COMMengine. Therefore the host has more processing capability for user applications or other tasks. COMMengines also allow the networking of existing systems without forcing a redesign of the entire system architecture.

The iSBC 554 board can be used as a front end COMMengine for a MULTIBUS-based host running any operating system. This is because the on board software provides a high level interface to the host (e.g., application or transport level commands). This results in a powerful system building block which enables an OEM to connect MULTIBUS-based systems onto IEEE 802.4 10 Mbps LANs. Applications for the iSBC 554 include networked iRMX™-based systems for real time applications and networked XENIX* systems for laboratory and data base application. The iSBC 554 is preconfigured to run iNA 961 R2.0 transport and network software. iNA 961 R2.0 is a preconfigured version for the iSBC 554 of Intel's iNA 960 LAN software which implements the ISO 8073 Class 4 transport protocol and the ISO 8473 network layer protocol.

The iSBC 554 COMMengine supports multiple datalinks via the iSBX connector located on the iSBC 554 baseboard. The user has the option to interface any of Intels iSBX communication interfaces to support a two way router. For example iNA 960 supports the MAP/TOP router using the iSBX 586 interface. The preconfigured router software is supplied in iNA 961.

The iSBC 554 is also capable of running on a board MAP2.1SXMSW preconfigured implementation of the MAP software for layers 3 through 7 of the ISO/OSI model. This is an ideal turnkey solution for OEMs requiring a 7 layer MAP COMMengine. MAP-NET™ provides layers 5 through 7 of the MAP specifications and can be configured with iNA 960 R2.0 to run on the iSBC 554, providing a complete on-board seven layer COMMengine.

*XENIX is a trademark of Microsoft Corporation.

September 1986
Order Number: 231594-002

iSBC® 554 FUNCTIONAL DESCRIPTION

The iSBC 554 board is a preconfigured MAP Communication Engine with boot firmware and 256K bytes of RAM. The iSBC 554 board is offered for use with Intel's MAP-NET/iNA 960 based MAP software. The iSBC 554 firmware provides the capabilities to load Intel's MAP software on the iSBC 554 from either a buffer in the local host or remotely from another Token Bus station. It also performs a variety of on-board diagnostics.

The MAP-NET with iNA 960 R2.0 software and the iSBC 554 board together provide the functionality of a preconfigured OS independent 7 layer engine. In addition to transport services, iNA 960 R2.0 software also includes ISO 8473 Internet network layer, extensive data link and network management facility services. Figure 1 shows the configuration of MAP-NET and iNA 960 R2.0. Table 1 shows some examples of functions provided by MAP-NET and iNA 960 R2.0. iNA 961 R2.0 is a preconfigured version of iNA 960 for the iSBC 554. Refer to the iNA 960 R2.0 data sheet for more information.

MAP-NET is Intel's implementation of the MAP software for layers 5 through 7. Refer to the MAP-NET data sheet for more information. This implementation of layers 5 through 7 will run on the iSBC 554 along with iNA 960 R2.0. The iSBC 554 coupled with the software packages provides a high performance, 7-layer communication engine (see Figure 1). MAP 2.1SXMSW is also available as a preconfigured software package providing layers 3 through 7 of the MAP software. This package and the iSBC 554 provides a 7 layer turnkey MAP solution.

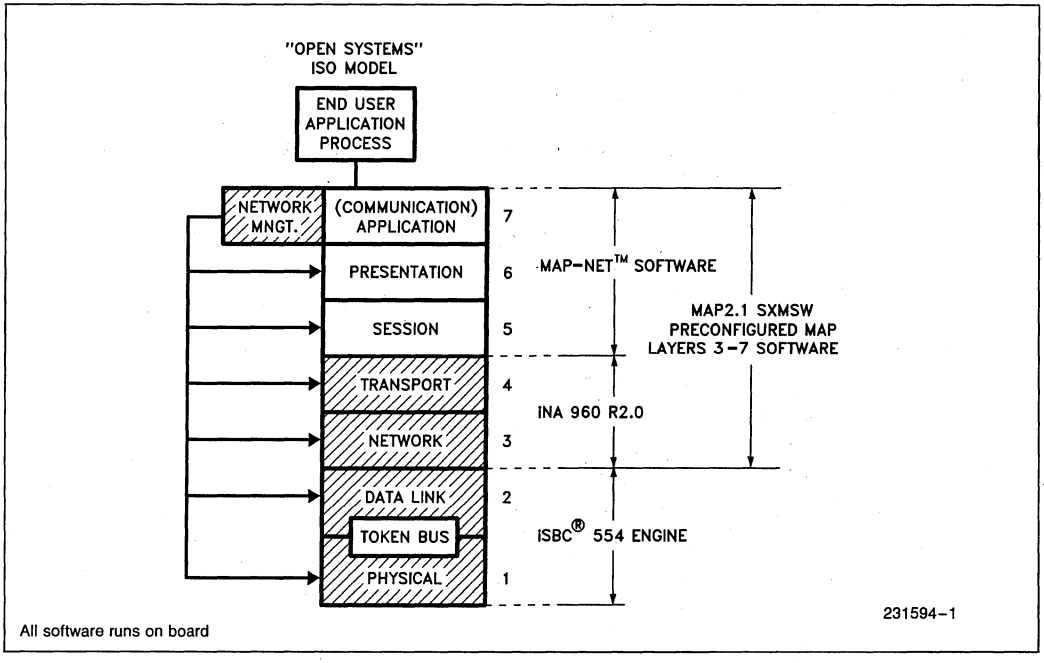


Figure 1. MAP-NET™ and iNA 960 Configuration on iSBC® 554 Board

Table 1. MAP-NET™ and iNA 960 R2.0 Services

Application	File Transfer, Access and Management (FTAM) Provides remote operations on files (Create, Read, Write, Delete, Get File Attributes) Common Application Service Elements (CASE) Supports all the services provided by the lower ISO layers Provides name to address translation support Directory Services Performs name to address conversion Maintains local cache of resolved names Two forms of directory service—client service agent for local data base and directory-service agent for remote (master) data base
Session	Implements subset of ISO Session 8327 specified by the MAP 2.1 Specifications Provides "Graceful Close" "Graceful Close" allows the closing of a connection without any loss of queued requests It enhances the transport provided "close" which aborts a connection
Transport	Virtual circuit open: establish a virtual circuit data base send connect: actively try to establish a virtual connection await connect: passively awaits the arrival of a connection request send: send a message receive: post a buffer to receive a message close: close a virtual circuit Datagram send: send a datagram message receive: post a buffer to receive a datagram message
Network	Internetworking routing between multiple lans segmentation/reassembly user defined routing tables Multiple subnets supported user supplied 802.3, 802.4
Data Link	Transmit: transmit a data link packet Receive: post a buffer to receive a data link packet Connect: make a data link logical connection (link service access point. IEEE802.4) Disconnect: disconnect a data link logical connection Change token bus address Add multicast address Delete multicast address Configure TBH

Table 1. MAP-NET™ and iNA 960 R2.0 Services (Continued)

Network Management	Read/Clear/Set network objects (local/remote): read/clear/set local or remote MAPNET/iNA 960 network parameters Read/Set network memory (local/remote): read/set memory of the local or a remote station Useful in network debug process Boot consumer: requests a network boot server to load a boot file into this station Echo: Echo a packet between this station and another remote station on the network

ARCHITECTURE DESCRIPTION

The iSBC 554 board consists of the following major architectural blocks (see Figure 2): an 80186 processor running at 8 MHz, the Token Bus channel based on the Token Bus Handler chip set and the Token Bus Modem, the on-board memory consisting of ROM and RAM, the iSBX interface, and the MULTIBUS interface.

PROCESSOR

The iSBC 554 board contains an 80186 processor operating at 8 MHz. It is responsible for implementing the intelligent interface between the iSBC 554 board and a host processor. The 80186 processor runs the MAP-NET/iNA 960 R2.0 transport software and the data link software needed by the Token Bus Handler chip set. It is responsible for the delivery of data between user buffers in MULTIBUS memory and iNA buffers on the iSBC 554 board. The iNA software is responsible for the reliable transfer of information across the Token Bus LAN.

MEMORY

The one megabyte address space of the 80186 is divided into four quadrants (see Figure 3). The first quadrant (0–256K Byte) is local RAM memory. The second quadrant is memory mapped Token Bus Handler address. The third quadrant (512–768K Byte) maps into two MULTIBUS windows (128K Byte each). These windows allow the iSBC 554 board to access the total 16M Byte of MULTIBUS memory in 128K Byte segments. The fourth quadrant (768–1M Byte) is local ROM which contains the 80186 firmware, the Token Bus station address, and relocated 80186 internal registers.

The two 128K Byte MULTIBUS windows each start on 64K Byte boundaries anywhere in the 16M Byte MULTIBUS memory. The starting location of either window is determined by writing to a local I/O mapped latch.

Options on the iSBC 554 board allow up to 128K Byte of RAM to be accessible by the host. This dual port RAM is jumper selectable to appear anywhere in the MULTIBUS 16M Byte memory space on 128K Byte boundaries. The dual port RAM memory is a data link between the on board 80186, the token bus controller, and the bus master (if any) managing the systems functions. This shared dual port RAM can be used to transfer command, status and data between the on board 80186 processor and the host. This feature minimizes the necessity for the 80186 to access MULTIBUS while acquiring shared information. This has a direct positive effect on performance, serving to eliminate bus contention.

TOKEN BUS INTERFACE

The Token Bus interface on the iSBC 554 is implemented by the Token Bus Handler (TBH) chip set and the Token Bus Modem (TBM). Data is transferred between the on-board memory and the TBH by the TBH initiated DMA. The TBH will then pass data, operating according to the IEEE 802.4 Token Bus Specification, to the TBM which handles the physical interface to the Token Bus.

Each iSBC 554 board is manufactured with a unique default Token Bus network address stored in an address PROM. This address PROM is protected by checksum and can be read by utilizing the on board I/O.

MULTIBUS® INTERFACE

The iSBC 554 board can access the MULTIBUS with an 8- or 16-bit data path and can support up to 24 address bits. The internal 80186 registers are relocated into the local memory map to avoid conflicts with MULTIBUS I/O during 80186 internal register accesses. The iSBC 554 board is capable of accessing the MULTIBUS I/O from 384-64K (180H–FFFFH) Byte of I/O space locations.

A host processor in a system communicates with the iSBC 554 board via a flag byte port in the MULTIBUS interface. The flag byte port is presented as a

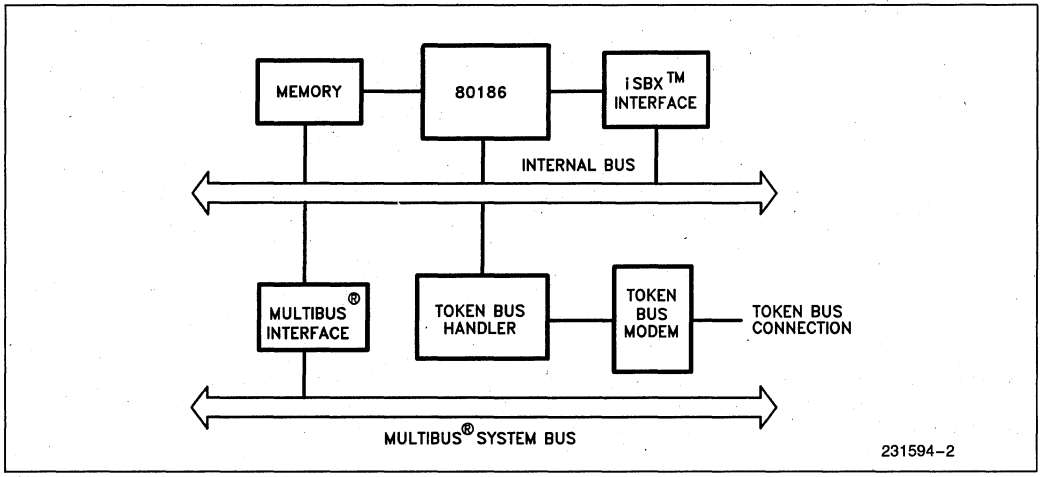


Figure 2. iSBC® 554 Architectural Blocks

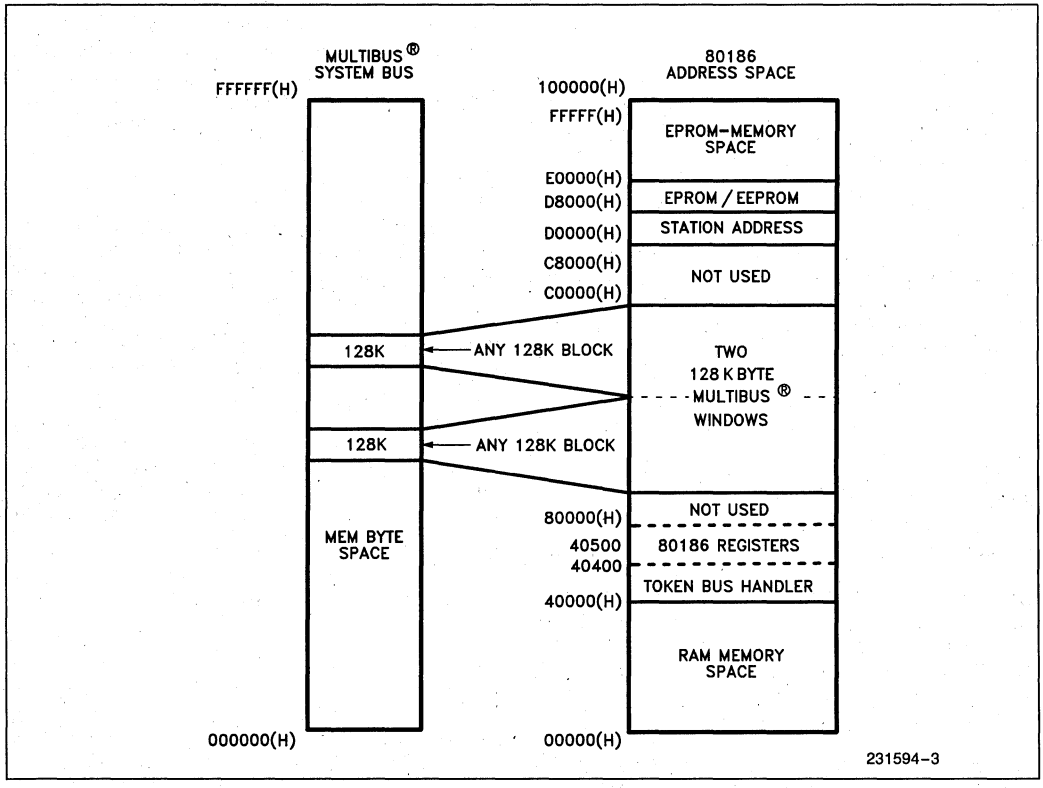


Figure 3. iSBC® 554 Memory Configuration

MULTIBUS I/O port to the host processor. The location of this I/O port on the MULTIBUS is configurable on the iSBC 554 board. To the 80186 processor on the iSBC 554 board, the flag byte is in a local I/O mapped location.

The flag byte port is used by the host processor to reset the iSBC 554 board, to interrupt the 80186 processor and to reset a MULTIBUS interrupt generated by the iSBC 554 board. The iSBC 554 board uses the flag byte to set or clear an interrupt to the MULTIBUS, or clear an interrupt from the MULTIBUS (Table 2).

For those applications requiring processing capacity and the benefits of multiprocessing (i.e., several CPUs and/or controllers logically sharing system tasks through the communication of the system bus), the iSBC 554 board provides full MULTIBUS arbitration control logic.

iSBX™ INTERFACE

One 8/16 bit iSBX MULTIMODULE™ connector is provided on the iSBC 554 board. Through this connector, additional on-board I/O functions may be added. iSBX MULTIMODULE boards optimally support functions provided by VLSI peripheral components such as additional parallel and serial I/O, analog I/O, small mass storage device controllers (e.g., cassettes and floppy disks) and other custom interfaces to meet specific needs. By mounting directly on the iSBC 554 board, less interface logic, less power, simpler packaging, higher performance, and lower cost results when compared to other alternatives such as MULTIBUS form factor compatible boards. The iSBX connector on the iSBC 554 board provides all signals necessary to interface to the local on-board bus, including 16 data lines for maximum data transfer rates. iSBX MULTIMODULE boards designed with 8-bit data paths and using the 8-bit iSBX connector are also supported on the iSBC 554 board. A broad range of iSBX MULTIMODULE options are available in this family from Intel. Custom iSBX modules may also be designed for use on the iSBC 554 boards. An iSBX bus interface specification and iSBX connector documentation are available from Intel.

iSBC® 554 USER INTERFACE

The iSBC 554 board communicates with a host processor through a handshake of interrupts. The host processor can generate flag byte interrupts to the 80186 on the iSBC 554. The iSBC 554 can generate MULTIBUS interrupts to the host processor. The host processor and the iSBC 554 can also com-

Table 2. Flag Byte Ports

Value Written to Flag Byte Port	Source	Actions
1	iSBC 554 board	Clears interrupt to the MULTIBUS
	MULTIBUS backplane	Resets iSBC 554 board
2	iSBC 554 board	Sets interrupt to the MULTIBUS
	MULTIBUS backplane	Sets interrupt to the iSBC 554 board
3	iSBC 554 board	Clears interrupt to the iSBC 554 board
	MULTIBUS backplane	Clears interrupt to the MULTIBUS

municate through shared MULTIBUS system memory. As much as 128K byte of the on-board RAM on the iSBC 554 board is accessible to the host processor and the iSBC 554 board can read and write all of the 16M byte of MULTIBUS system memory.

OPERATING ENVIRONMENTS

The iSBC 554 is designed to function in any MULTIBUS system as a communication processor. It can function as both a MULTIBUS bus master or a slave. As a MULTIBUS master, it can access up to 16M Byte of host memory and 64K byte of I/O address. As a MULTIBUS slave, it occupies one location reserved for the flag byte.

MAP-NET/iNA 960 R2.0 USER INTERFACES

User programs give MAP-NET/iNA 960 commands to the MAP-NET/iNA 960 R2.0 software on the iSBC 554 board via the MULTIBUS Interface Protocol (MIP). MIP is an Intel reliable process to process message delivery protocol between MULTIBUS processors. An implementation of the MIP protocol is provided on the iSBC 554 board for communication with the host. The corresponding MIP protocol implementation will have to be provided by the user on the host side for communicating with the iSBC 554. Figure 4 illustrates how this message delivery functions. Commands are passed between the iSBC 554 and the host processor in the form of request blocks. A request block is a buffer that contains a command specification and the command parameters. Each request block (or equivalently, each command) is reliably delivered from the host processor to MAP-NET/iNA 960 R2.0 via the MIP facility. MAP-NET/iNA 960 R2.0 will extract the command information and carry out the command. After a command is done, MAPNET/iNA 960 R2.0 will use the MIP facility to return the command result to the user program.

iNA 960 R2.0 request blocks are in the same formats as iNA 960 commands. Refer to the iNA 960 and MAP-NET data sheets and reference manuals for more details on the iNA 960 R2.0 and MAP-NET software.

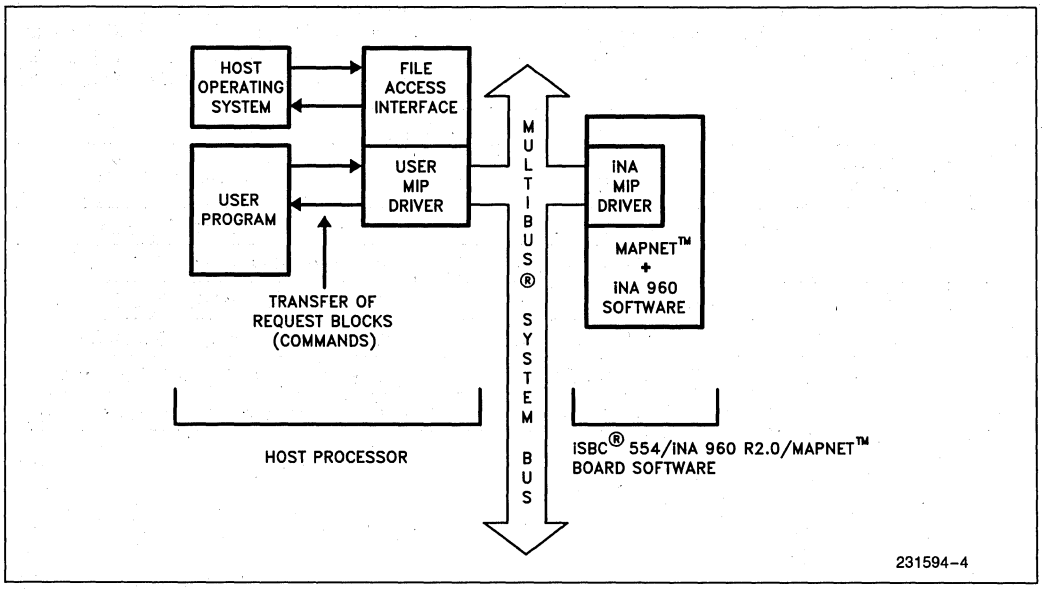


Figure 4. MAP-NET™ and iNA 960 MIP Interface

PRECONFIGURED SOFTWARE—iNA 961 AND MAP 2.1SXMSW

Preconfigured iNA 960 software supports the iSBC 554 COMMengine as a router (MAP/TOP) or as a transport and network communications engine. The iNA 961 package contains the iRMX 86 device driver, user interface utilities and preconfigured communications software.

MAP 2.1SXMSW preconfigured 7 layer solution supports all seven layers on the iSBC 554 COMMengine board. The layers that are located on the COMMengine includes FTAM, Directory Services, CASE, Session, Transport, Network, and the Data Link layer. In order to allow the maximum flexibility in interfacing users applications, the Network Management facility has been added. The combined layer solution provides the user with a certified, and conformance tested COMMengine, with the flexibility to modify all the system parameters.

The above preconfigured MAP product is supplied with iRMX 86 device drivers, user interface utilities and the 7 layer conformance tested software. The iSBC 554 COMMengine and software is designed to support generic operating systems and different host processors.

OPERATING SYSTEMS ENVIRONMENT

The iSBC 554 board and iNA 960 R2.0 software can function in any MULTIBUS environment. The communication between the iSBC 554 board and the host processor is entirely independent of any host operation systems. MAP-NET/iNA 960 R2.0 use the MIP protocol to interface with the host processor. MAP-NET/iNA 960 R2.0 can service multiple processes utilizing its services at the same time.

A host processor passes MAP-NET/iNA 960 R2.0 commands and buffers in the MULTIBUS system memory to the MAP-NET/iNA 960 R2.0 software. MAP-NET/iNA 960 R2.0 is responsible for updating the response fields of these commands. It is responsible for copying the user send buffer in MULTIBUS system memory into its on board buffers for transmission and for copying received messages to user buffers in MULTIBUS system memory.

iSBC® BOOT FIRMWARE USER INTERFACE

The iSBC 554 boot firmware is used to load MAP-NET/iNA 960 R2.0 or other software onto the 554 from either local MULTIBUS memory or a remote network station. The firmware performs a number of local and network diagnostics.

The iSBC 554 boot firmware commands fully support the initialization of the MIP interface. The MIP interface is used by the host processor to communicate with the iNA 960 R2.0 once it is loaded and started.

DIAGNOSTICS

The iSBC 554 board offers a range of power up diagnostics designed to ensure that the 80186 processor, the memory (EPROM and RAM), and the Token Bus Interface are functioning properly.

Available Literature:

- iNA 960 Release 2.0 Programmers Reference Manual
- iNA 960 Release 2.0 Configuration Guide
- iSBC 186/51 Hardware Reference Manual
- iSBC/iSXM 552 Hardware Reference Manual
- iSBC/iSXM 552A Hardware Reference Manual
- iSBC 554 Hardware Reference Manual
- MAP-NET Programmers Reference Manual
- RMX-NET Programmers Reference Manual

ORDERING INFORMATION

HARDWARE

Part Number	Modem Frequencies/Channel Pairs
iSBC 554-1	Transmit: 59.75 to 71.75 MHz/Ch. 3 and 4
	Receive: 252 to 264 MHz/Ch. P and Q
iSBC 554-2	Transmit: 71.75 to 83.75 MHz/Ch. 4A and 5
	Receive: 264 to 276 MHz/Ch. R and S
iSBC 554-3	Transmit: 83.75 to 95.75 MHz/Ch. 6 and FM1
	Receive: 276 to 288 MHz/Ch. T and U

SOFTWARE

Code	Description
MAP21SXMSWRO	License for preconfigured MAP 2.1 Layers 3–7 software.
MAP21SXMSWRF	Incorporation fee for preconfigured MAP 2.1 Layers 3–7 software (licence required).
MAPNET 21RO	License for configurable MAP 2.1 layers 5–7 software.
MAPNET 21RF	Incorporation fee for configurable MAP 2.1 layers 5–7 software (license required).
iNA 961 R2	Preconfigured transport and internet software for an IEEE 802.3 to IEEE 802.4 Router.
iNA 960 R2	Configurable MAP 2.1 layers 3–4 software.

HARDWARE/SOFTWARE PACKAGES

Code	Description
MAP554NODEKIT-X (X = 1, 2 or 3)	Package consists of one iSBC 554-X (X = 1, 2 or 3) and one MAP21SXMSWRF. This kit requires the prior purchase of MAP21SXMSWRO—the software license.

SPECIFICATIONS

Network Interface

Compatibility/ Conformance	IEEE 802.4, Token Bus 10 Mbps Broadband
Cable Connection	75Ω Output on Type F Female Connector
Head End	Operates with Remodulator Head End

Host Interface

MULTIBUS® Interface	Conforms to All AC and DC Requirements of the Intel MULTIBUS Specification
DC Power Required (Maximum Excluding iSBX)	+5 VDC – 5.5A +12 VDC – 0.3A –12 VDC – 0.15A

Environmental

Temperature:	0°C to 60°C Operating –40°C to +85°C Storage
Humidity:	5% to 95%, Non-Condensing, for Both Operating and Storage

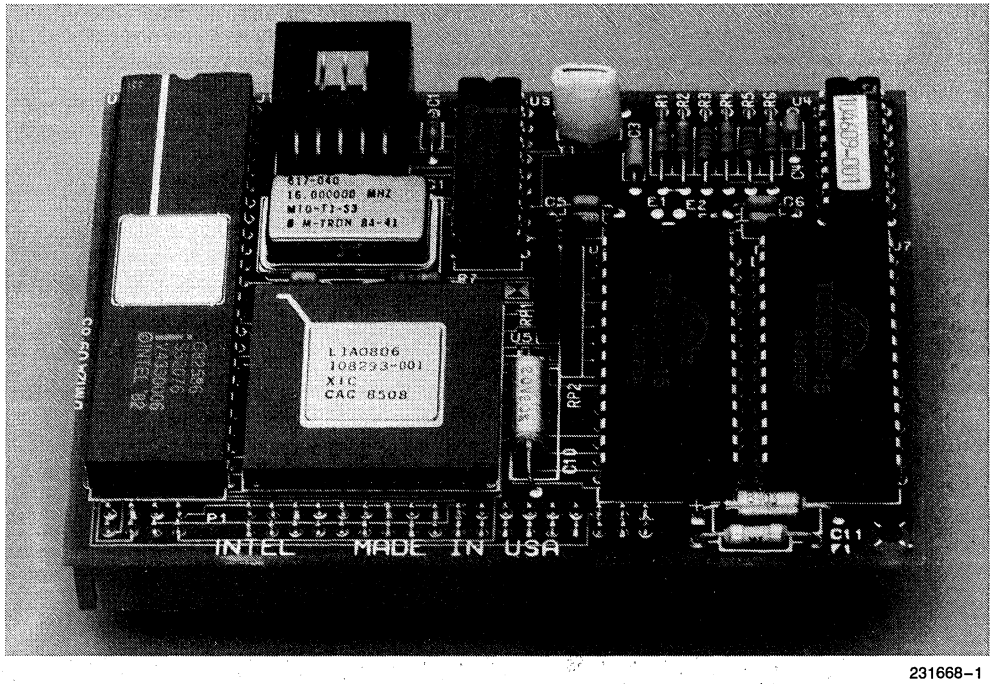
iSBX™ 586 ETHERNET DATA LINK ENGINE

Member of the OpenNET™ Product Family

- **Provides an IEEE 802.3 (Ethernet) Connection for Host Boards with 16-Bit iSBX™ Capabilities**
- **Based on Intel's 8 MHz 82586 LAN Coprocessor Chip which Includes the following features:**
  - **— Automatic Retransmission**
  - **— On-Board Multicast Address Filtering**
  - **— Host Interface via Buffer Chaining**
- **16 Kbytes of Local Dual-Ported Buffer RAM**
- **Single Wide iSBX™ MULTIMODULE™ that Conforms to Intel's iSBX Bus Specifications**
- **Compatible with iNA 960 ISO Transport Layer Software**
  - **— Direct Support for iRMX™ Operating Systems**
  - **— Source Code Support for Other Operating Systems**
- **Building Block for IEEE 802.3 to IEEE 802.4 Router**

The iSBX™ 586 Ethernet Data Link Engine is a single wide iSBX sized card that provides a low cost Ethernet controller MULTIMODULE™ for MULTIBUS® based systems with 16-bit iSBX bus capabilities. Based on the 82586 Local Area Network Coprocessor, the iSBX 586 implements the data link (Layer 2) and physical (Layer 1) layers of the International Standards Organization (ISO) Open Systems Interconnect (OSI) Reference Model. This allows the iSBX 586 to supply an IEEE 802.3 10 Mbps (Ethernet) connection for an iSBC board with iSBX capabilities.

The iSBX 586 MULTIMODULE is a low cost building block that can implement an Ethernet connection at various levels of integration. One application for the iSBX 586 is as a "best effort" datagram message delivery engine. In conjunction with the host iSBC board running iNA 960 R2.0 ISO Transport Software, the iSBX 586 can allow for a four-layer, OpenNET compatible solution for Ethernet connections. With the iSBC 554 IEEE 802.4 LAN controller as the host running iNA 960, the iSBX 586 provides the Ethernet connection for an IEEE 802.3 to IEEE 802.4 router configuration.



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September 1987
Order Number: 231668-002

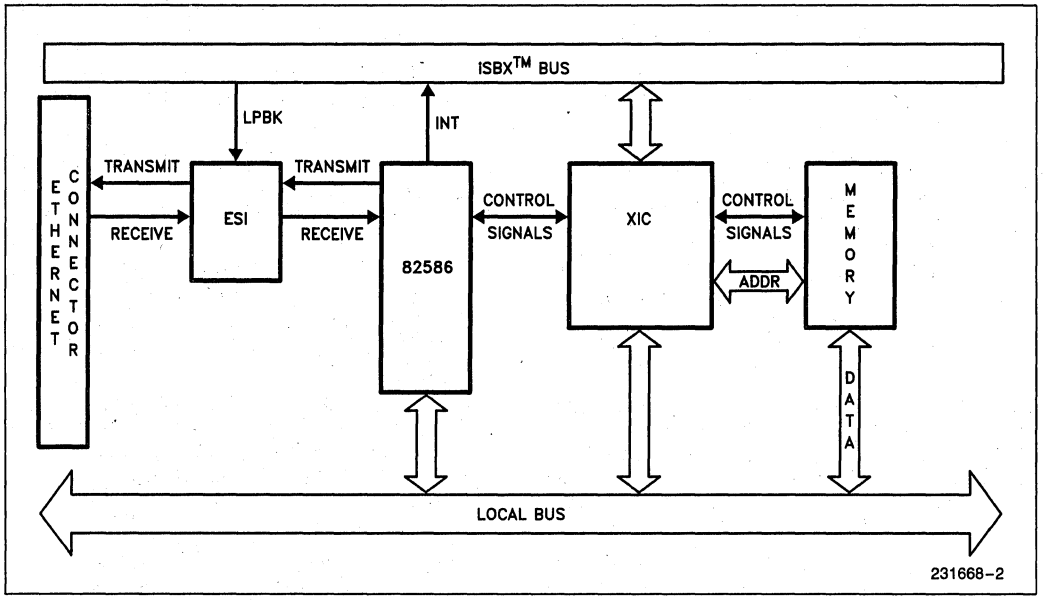


Figure 1. iSBX™ 586 Block Diagram

ARCHITECTURAL DESCRIPTION

The iSBX 586 MULTIMODULE consists of the following major architectural blocks (see Figure 1): an 8 MHz 82586 LAN Coprocessor configured for Ethernet, an Ethernet Serial Interface (ESI), an iSBX Interface Controller (XIC) chip, 16 KB of on-board RAM memory and the iSBX Bus Interface.

ETHERNET INTERFACE

The Ethernet Interface of the iSBX 586 consists of the 82586 Local Area Network Coprocessor and the Ethernet Serial Interface components. The 82586 is made up of a serial machine, which provides the data link control and a parallel interface that is compatible with MCS-86 based systems. The ESI, essentially, is a 10 Mbps Manchester encoder/decoder.

82586 LAN Coprocessor

The 82586 is an intelligent peripheral that completely manages the processes of transmitting and receiving frames over the network, thus off-loading the host CPU of communication management tasks. The 82586 features an on chip DMA controller which allows it to access the local memory through the efficient buffer chaining mechanism. Other features of the 82586 are the ability to perform network management activities including error and collision tallies and diagnostic capabilities via the internal and external loopback functions. Control of the 82586 is through high level commands such as TRANSMIT and CONFIGURE.

All information passed between the 82586 and the host board is made through the shared local memory. The host CPU may load the memory with a command and prompt the 82586 to execute. While receiving a packet, the 82586 loads receive buffers in local memory and, after completing the reception, interrupts the host board to indicate that a packet has been received.

The interrupt output of the 82586 is connected directly to the iSBX interface and is the only direct contact that the 82586 has with the host board. This interrupt is used to inform the host board of any event that has occurred which requires the host's attention.

A typical local bus cycle begins with a channel attention issued by the baseboard to the iSBX 586 (see section on the iSBX Bus Interface). Following the channel attention, the 82586 generates a HOLD. The iSBX Interface Controller (XIC) arbitrates the request, releases the control lines and issues a HOLDA (Hold Acknowledge). The 82586 can then proceed with normal read and write cycles. After completing the required memory accesses, the 82586 de-asserts the HOLD signal and the XIC removes the HOLDA. After completing the cycle, an interrupt to the host board is generated. For further information regarding the 82586, refer to the 82586 Data Sheet.

Ethernet Serial Interface

The ESI is a 10 Mbps Manchester encoder/decoder designed to work directly with the 82586 LAN Coprocessor. Additionally, the ESI generates the 10 MHz transmit and receive clocks for the 82586 and drives the transceiver cable. The internal loopback function of the ESI allows for fault isolation.

Loopback is asserted directly through the iSBX Interface Bus and as such, is controlled by the host CPU. When asserted, the ESI routes the serial data through the transmit logic (without activating the output drivers) and back through the receive logic to be output to the 82586.

iSBX™ Interface Controller

The iSBX Interface Controller (XIC) chip integrates the functions necessary to allow the 82586 LAN Coprocessor and the static memory on board the iSBX 586 to interface with the iSBX Interface Bus. The XIC chip was designed to accept all pertinent iSBX bus signals and act on them in accordance with the iSBX Bus Specification for 16-bit iSBX systems. The XIC chip is an Intel proprietary component and is not offered as a unique product.

The XIC arbitrates local bus control between the 82586 and the iSBX Bus Interface. After decoding the chip select, address and command lines from the iSBX Bus and the HOLDA signal from the 82586, the XIC synchronizes the request, determines priority and surrenders control of the local bus to the appropriate bus master. The 82586 has priority over the iSBX Interface Bus in terms of local bus arbitration. Once the arbitration has been resolved, the XIC chip is responsible for activating the proper address lines and chip selects for local memory. Additionally, the XIC turns on the proper data drivers and manages the memory control lines.

On Board Memory

The iSBX has 16 Kbytes of on board local RAM that serves as a communication liaison between the 82586 and the host CPU as well as providing buffers for packet storage prior to transmission and after reception. The RAM consists of two 8K × 8-bit CMOS static RAM chips configured as a two byte word to provide the full 16 bits of data. The RAM is addressed from 0 to 3FFFH locally but may be accessed at any 16K boundary (0, 4000H, 8000H, etc.) by the host board. In this way, the 82586 can access the fixed System Configuration Pointer (SCP) at memory location 3FF6H. Refer to the 82586 Data Sheet for information on the SCP.

A standard 32 × 8-bit PROM is used to contain the unique Ethernet station address. The station address is factory programmed and can only be accessed by the host board via the iSBX Bus.

iSBX™ Bus Interface

The iSBX Bus Interface is a major portion of the iSBX 586 MULTIMODULE. The XIC provides the interface between the iSBX Bus and the 82586 LAN Coprocessor and the local memory. The iSBX 586 is addressed as if it is an I/O slave on the iSBX Bus. There are four iSBX ports allocated for baseboard communication. The decoding of the ports is outlined in Table 1. MA0–MA2 are iSBX bus address lines.

Table 1. iSBX™ Bus I/O Slave Address Decode

MA2	MA1	MA0	Function	Read/Write
X	0	0	Memory Access	RD/WR
X	0	1	iSBX™ Address Load	WR Only
X	1	0	Station Address Read	RD Only
X	1	1	Channel Attention	WR Only, Data = X

X = don't care

NOTE:
As described in the iSBX Bus Specification, 16-bit iSBX base boards may connect ADR1–3 to the MULTIMODULE MA0–2 lines.

Due to the lack of addresses on the iSBX bus, the local iSBX 586 memory address must be set prior to the actual read or write operation over the iSBX Bus. The baseboard must first set up the appropriate address by executing an I/O write to the iSBX Address Load port 1 (MA1 = 0, MA0 = 1). The data written to port 1 is considered the iSBX memory address for the following iSBX memory access. The baseboard accesses the memory by addressing the iSBX Mem-

ory Access port 0 (MA1 = 0, MA0 = 0) for either a read or a write operation. The previously loaded memory address automatically increments allowing for sequential memory access without reloading the iSBX address (port 1).

Channel attention is the signal used by the host CPU to prompt the 82586 into action. The baseboard issues a channel attention by simply writing to the iSBX port address 3 (MA1 = 1, MA0 = 1). In response, the XIC chip asserts the Channel Attention signal directly to the 82586.

The unique, factory programmed Ethernet station address can only be read by the host board. Reading the station address is accomplished by the base board issuing an I/O read to the iSBX port address 2 (MA1 = 1, MA0 = 0). The PROM address space is between 0 and 3EH.

A typical iSBX Bus Cycle is intiated by the baseboard activating the appropriate address, chip select and command lines. After the XIC chip receives the active address and chip select signals, it issues an $\overline{\text{MWAIT}}$ to the baseboard. When the command is received, the XIC arbitrates between the 82586 and the baseboard. If the arbitration is resolved in favor of the baseboard, the XIC turns on all drivers on the iSBX 586 board for the current cycle. Subsequently, the $\overline{\text{MWAIT}}$ signal is de-asserted, allowing the baseboard to complete the cycle.

OPERATING ENVIRONMENTS

The iSBX 586 is designed to operate as a slave to MULTIBUS hosts with 16-bit iSBX bus capabilities. Because the iSBX 586 has no processing ability, all associated software must be executed by the host. Most of the functions of the Data Link and Physical layers of the ISO Model are supported by the iSBX 586. iNA 960 R2.0 is Intel's ISO compatible software package for the Network and Transport Layers.

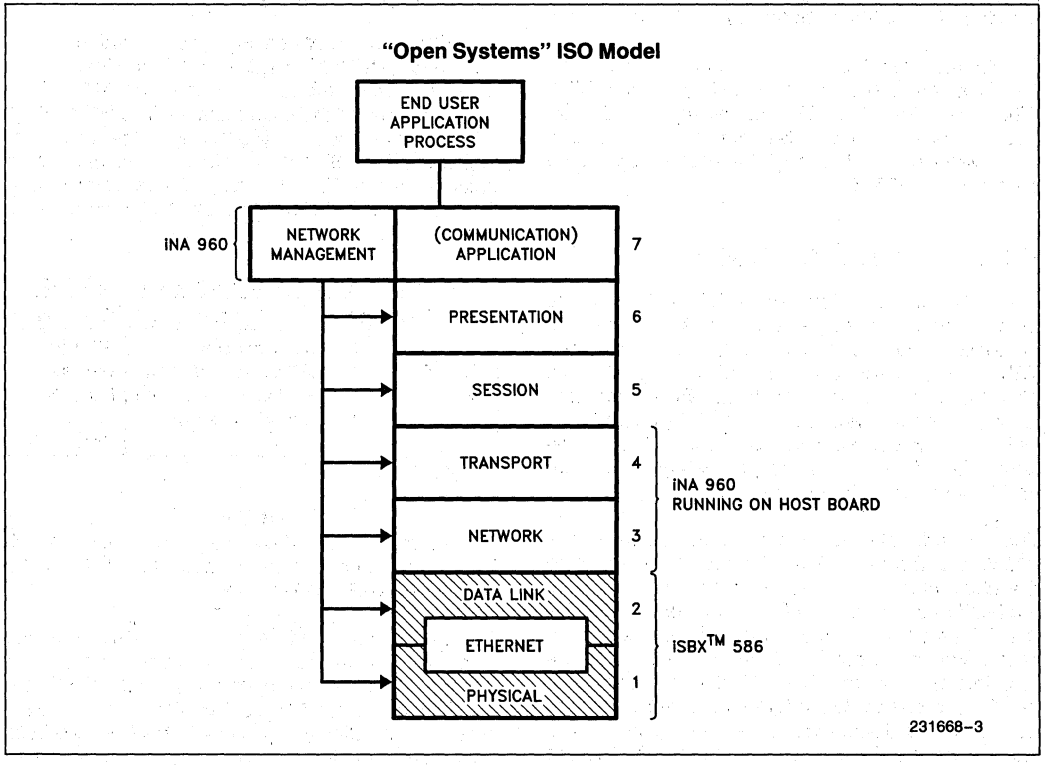


Figure 2. Mapping the iSBX™ 586 into the ISO Model

ORDERING INFORMATION

Part Number	Description
iSBX 586	Ethernet Data Link Engine

SPECIFICATIONS

iSBX Interface

Data Transfer	16 bits
Signal Levels	See the iSBX 586 Hardware Reference Manual
Signals Supported	All iSBX bus signals are supported except: MA2 MINTR1 MCLK OPT1 MDACK TDMA MDRQT −12V
Serial Interface	IEEE 802.3 compatible
DC Power Requirements	All voltages supplied by the iSBX Interface +5V DC ±5%, 2A max. +12V DC ±5%, 1A max.

ENVIRONMENTAL

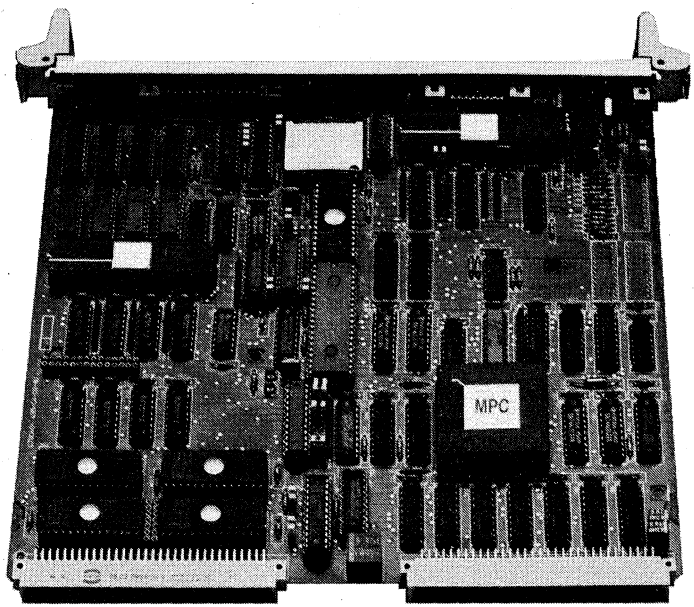
Temperature	0°C to 55°C Operating (Free moving air across the base board and iSBX 586)
	−40°C to +65°C Non-Operating
Humidity	5% to 90% Operating
	5% to 95% Non-Operating

Refer to the iSBX™ 586 Hardware Reference Manual (not supplied) for details.

iSBC® 186/530 MULTIBUS® II ETHERNET (IEEE 802.3) COMMUNICATIONS ENGINE

- **Provides ETHERNET (IEEE 802.3) Compatible Networking Capability for all MULTIBUS® II Systems**
- **High Integration 8 MHz 80186 Microprocessor**
- **256K Bytes DRAM Provided, with Sockets to Expand to 512K Bytes DRAM On-Board**
- **MULTIBUS II iPSB (Parallel System Bus) Interface with Full Message Passing Capability**
- **Host Operating System Independent**
- **Four 28-Pin JEDEC Sites, Expandable to 8 Sites with iSBC® 341 MULTIMODULE™ for a Maximum of 512K Bytes EPROM**
- **Provides one RS232C Serial Port for Use in Debug and Testing**
- **MULTIBUS II Interconnect Space for Software Configurability and Diagnostics**
- **Resident Firmware to Support Built-in-Self-Test (BIST) Power-up Diagnostics, and Host-To-Controller Software Download**

The iSBC® 186/530 MULTIBUS® II ETHERNET (IEEE 802.3) Communications Engine is a dedicated ETHERNET communications front-end processor implementing the full, high performance message passing interface of the MULTIBUS II (iPSB) Parallel System Bus. This iSBC board combines an 8 MHz 80186 16-bit microprocessor, an 82586 Local Area Network Coprocessor, an Ethernet Serial Interface component, up to 512K bytes of DRAM, four 28-pin JEDEC sites, and one RS232C serial port on a single 220 mm × 233 mm (8.7 in. × 9.2 in.) Eurocard printed circuit board. Acting as a communications engine, the iSBC 186/530 board off-loads the host CPU(s) in a MULTIBUS II system from managing and executing Ethernet LAN communications tasks. The main advantage of the communications engine concept is the ability to add IEEE 802.3 networking capability to a MULTIBUS II system without requiring a major design effort. The features of the board create a flexible, intelligent communications controller capable of supporting off-the-shelf or custom configurations on IEEE 802.3 LANs.



280269-1

September 1987
Order Number: 280269-002

FUNCTIONAL DESCRIPTION

Overview

The iSBC 186/530 MULTIBUS II ETHERNET Communications Engine is a powerful IEEE 802.3 LAN communications sub-system specifically designed to operate in and support message-based, multiprocessor system configurations being implemented on the MULTIBUS II architecture. The board's on-board CPU, an 8 MHz 80186 microprocessor, provides significant intelligence to off-load and distribute the LAN communications functions away from one or all of a system's processor boards.

The iSBC 186/530 board was designed as a dedicated ETHERNET LAN front-end processor to enable the OEM to connect MULTIBUS II-based systems with different operating systems to the same network.

ARCHITECTURE

The iSBC 186/530 board supports the full iPSB bus interface functions of data and interrupt message passing, interconnect space, memory space, and I/O references. This board supports both requestor and replier functions as described in the MULTIBUS II Architecture Specification Handbook (#146077, Rev. C). The board consists of six major subsystem areas: Processor, ETHERNET I/O, Memory, General I/O, iPSB bus Interface, and Interconnect (See Figure 1).

Processor Subsystem

80186 PROCESSOR

The central processor unit on the iSBC 186/530 board is Intel's 16-bit 8 MHz 80186 microprocessor.

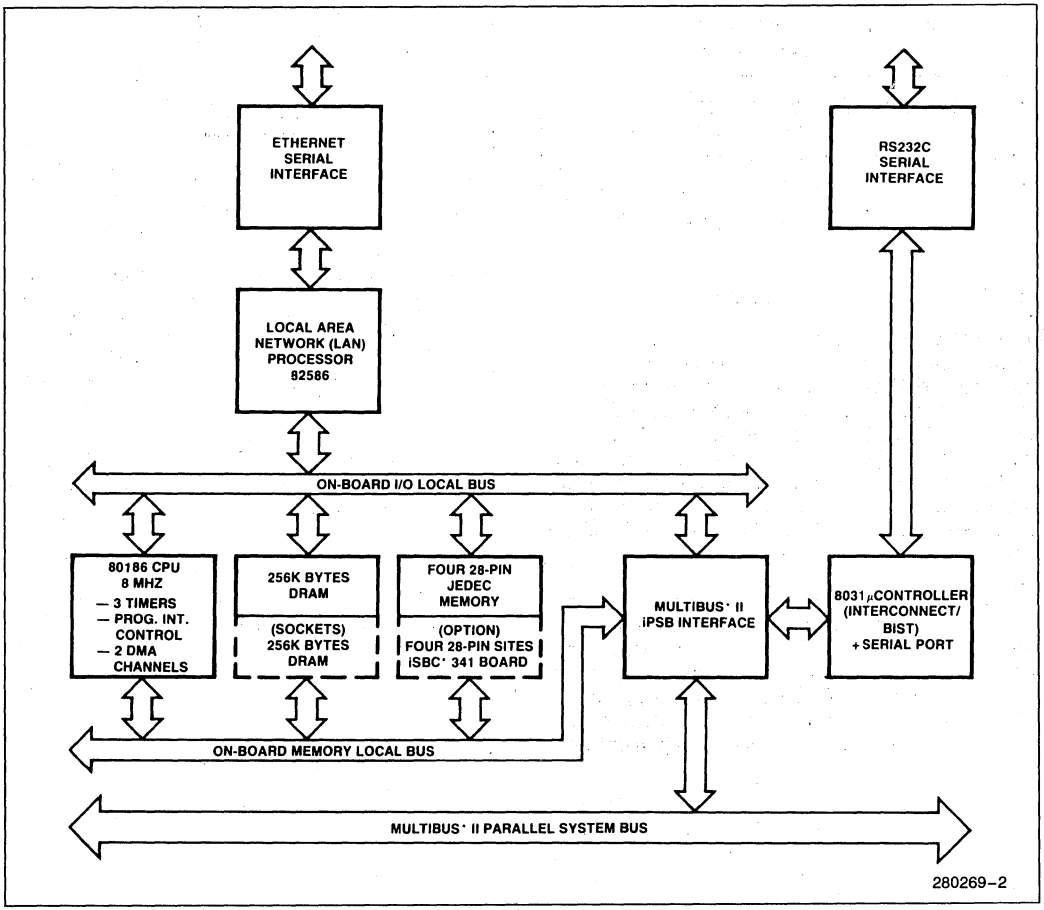


Figure 1. iSBC® 186/530 Board Functional Block Diagram

The highly integrated 80186 CPU combines several system components onto a single chip (i.e., two Direct Memory Access lines, three Interval Timers, Clock Generator, and Programmable Interrupt Controller). The 80186 instruction set is a superset of the 8086 and maintains object code compatibility while adding additional instructions. This high performance component provides the intelligent interface between engine and host processor(s) and manages the board's LAN communications capability. Refer to the Microsystem Components Handbook, Order Number 230843-00X, for more detailed information on the hardware operation and requirements of the 80186 microprocessor component.

DIRECT MEMORY ACCESS (DMA) FUNCTION

The iSBC 186/530 board uses the 80186 microprocessor to provide two DMA channels for DMA support of the iPSB bus interface, the MPC Message Passing Coprocessor chip (See Table 1).

Table 1. iSBC® 186/530 Board DMA Channel Allocation

DMA Configuration (80186)	
80186	**Local Bus Resource**
DMA Channel 0	Output DMA to MPC
DMA Channel 1	Input DMA from MPC (Message Passing Coprocessor)

ETHERNET I/O Subsystem

The ETHERNET interface on the iSBC 186/530 board is implemented by the 82586 LAN Coprocessor and the Ethernet Serial Interface component. Data is transferred between the on-board memory of the iSBC 186/530 board and the 82586 controller by 82586 initiated DMA. The 82586 initiates the DMA cycles by activating the HOLD signal to the 80186 processor. The DMA cycle begins when the 80186 processor activates the HOLD ACKNOWLEDGE signal.

The 82586 component provides most of the functions normally associated with the data link and physical link layers of a local network architecture (See Figure 2). In particular, it performs framing (frame boundary delineation, addressing, and bit error detection), link management, and data modulation. It also supports a network management interface.

The Ethernet Serial Interface component performs Manchester encoding and decoding of the transmit and receive frames. It also provides the electrical interface to the Ethernet transceiver cable. Both chips support a loop-back function. The pin assignments for the Ethernet connector are shown in Table 2.

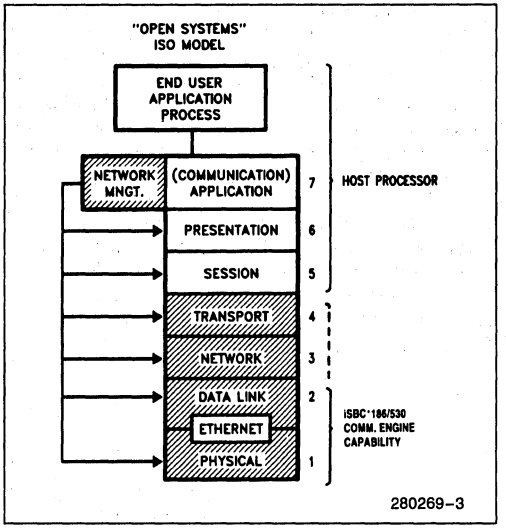


Figure 2. ISO Layered Model and the iSBC® 186/530 Board

Table 2. ETHERNET Connector, Pin Assignments

Pin	Description	Pin	Description
1	Shield	9	Collision (−)
2	Collision (+)	10	Transmit (−)
3	Transmit (+)	11	Reserved
4	Reserved	12	Receive (−)
5	Receive (+)	13	Power
6	Power Return	14	Reserved
7	Reserved	15	Reserved
8	Reserved		

Each iSBC 186/530 board is manufactured with a unique default 48-bit Ethernet network address

stored in an address PROM. This address PROM is protected by checksum and can be read by utilizing the on-board I/O space. The 82586 component can be programmed to have this or any other Ethernet address.

80186/82586 COMMUNICATION

The 80186 and the 82586 communicate entirely through a shared memory space. To the user, the 82586 appears as two independent but communicating units: the Command Unit (CU) and the Receive Unit (RU). The CU executes the commands given by the 80186 to the 82586. The RU handles all activities related to packet reception, address recognition, CRC checking, etc. The two are controlled and monitored by the CPU via a shared memory structure called the System Control Block (SCB). Commands for the CU and RU are placed into the SCB by the host processor. Status information is placed into the SCB by the CU and RU (via the CU). The Channel Attention and Interrupt lines are used by the CPU and the 82586 to get the other to look into the SCB (See Figure 3).

The 82586 features a high level diagnostic or maintenance capability. It automatically gathers statistics on CRC errors, frame alignment errors, overrun errors, and frames lost due to lack of reception resources. In addition, the user can output the status of all internal registers to assist in system design.

Upon initialization, the 82586 obtains the address of its System Control Block through the Initialization Root which begins at location 0FFFFF6H (See Figure 4). The SCB contains control commands, status register, pointers to the Command Block List (CBL) and Receive Frame Area (RFA), and tallies for CRC, Alignment, DMA Overrun, and No Resource errors. Through the SCB, the 82586 is able to provide status and error counts for the 80186, execute "programs" contained in the CBL and receive incoming frames in the Receive Frame Area (RFA).

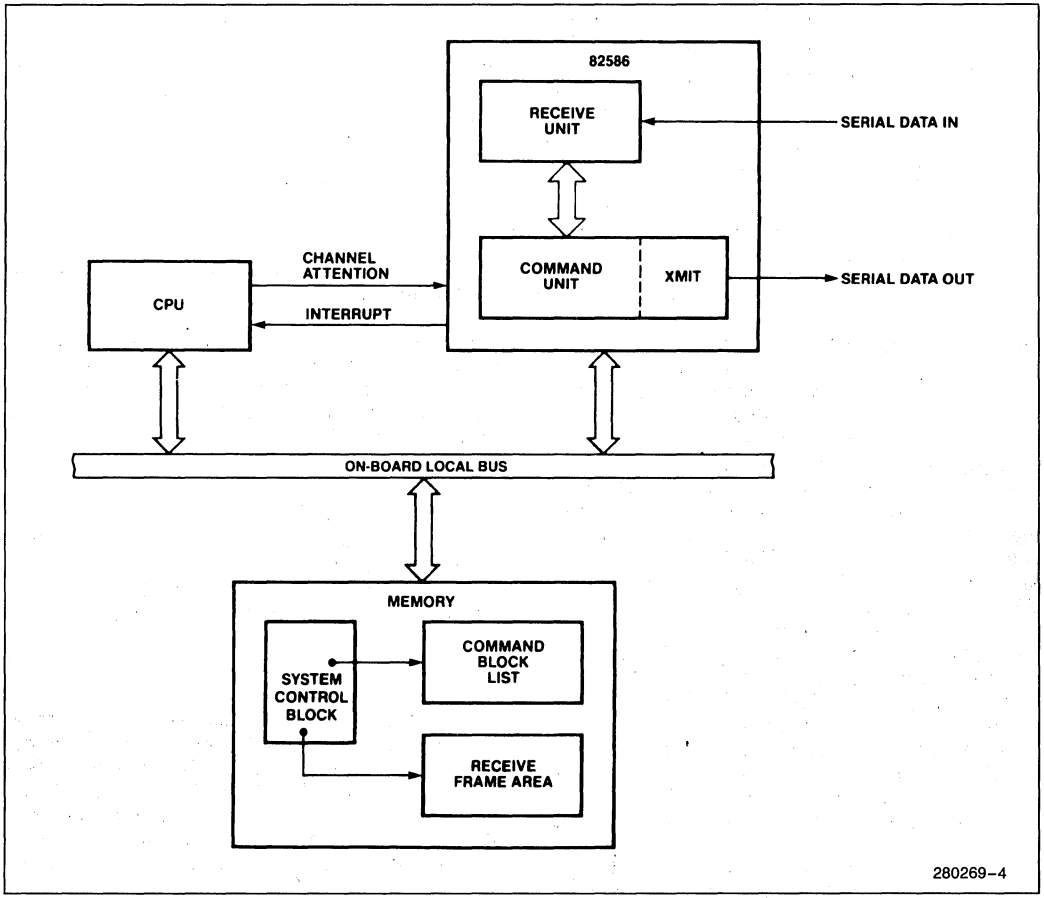


Figure 3. System Overview

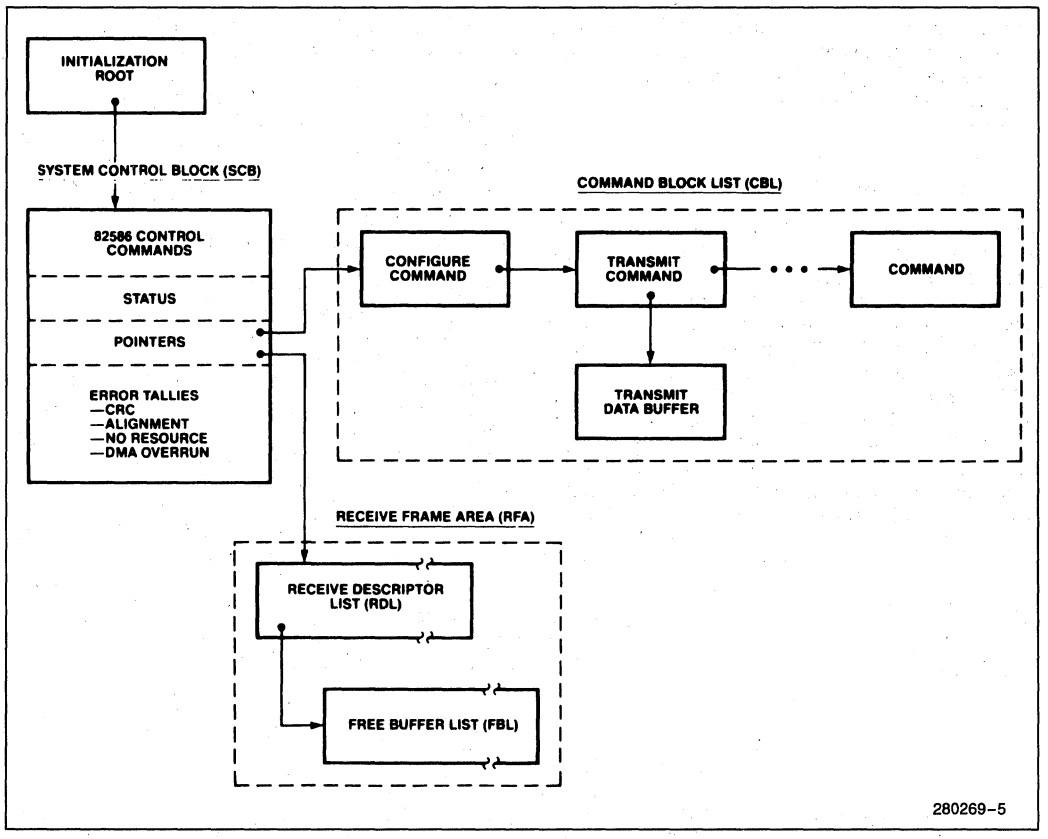


Figure 4. 82586 Memory Structures

Memory Subsystem

The iSBC 186/530 board's on-board memory subsystem consists of a large DRAM array and a set of ROM/EPROM memory sites. Access to the on-board memory subsystem resources, as well as off-board iPSB bus access, is accomplished by observing the iSBC 186/530 board memory map (See Figure 5). The mapping occurs within the 1 megabyte memory space of the 80186 microprocessor, and is split into three main areas: DRAM reserved, iPSB window, and EPROM reserved. The first 0 to 512K bytes is always reserved for local DRAM, the next 128K or 256K bytes (or up to 768K) is the iPSB window, and the remaining 384K or 256K byte area is reserved for local EPROM. The iPSB window maps a 128K or 256K byte memory area into the 4 gigabyte global physical address range of the MULTIBUS II iPSB bus. This window is programmable and allows the 80186 processor to access the complete 4 gigabyte memory space of the iPSB bus.

The board's memory map also supports a 64K byte access window for I/O space between local and iPSB bus access. The 64K bytes of local I/O space is mapped 1-to-1 to the iPSB bus' 64K byte I/O space. The upper 32K bytes access the iPSB bus I/O space, and the lower 32K bytes are reserved for local on-board I/O.

DRAM CAPABILITIES

The iSBC 186/530 board comes standard with a 256K byte DRAM memory array on-board. Eight additional 18-pin sockets are provided to the OEM for expanding the DRAM array to 512K bytes.

EPROM MEMORY

A total of four 28-pin JEDC universal sites reside on the iSBC 186/530 board. These sockets support additon of byte-wide ROM and EPROM devices in densites from 8K bytes (2764) to 64K bytes (27512) per device. Two of the four sockets contain a pair of 27128 EPROM devices installed at the factory. These devices contain 32K bytes of firmware provi-

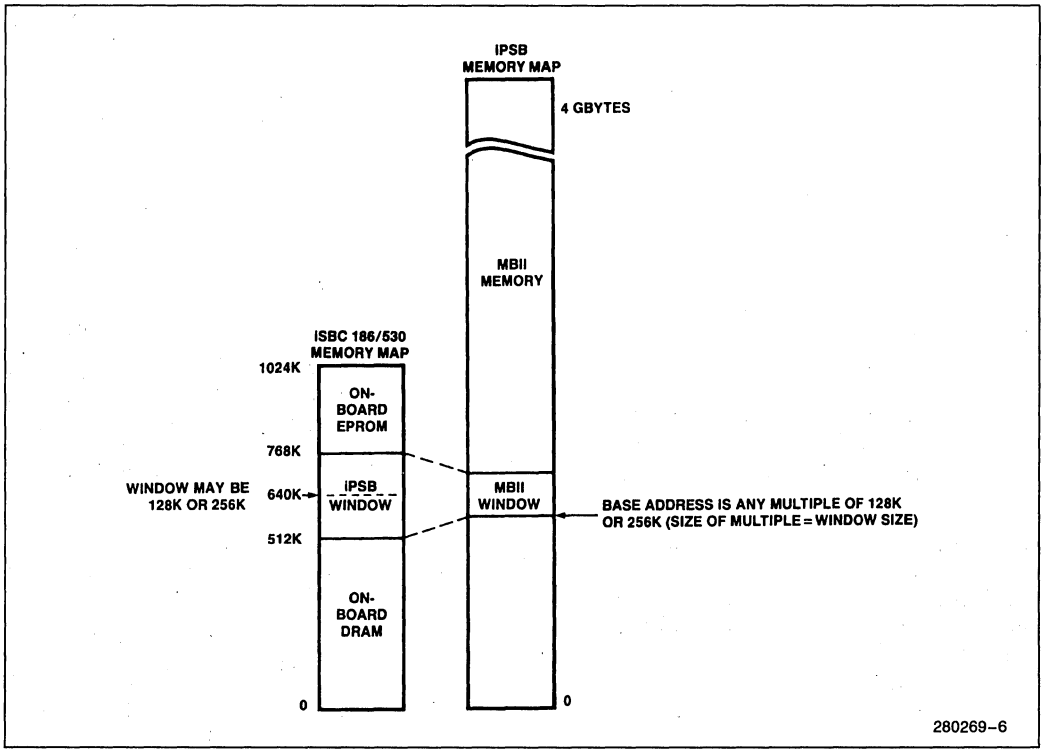


Figure 5. iSBC® 186/530 Board Memory Map Diagram

ded to execute the Built-In-Self-Test (BIST) power-up diagnostics routine, EPROM devices installed at the factory. These devices contain 32K bytes of firmware provided to execute the Built-In-Self-Test (BIST) power-up diagnostics routine. The remaining two sockets allow the user to add either two ROM/EPROM devices or an iSBC 341 256K byte EPROM MULTIMODULE™ board for a maximum of 512K bytes of ROM/EPROM on-board.

General I/O Subsystem

The I/O subsystem provides timers, interrupt control and an RS232C serial port for debug and test.

PROGRAMMABLE TIMERS AND INTERRUPT CONTROL

The board's 80186 microprocessor provides three independent, fully programmable 16-bit interval timers/event counters and an interrupt controller.

The 80186 interrupt controller is configured in the "fully nested mode," and supports five external interrupt sources via five dedicated pins provided on the 80186. All five pins are used as interrupt requests from other hardware on-board (See Table 3).

Table 3. External Interrupt Sources

Interrupt	Vector Type	Vector Location	Default Priority	Function
NMI	2	00008 H	1	Reset stake pin
INT0	12	00030 H	6	Interrupt from the Ethernet Controller
INT1	13	00034 H	7	Message Interrupt from the MPC (MINT)
INT2	14	00048 H	8	Error Interrupt from the MPC (EINT)
INT3	15	0004C H	9	Interrupt from the 8031 Interconnect Controller

RS232C SERIAL PORT

There is a simple RS232C serial port provided on the iSBC 186/530 board for use in debug and test. The serial interface is derived from the 8031 serial interface port. Only the Receive Data (RD) and Transmit Data (TD) lines are supported, connected to a 25-pin connector on the front panel. The pin assignments for the 25-pin connector are shown in Table 4.

Table 4. Serial Interface Connector, Pin Assignments

Pin	RS232CFunction	Pin	RS232C Function
1	Shield	14	Not used
2	Transmit Data (T×D)	15	Not used
3	Receive Data (R×D)	16	Not used
4	Not Used	17	Not Used
5	Not Used	18	Not Used
6	Not Used	19	Not Used
7	Signal Ground (0V)	20	Not Used
8	Not Used	21	Not Used
9	Not Used	22	Not Used
10	Not Used	23	Not Used
11	Not Used	24	Not Used
12	Not Used	25	Not Used
13	Not Used		

iPSB Bus Interface Subsystem

This subsystem's main component is the MPC Message Passing Coprocessor chip. Subsystem services provided by the MPC bus interface component includes full message, memory, I/O, and interconnect access to the iPSB bus by the 80186 and 82586 processors.

The single-chip Message Passing Coprocessor is a highly integrated CMOS device implementing the full message passing protocol and performing all the arbitration, transfer, and exception cycle protocols specified in the MULTIBUS II Architecture Specification Handbook, Rev. C., Order Number 146077.

Interconnect Subsystem

MULTIBUS II interconnect space is a standardized set of read-only and software configurable registers designed to hold and control board configuration information, and communicate system and board level diagnostics and testing information. Interconnect space is implemented with an 8031 microcontroller and the MPC silicon resident on the iSBC 186/530 board.

The read-only registers store information such as, board type, vendor I.D., firmware rev. level, etc. The software configurable registers are used for auto-software configurability and remote/local diagnostics and testing. For example, a software monitor can be used to dynamically change bus memory sizes, enable on-board resources such as memory, read if the PROM devices are installed, or access results of Built-In-Self-Tests and other diagnostics.

Most options on the iSBC 186/530 board are controlled by interconnect space. In addition, many of the interconnect registers on the board perform functions traditionally done by jumper stakes. Other interconnect registers provide status information allowing system software to determine configuration status.

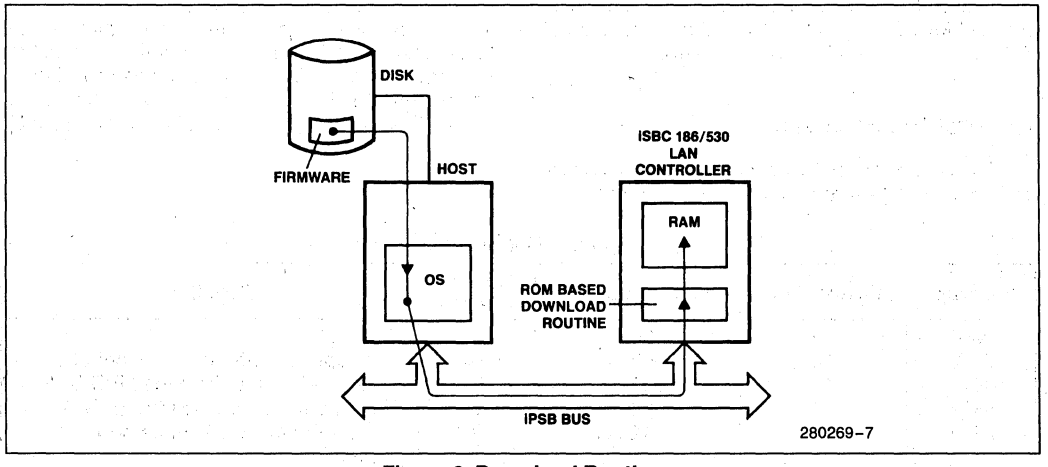


Figure 6. Download Routine

Firmware Capability

HOST/CONTROLLER SOFTWARE DOWNLOAD ROUTINE

Resident in ROM on this controller is a host-to-controller software download routine to support the downloading of communication firmware into the iSBC 186/530 board. This loader adheres to the MULTIBUS II Download Protocol and responds to commands issued by software running on a host CPU board. The host CPU passes these commands to the loader via registers defined in the board's interconnect space. A download function, a commence execution function, and an examine local memory function are all provided in the routine. Data transfers are supported by both shared memory systems and message based systems. The top 1K of DRAM on the board is reserved for the exclusive use of the download program. Host CPUs must not overwrite this area with download commands.

Software on the host is responsible for accessing the iSBC 186/530 board's firmware on disk or from ROM visible to the host and translating it into linear sequences of bytes suitable for downloading (See Figure 6). After downloading the firmware, the host issues a command for the loader routine on the controller to begin execution of the download software.

Built-In-Self-Test Diagnostics

On-board initialization checks and built-in-self-test (BIST) diagnostics are implemented using the 8031 microcontroller and the 80186 microprocessor. On-board tests included in the BIST package are: DRAM, EPROM, 80186, 82586, 8031, and MPC. These tests are performed by the 80186 microprocessor.

Additional activities performed include a Reset Operating System initialization at power-up and a program table check, a feature allowing users to add custom code in EPROM while still maintaining full use of the facory supplied BISTs. Immediately after power-up and the 8031 microprocessor is initialized, the 80186 microprocessor begins its own initialization and on-board diagnostics. Upon successful completion of these activities, the Reset Operation System invokes the user-defined program table. A check is made of the program table and the custom programs that the user has defined for his application will then execute sequentially.

The BIST package provides a valuable testing, error reporting and recovery capability of MULTIBUS II boards enabling OEMs to reduce overall system manufacturing and maintenance costs. An LED on the board's front panel indicates the status of power-up diagnostics. It is on when BIST diagnostics start running and is turned off upon successful completion of the BISTs.

SPECIFICATIONS

Word Size

Instruction—8-, 16-, 24-, or 32-bits
Data—8-, or 16-bits

System Clock

CPU—8.0 MHz

Cycle Time

Basic Instruction—8.0 MHz—375 ns; 250 ns (assumes instruction in queue)

NOTE:
Basic instruction cycle is defined as the fastest instruction time (i.e., two clock cycles).

Memory Capacity

Local Memory

DRAM—256K bytes on-board (64K x 4-bit devices). 8 sockets provided to support additional 256K bytes

EPROM—Number of sockets—four 28-pin JEDEC sites

EPROM	Device Size (Bytes)	Maximum Memory Capacity
2764	8K	32K bytes
27128	16K	64K bytes
27256	32K	128K bytes
27512	64K	256K bytes

**EPROM expansion to up to a maximum of 512K bytes is achieved via attachment of the iSBC 341 EPROM (256K byte) MULTIMODULE board.

I/O Capability

ETHERNET (IEEE 802.3)— One ETHERNET channel. Uses 15-pin connector, 82586 LAN Coprocessor and an Ethernet Serial Interface component

RS232C-only Serial Port— Simple serial port, RS232C, driven off 8031 microcontroller serial port interface; used for debug and test

Timers— Three programmable timers on the 80186 microprocessor

Input Frequencies— Frequencies supplied by the internal 80186 16 MHz crystal

Interrupt Capability

Potential Interrupt Sources from iPSB Bus— 255 individual and 1 Broadcast

Interrupt Levels — 5 interrupt sources using 80186 Interrupt Controller

Interrupt Requests — All levels TTL compatible

Eurocard Form Factor

Depth — 220mm (8.7 inches)

Height — 233mm (9.2 inches)

Front Panel Width — 20mm (0.784 inches)

Weight — 743 g (26 ounces)

Environmental Characteristics

Temperature:	Inlet air at 200 LFM airflow over all boards
(non-operating)	−40°C to +70°C
(operating)	0C° to +55°C
Humidity	
(non-operating)	95% Relative Humidity @ +55°C, non-condensing
(operating)	95% Relative Humidity @ +55°C, non-condensing

Electrical Characteristics

The maximum power required per voltage is shown below. These numbers do not include the power required by the optional memory devices or expansion modules.

Voltage (volts)	Max. Current (amps)	Max. Power (watts)
+5V	6.5A	34.13W
+12V	50 mA	0.06W
−12V	50 mA	0.06W

Reference Manuals

iSBC 186/530 ETHERNET (IEEE 802.3) Communications Engine User's Guide **149226-001**

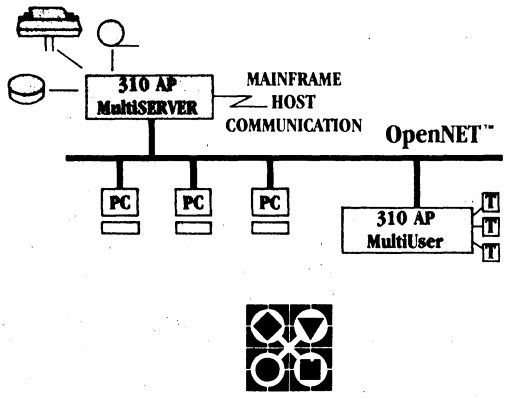
Intel MULTIBUS II Architecture Specification Handbook **146007**

Reference manuals may be ordered from any Intel Sales Representative, Distribution Office, or from the Intel Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051.

ORDERING INFORMATION

Part Number	Description
iSBC 186/530	MULTIBUS II ETHERNET (IEEE 802.3) Communication Engine

XENIX*-NET NETWORKING OpenNET™ PRODUCT FAMILY



- ▶ *Complete LAN Solution based entirely on standards*
- ▶ *Multiple operating system interoperation: XENIX, MS*-DOS, iRMX™, iNDX*
- ▶ *Existing applications distributed without change*
- ▶ *Comprehensive network services:*
  - *— Network File Access*
  - *— Remote Job Execution*
  - *— Network XENIX Mail*
  - *— Network Administration*
  - *— Virtual Terminal*
  - *— MS-DOS Virtual Terminal*
  - *— Print Spooling*

■ TOTAL LAN SOLUTION FOR MICROSYSTEM APPLICATIONS

OpenNET is Intel's Open System strategy and product family for local area networks (LANs). XENIX-NET represents the first truly integrated department service network to provide all the necessary hardware and software to link Intel microsystems, terminals, PCs, mainframes, minis, peripherals and software in one consistent, integrated system.

■ XENIX-NET NETWORK FILE ACCESS FOR TRANSPARENT INTEROPERATION

XENIX-NET provides transparent network file access (NFA) and additional network services to interoperate among various nodes on the LAN. XENIX-NET NFA runs under the XENIX 3.0 operating system from Intel. There are no special operating system calls to access remote files.

Applications and users make standard XENIX file access requests such as OPEN, CLOSE, READ and WRITE. XENIX-NET NFA transparently accesses files across the network. XENIX-NET NFA determines from the filename if the file is on a local storage device or remote across the network. Applications access remote files as if they were local; no modifications to applications software are required to run across the network.

XENIX-NET NFA makes networked microsystems look like one large integrated computer system with a single network-wide hierarchical file system.

■ XENIX-NET COMPLETE NETWORK SERVICES

In addition to transparent network file access, XENIX-NET makes available critical services to all nodes in a LAN providing for increased group productivity and system utilization.

Remote Job Execution. With Remote Job Execution, a user can execute a XENIX command stream at single or multiple remote nodes. Additionally, these command streams can be queued for execution at specific times throughout the day. This facility allows users to distribute and balance the workload logically throughout a network, completely utilizing the combined power of the network resources.

Network XENIX Mail. The XENIX Mail facility has been extended to transparently reach beyond a single XENIX system to remote nodes within a LAN. XENIX Mail users don't have to concern themselves with where a particular user resides on the network. Network XENIX Mail service provides the necessary routing and delivery throughout the network and through a UUCP link.

Virtual Terminal. Packaged as a separate network service, Virtual Terminal allows local XENIX users to "logon" to a remote Intel XENIX node within the network. This capability allows users to access all available resources and functions such as host communications and peripherals.

JANUARY, 1987
ORDER NUMBER 270055-004

DOS-NET Virtual Terminal. Packaged as a separate network service, DOS-NET Virtual Terminal is an MS-DOS service which allows IBM PCs and compatibles connected through the OpenNET LAN to "logon" to any remote Intel XENIX system and access the multiuser applications and services (such as mail) available in that environment.

Easy Network Administration. XENIX-NET provides a complete set of interactive network configuration and maintenance utilities. With the addition of iBASE, Intel's menu driven business shell, network administration is further simplified by giving the network administrator a "window" to all nodes residing on a sub-network. A series of screens and menus prompts the administrator through network configuration and maintenance.

Print Spooling. XENIX-NET Print Spooling provides shared access to single or multiple printers distributed throughout a network. Expensive laser and letter-quality printers, for example, can be shared among numerous users from one site and need not be duplicated at each node in the network.

■ OpenNET LAN STANDARDS

Intel supports and drives LAN standards and technology for the microsystems and microcommunications industries. The OpenNET product family adheres to the International Standards Organization's (ISO) seven layer Open Systems Interconnect (OSI) model. Only complete products that conform to this model and are based on open and public standards carry the OpenNET name.

■ COMPLETE NETWORK SUPPORT AND SERVICE FROM A SINGLE SOURCE

Intel takes ownership of the complete network system by offering a broad range of service and support packages.

Network consulting, planning, design and analysis is available for customers to ensure proper, cost-effective network selection and configuration.

Network installation and check-out service consolidates the complex coordination of a network installation to one vendor. Intel reduces the time to network availability by ensuring the proper functioning of all nodes on the network, including the cabling.

Intel extended hardware/software service and support agreements are designed to support both Intel and non-Intel components of a network — making Intel the single point of contact for problems or questions relating to the network.

Finally, Intel offers complete training on XENIX-NET software, as well as for the entire OpenNET product line to make network users as productive as possible.

■ OpenNET XENIX-NET — THE TOTAL LAN SOLUTION

No other hardware and software LAN combination integrates such a breadth of services or offers a faster or more economical path to getting networked application systems that transform personal productivity into organizational efficiency.

ORDERING INFORMATION

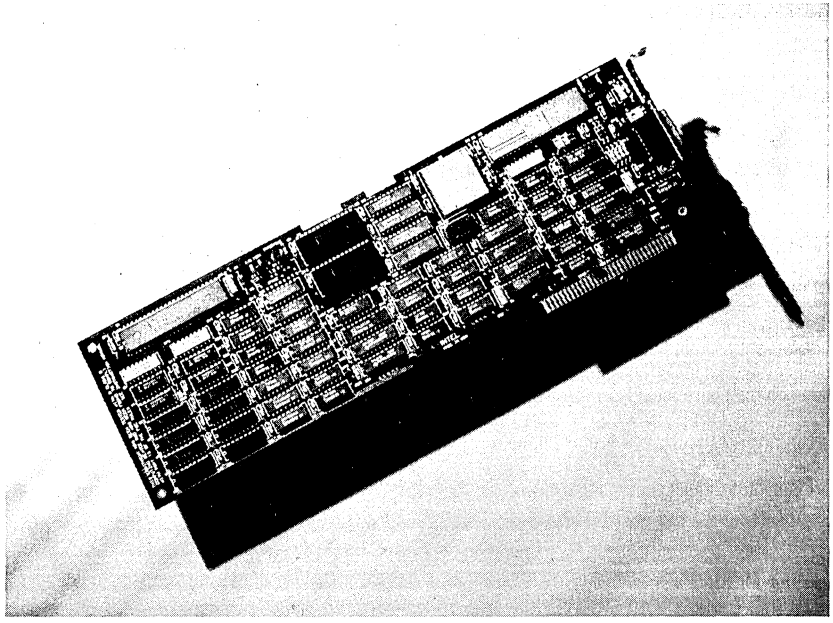
Complete Network-Ready Systems

Complete XENIX-NET ready systems are available from Intel. SYS310-141 comes complete with an integrated LAN controller.SYS310-145 comes with an integrated LAN controller as well as an integrated mainframe Host Communication Controller for ASYNC and BYSNC communication protocols.

Any Series 300 microsystem from Intel may be upgraded to a network-ready system by adding an XNXNFAEKRIKIT option, or at initial order appending "XN" option designator for System 300 hardware configuration orders.

XENIX Networking Software and Kits	
XNXNFAEKRI	XENIX Networking and iNA 961 Object Software plus rights for 8 copies
XNXNFAEKRIKIT	XENIX Networking and iNA 961 Object Software plus an iSXM 552S Ethernet controller for pass-through product
DOSNETVTSKRI	PC terminal emulator that enables a PC user to "login" directly to a XENIX system running XENIX virtual terminal
XNXNETVTSKRI	Provides XENIX-to-XENIX virtual terminal capabilities
LAN Hardware	
iSXM552	Ethernet COMMengine plus one iNA 961 Software Incorporation Fee
iMDX457	Ethernet Transceiver Cable
iMDX3015	Ethernet Transceiver
iMDX3016-1	Ethernet Cable
iDCM911-1	Intellink
PCLINK	Includes the Network Interface Unit (NIU) add-in IEEE 802.3 "Ethernet" controller for IBM PC and compatibles, preconfigured iNA 961 ISO transport software for NIU and MS NET network file access software for PC DOS/MS-DOS PC or compatible.

OpenNET™ PERSONAL COMPUTER LINK2



OpenNET™, MS-NET Access for the IBM™ PC

Now users of IBM™ PC AT, PC XT and other compatible computers can access Intel's OpenNET™ networking system, using Microsoft's MS-NET, through the OpenNET Personal Computer Link2 (PC Link2). An 80186/82586 microprocessor-based expansion board, PC Link2 is easily installed in a PC expansion card slot and uses only 44 K of PC memory. The software package incorporates the MS-NET and iNA 960 (ISO 8073 compatible) transport software.

OpenNET™ PERSONAL COMPUTER LINK2 FEATURES

- Runs on IBM PC AT, PC XT, and PC-DOS compatibles
- Uses standard DOS commands
- Interconnects to iRMX®, XENIX™, and VAX™/VMS™ NDS-II NRM Systems having OpenNET server capability
- Uses ISO 8073 transport and EtherNET/IEEE 802.3 standard communication protocols
- Intelligent high performance hardware with on-board microprocessor, 16 K bytes EPROM and 256 K bytes RAM

intel

June, 1987
Order Number: 280617-001

CONFIGURE SPECIALIZED PC-BASED SYSTEMS

OpenNET PC Link2 gives you the freedom to network your PCs in the most advantageous way possible, whether as consumer workstations or as file servers. PC Link2 also allows easy access to files on other operating systems, such as iNDX, XENIX, iRMX, or VAX/VMS.

OpenNET PC Link2 supports iNDX, XENIX, and iRMX networking software at the application layer.

INTELLIGENT HARDWARE OFFLOADS THE HOST CPU FOR OTHER APPLICATIONS

The PC Link2 board allows the host to concentrate on your applications because it contains an on-board processor and sufficient memory to handle the communication tasks. The components on the board include:

- 80186 microprocessor, 8 MHz zero-wait-state for memory access
- 82586 LAN communications controller
- 16 K bytes EPROM
- 256 K bytes RAM shared by the PC host and the PC Link2 board
- Jumper selection for EtherNET or IEEE 802.3

Effective Self Diagnostics. Diagnostics firmware on the network controller board is invoked each time the system is initialized, both during power-up and reset. The diagnostic routine displays the EtherNET address and tests these functions:

- 80186 and 82586 microprocessors
- I/O ports
- Shared 8 K byte memory window
- Interrupt channels
- EtherNET connection

PCLINK2 SOFTWARE PROVIDES YOU A COMPLETE SOLUTION

The network controller board performs all network communication functions for the first two layers of the ISO/OSI reference model. Layers three and four reside in the on-board iNA 960 transport software. The upper layers reside in the MS-NET networking software on the PC system.

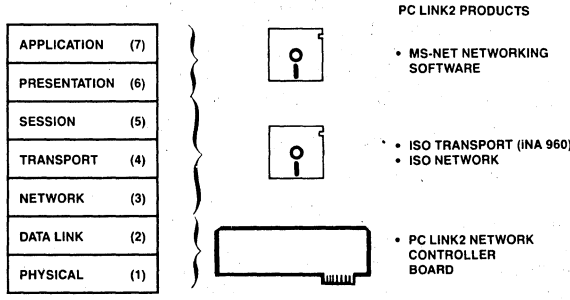


Figure 1: ISO/OSI Reference Model and PC Link2 Products

Software provides industry standard protocols. OpenNET PC Link2 software supports the protocols adopted by Intel, Microsoft and IBM networking products. The software includes:

- MS-NET Microsoft Networks networking software 1.01, giving access to remote file servers on the network system.
- Customized iNA 960 transport layer software operating on the network controller board.

DESIGNED FOR EASY CONFIGURATION, AND EFFICIENT, TRANSPARENT OPERATION

Easily installed controller board. The network controller fits any available expansion slot of a PC system. Industry standard IEEE 802.3/EtherNET and ISO 8073 transport protocols provide compatibility with existing installed networks.

Ready for use in just three steps. To install OpenNET PC Link2 in an end-user workstation, simply follow these three steps:

- Install the network controller board and connect the PC system to an EtherNET transceiver or an Intellink module.
- Configure the software, including the name and EtherNET address assigned to the PC system.
- Define the PC system as a valid user of the remote server system.

Three-step network access. To access files, directories, or printers at remote servers on the network, follow these steps:

- Invoke the PC system's consumer networking software.
- Execute a connect-to-server command.
- Execute standard DOS commands.

When workstations are dedicated to specific applications, the user can place these commands in a DOS batch file so that the PC system will automatically be connected to a remote server when the operating system is booted.

Powerful features aid efficient performance. OpenNET PC Link2 capabilities include:

- Remote access to any file within the server home directory including multiple subdirectories.
- Applications such as Lotus 1-2-3 can be stored on the server and accessed from the network.
- Common DOS commands are valid across the network. This powerful capability provides the user with access to many DOS utilities.
- Shared printer access, eliminating the need for a dedicated printer at the workstation.

OTHER ACCESSORIES ARE AVAILABLE TO PROVIDE YOU A COMPLETE NETWORK CONNECTION

IEEE 802.3 EtherNET accessories include transceivers, cables and an EtherNET cluster module to reduce the cost of your network.

EtherNET Transceiver. The N-series transceiver meets the requirements of IEEE 802.3 and EtherNET 1.0/2.0 specifications. Heartbeat, jabber, halfstep signalling and 2 KV RMS isolation voltage as specified in the IEEE 802.3/EtherNET standard are provided. The heartbeat is disabled by a simple jumper selection.

Transceiver Cables are available in two different lengths—10 and 50 meters.

The EtherNET Cluster Module, also known as Intellink, is an EtherNET-compatible network element that can be used as a means of interconnecting up to nine EtherNET stations without the need of a coaxial cable. With the addition of the Intellink Cascade Adapter, it is possible to cascade two levels of Intellinks. This will permit the interconnection of up to 81 EtherNET workstations without the need of a coaxial cable. The Intellink EtherNET Cluster Module is shown in the figure below.

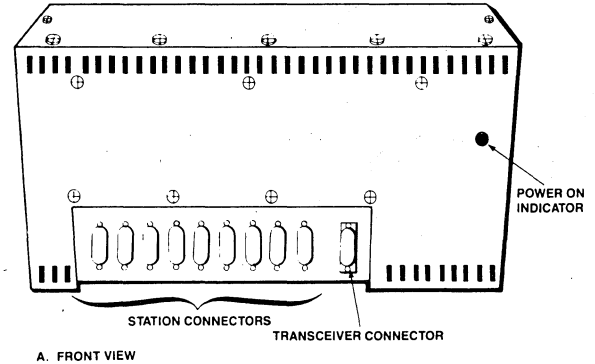


Figure 2: Intellink™ EtherNET Cluster Module

SPECIFICATIONS

HOST REQUIREMENTS

IBM PC AT, PC XT or compatible computer system
192 K system memory
MS-DOS or PC-DOS operating systems, version 3.1 or later

PHYSICAL CHARACTERISTICS

Network controller board

Width:	13.315 in (33.82 cm)
Height:	4.15 in (10.54 cm)
Weight:	35 oz (.99 kg)

Software
5¼ in double-density disk (360 K)

Power Requirements
+ 5 V at 2 A
+ 12 V at .5 A

Environmental Characteristics

Operating temperature:	0° to 55°C (32° to 131°F)
Operating humidity:	Maximum of 85% relative humidity, non-condensing

Convection cooling
MBTF: 49,000 hours

DOCUMENTATION

460665-001	MS-NET User's Guide
460992-001	OpenNET PC Link2 Installation Guide
460763-001	iNA960 Programmer's Reference Manual
460857-001	iNA960 PC LINK Programmer's Reference Manual
450772-001	OpenNET PC LINK2 Hardware Reference Manual

IEEE 802.3/ETHERNET ACCESSORIES

iMDX457 Transceiver Cable 32.8 ft (10 m)
iMDX458 Transceiver Cable 164 ft (50 m)
DCM911-1 Intellink module
iMDX3015F Transceiver

ORDERING INFORMATION

PCLINK2

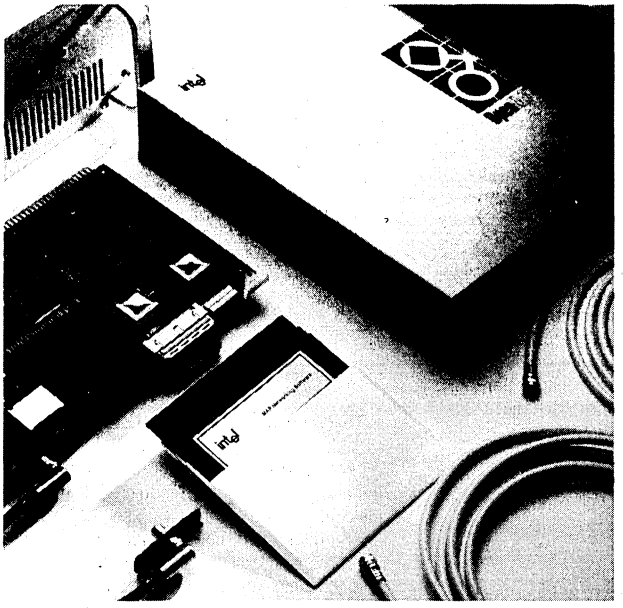
Intelligent Network interface adapter
Software:
- MS-NET,
- iNA960

PC/XT card support
Cable mounting hardware
MS-NET User's Guide
OpenNET PC Link2 Installation Guide

PCLINK2BD

Intelligent Network interface adapter
Software: iNA960rl
PC/XT card support
Cable mounting hardware
OpenNET PC Link2 Installation Guide

MAP NETWORKING SOFTWARE



COMPLETE SEVEN-LAYER SOLUTION FOR BUILDING MAP NETWORKING APPLICATIONS

Intel's MAP solution provides all seven layers of the industry-standard ISO/OSI Manufacturing Automation Protocol (MAP) for both Broadband and EtherNET® environments. Included are human and programming interfaces to Intel's iRMX® 86 and iRMX 286 real-time operating systems. The Intel MAP solution comes preconfigured or configurable, to allow you to change parameters as necessary. In addition Intel provides multiple implementation methods to get started with MAP. The software architecture allows an easy port to other custom operating systems.

STANDARD INTEL MAP-NET™ SOFTWARE FEATURES:

- Provides layers 3 through 7 of the industry-standard ISO/OSI Manufacturing Automation Protocol (MAP) local area network (LAN) for multi-vendor interoperability
- Provides a seven-layer turnkey solution for MAP Broadband
- Provides a seven-layer turnkey solution for developing "MAP" applications on an EtherNET network
- Choice of three implementation methods, including MAP on Broadband, "MAP" on EtherNET and the co-existence of Broadband and EtherNET networks
- Multiple application-layer functions, including CASE, FTAM, Directory Services and Network Management
- Human and programming interfaces for iRMX 286 and iRMX 86 real-time operating systems
- Modular architecture for easy configuration and implementation

intel

June, 1987
Order Number: 280614-001

THE INTEL MAP-NET™ TOOLKIT FOR DESIGNING NETWORKED FACTORY APPLICATIONS

The Intel MAP solution is comprised of three modules: MAP-NET™ 2.1 networking software, iNA 960 (R2.0) transport and network software, and the iSBC™ 554 MAP board. Together, these three modules provide all seven layers of the ISO/OSI reference model of the Manufacturing Automation Protocol, version 2.1. MAP-NET 2.1 software provides layers five through seven; iNA 960 provides layers three and four; and the iSBC 554 MAP board provides layers one and two (see Figure 1).

Intel's MAP software is easily configured for use on Intel's iSBC 554 (IEEE 802.4) and iSBC 552A (IEEE 802.3 or EtherNET) intelligent communication controllers. This configurability makes it possible to implement MAP applications on existing EtherNET cables on MAP Broadband cables, as well as to easily change parameters such as the number of virtual circuits. Since the application interface remains constant in both environments, you can migrate from one media to another without changing a single line of your application software. Intel MAP software is also available preconfigured, for quick and easy implementation.

Intel MAP software contains both human and programmatic interfaces for the iRMX 86 and 286 real-time operating systems. In addition, the software is designed with minimal dependence on the host operating system, so it can be ported easily to other operating environments.

MAP-NET™ APPLICATION LAYER FUNCTIONS

MAP-NET 2.1 software from Intel provides the following MAP application-layer functions:

- Common Application Service Elements (CASE)
- Application subsystem interface
- File Transfer, Access and Management (FTAM)
- Directory Services
- Network Management functions

The MAP-NET 2.1 Common Application Service Elements (CASE), built on top of the MAP-NET 2.1 Session Service, greatly simplify the use of network services provided by underlying MAP layers. The CASE service allows a process to make a connection request to a remote process by using only the names of the processes. MAP-NET CASE takes process names supplied by the user and resolves them into network addresses and identification using MAP-NET Directory Services.

Application Subsystem Interfaces. Intel's MAP products provide both human and programming interfaces to iRMX 86 (R7.0) and iRMX 286 (R2.0). This allows you to quickly exercise application-level functions from either a terminal or an application program. The software allows you to interface to other layers (for example, Transport or Data Link) for special application requirements. The application level interface to all layers of the reference model is the same.

File Transfer, Access and Management (FTAM). The FTAM software in MAP-NET 2.1 provides remote file transfer capability by providing the file request Initiator and Responder modules. The Initiator intercepts file commands from the local user and transmits them across the LAN to the Responder, which receives, interprets and executes the command. The FTAM server and consumer functions reside on-board on top of the session layer. The host-dependent file access interface is provided for iRMX 86 (R7.0) and iRMX 286 (R2.0).

Directory Services. The MAP-NET 2.1 directory services software maintains a database of network objects such as node names, user names and related properties, used to perform name-to-address conversions. For example, you might use Directory Services to store the name of a network user and his network address as the properties associated with his name. Another network user or application can then query the Directory Service to retrieve, add or delete information from this database.

Directory Services provide two methods of access, depending on the size of the host memory pool: Client Service Agent for local database, and Directory Service Agent for remote/master database.

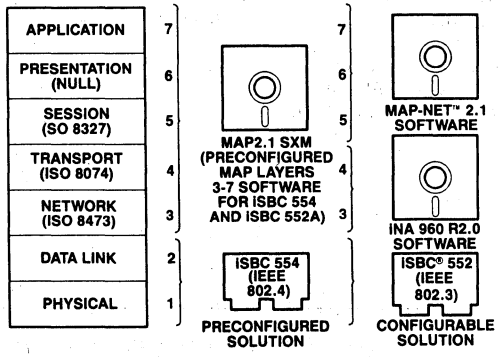


Figure 1: ISO/OSI Reference Model and Intel's MAP Products

Network Management Functions (NMF). The MAP-NET network management functions interface to the CASE, session, transport, network and data link layers. Three basic Net Management functions are provided: read net management object, set net management object, and event notification. The NMF can be configured as a net manager or as a net agent. The net manager interfaces with local or remote net agents in order to manage the entire network.

MAP-NET™ SESSION LAYER SERVICES

MAP-NET 2.1 provides all the ISO session services required by MAP 2.1. These session services are built on top of Intel's iNA 960 Transport service, providing ISO 8073 Transport (Class 4) and ISO 8473 network services.

In addition to supporting all the services provided by the underlying transport layer, the MAP-NET session layer provides "graceful close." This enables users to release a session connection without losing any outstanding requests. The "graceful close" feature complements the standard "abort" closure method.

TRANSPORT AND NETWORK LAYER SERVICES

Intel's iNA 960 R2.0 provides the ISO 8073 transport and ISO 8473 network services as required by MAP 2.1. iNA 960 R2.0 and the iSBC 554 Broadband controller board have successfully passed the MAP conformance tests conducted by the Industrial Technology Institute (ITI). Table 1 lists the services provided by iNA 960. For more information, please refer to the iNA 960 data sheet.

OPERATING SYSTEM ENVIRONMENT

Figure 2 shows the complete seven-layer Intel MAP solution. Once preconfigured MAP software is downloaded on the iSBC 554 or iSBC 552A board, the application interfaces on the host are used to communicate with the controller board. Messages are passed between the host and the communications controller via the MULTIBUS® Interface Protocol (MIP). The MIP is a reliable mechanism for processing message delivery protocols for MULTIBUS systems.

An implementation of the MIP protocol is provided on the iSBC 554 and iSBC 552A for communication with the host. A corresponding MIP/file access interface has to be provided on the host side for communication with the controller board.

The MIP/file access interface is available from Intel for the iRMX operating system and can be ported to other operating system environments.

PRECONFIGURED LAYERS 3-7 MAP 2.1 SOFTWARE

The MAP 2.1 preconfigured solution supports all seven layers on the iSBC 554 MULTIBUS-based board. The services supplied by this preconfigured software package are FTAM, Network Management functions, Directory Services, CASE, Session, Transport and Network layers. The preconfigured MAP software product is supplied with iRMX 86 and 286 device drivers, user interface utilities and the conformance-tested software. In addition, MAP-NET includes preconfigured software for both the iSBC 554 and iSBC 552A communication controllers.

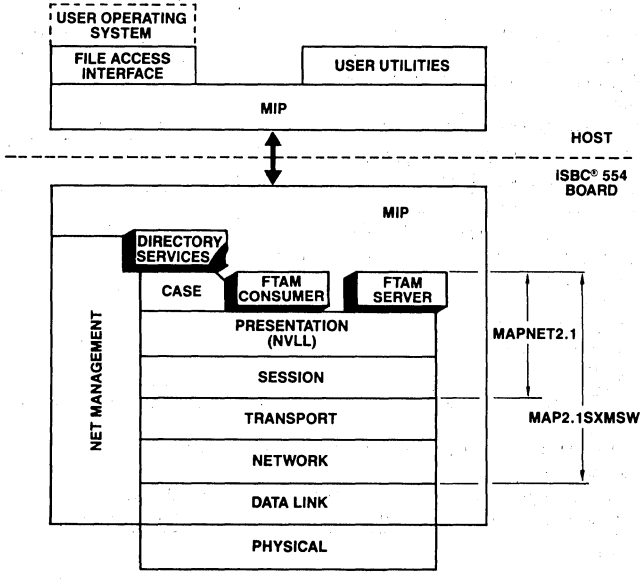


Figure 2: MAP-NET 2.1 User Interface

THREE WAYS TO GET STARTED WITH MAP

INTEL offers three methods for getting started with MAP: complete broadband MAP, MAP on EtherNET, and MAP broadband/EtherNET compatibility.

MAP Development Starter Kit. Intel's MAP Starter Kit allows you to begin learning and developing MAP broadband applications. This kit provides a low-cost, turnkey MAP development network with on-site installation and extended (12 months) software support to assist you during the application development cycle. The two node Starter Kit has been engineered to allow you to easily expand the network to eight nodes. Each node provides a complete seven-layer MAP solution, including network management, FTAM, Directory Services, CASE and application-level interfaces for all functions. The MAP Development Starter Kit documentation includes programming examples, a user's manual for layers five through seven, and a programmer's reference manual for layers three and four.

MAP application development on IEEE 802.3. "MAP on EtherNET" is intended for those users wanting to develop MAP-compatible software for use on existing EtherNET cables. When you install a broadband cable, you can migrate your EtherNET application to MAP broadband without changing a single line of code. That's because Intel's MAP software is configurable on both IEEE 802.3 and 802.4-based controllers, having the same programming interface. Preconfigured software for both the iSBC 554 (IEEE 802.4) and the iSBC 552A (IEEE 802.3) is available from Intel.

Co-existence of MAP and IEEE 802.3 networks. For existing 802.3 plant networks such as EtherNET, Intel provides the hardware and software needed to configure a "Router" to connect your existing network and MAP. The router hardware consists of the iSBC 554 and the iSBX 586 communications controllers for connection to a 10 MPBS 802.4 (MAP) and 802.3 (EtherNET) network, respectively. The inter-networking protocol is provided by Intel's preconfigured iNA 961 (R2.0); Intel's implementation of the ISO Internet and Transport layers.

Application	File Transfer, Access and Management (FTAM): provides remote operations on files (create, read, write, delete, get file attributes) Common Application Service Elements (CASE): supports all the services provided by the lower ISO layers; provides name to address translation support Directory Services: performs name to address conversion; maintains local cache of resolved names; two forms of Directory Service—client Service Agent for local data base and directory Service Agent for remote (master) data base
Presentation	Null
Session	Implements subset of ISO session 8327 specified by the MAP 2.1 specifications. Provides 'Graceful Close'; 'Graceful Close' allows the closing of a connection without any loss of queued requests; it enhances the transport provided 'Close' which aborts a connection
Transport	Virtual circuit open: establish a virtual circuit database; send connect: actively try to establish a virtual connection; await connect: passively awaits the arrival of a connection request; send: send a message; receive: post a buffer to receive a message; close: close a virtual circuit Datagram send: send a datagram message; receive: post a buffer to receive a datagram message
Network	Internetworking: routing between multiple lans; segmentation/reassembly; user defined routing tables Multiple subnets supported: user supplied; 802.3, 802.4
Data Link	Transmit: transmit a data link packet Receive: post a buffer to receive a data link packet Connect: make a data link logical connection (link service access point. IEEE802.4) Disconnect: disconnect a data link logical connection Change token bus address Add multicast address Delete multicast address Configure TBH
Network Management	Read/Clear/Set network objects (local/remote): read/clear/set local or remote MAP-NET/iNA 960 network parameters Read/Set network memory (local/remote): read/set memory of the local or a remote station; useful in network debug process Boot consumer: requests a network boot server to load a boot file into this station Echo: Echo a packet between this station and another remote station on the network

Table 1: iNA 960 Services

INTEL SUPPORT

Intel's MAP solution comes with full software support, including software updates and phone service for application development. Intel's MAP experts are never more than a phone call away. Intel application support includes regularly published hardware and software application articles, troubleshooting guides, responses to Software Problem Reports (SPRs), regular software and documentation updates, access to Intel's Insite User's Program Library and our Technical Information Phone Service (TIPS).

MAP software obtained from Intel requires the completion of an Intel Master Software License and may not be distributed in or outside your company.

ORDERING INFORMATION

HARDWARE

Part Number	Modem frequencies/channel pairs
iSBC 554-1	Transmit: 59.75 to 71.75 MHz/Ch. 3 and 4 Receive: 252 to 264 MHz/Ch. P and Q
iSBC 554-2	Transmit: 71.75 to 83.75 MHz/Ch. 4A and 5 Receive: 264 to 276 MHz/Ch. R and S
iSBC 554-3	Transmit: 83.75 to 95.75 MHz/Ch. 6 and FM1 Receive: 276 to 288 MHz/Ch. T and U

SOFTWARE

Code	Description
MAP21SXMRO	License for Map 2.1 layers 3-7 software preconfigured for iSBC 554 and 552 boards. Support for iRMX 86 (7.0) and iRMX 286 (2.0) operating systems.
MAP21SXMRF	Incorporates fee for preconfigurable MAP 2.1 layers 3-7 software. Media included with license only.
MAP-NET21RO	License for configurable MAP 2.1 layers 5-7 software.
MAP-NET21RF	Incorporates fee for preconfigurable MAP 2.1 layers 5-7 software. Media included with license only.
iNA 961 R2	Preconfigured transport and internet software for IEEE 802.3 to IEEE 802.4 router.
iNA 960 R2	Configurable MAP 2.1 layers 3-4 software

MAP KITS

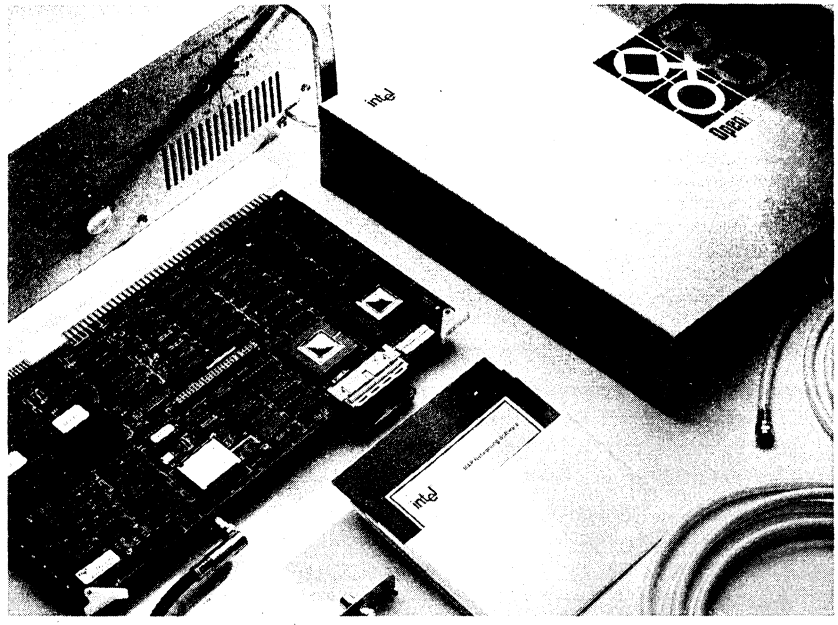
Kit name	Description
MAP310BBKIT	Two-node MAP broadband development starter kit for use with MULTIBUS I systems and iRMX 86 operating systems, languages and utilities (EMAPBBKIT -1, -3 for 240 VAC power).
MAPBBKIT -1, -3	Two-node MAP broadband development starter kit to retrofit with existing MULTIBUS I systems (EMAPBBKIT -1, -3 for 240 VAC power).
MAP554NODE- KIT -1, -3	MAP broadband node expansion kit.

AVAILABLE LITERATURE

MAP Network Development Starter Kits (order #280432-001)
iSBC/iSXM 552A Hardware Reference Manual (order #149228-001)
MAP-NET Programmers Reference Manual (contact your nearest Intel sales office)
iNA 960/961 Rel 2.0 Data Sheet (order #230777-003)
iSBC 554 Data Sheet (order #)
iSBC 552A Data Sheet (order #280385-001)
iNA 960 Release 2.0 Programmers Reference Manual (order #149231-001)
iNA 960 Release 2.0 Configuration Guide (order #149230-001)

CREDITS

MAP NETWORK DEVELOPMENT STARTER KITS



COMPLETE KITS FOR DEVELOPING MAP APPLICATIONS

The Manufacturing Automation Protocol (MAP) is a set of communication standards based on the seven-layer Open Systems Interconnection reference model from the International Standards Organization (ISO). MAP standards enable computers and other intelligent devices to work together in a multi-vendor factory setting.

The Intel MAP Development Starter Kit is a complete hardware/software/support kit for developing MAP applications, particularly at entry or pilot stages. In one package, from one vendor, you get all the broadband hardware, software, on-site installation and extended software support you need to establish a functional two-node MAP network and begin application development. The network can be easily expanded to support up to eight nodes.

The MAP Development Starter Kit includes two MAP Communications Boards (iSBC™ 554-X); a Head-End Remodulator; MAP communications software; a Cable Starter Kit containing coaxial cables, connectors, splitters, taps and terminators; complete documentation. Optional high-performance MULTIBUS® I based 310 systems and Real-Time Multitasking operating systems (RMX™), are available as hosts for the iSBC-554 Communications hardware.

FEATURES:

- Broadband hardware/software kit for application development and testing on a MAP Network
- Provides all seven layers of the ISO/OSI MAP protocol for multi-vendor interoperability.
- Preconfigured software with application level interfaces
- Support for iRMX® 86 and iRMX® 286 real-time operating systems
- Requires no special broadband expertise
- On-site installation for fast start-up
- 12-month software support for assistance during your development cycle, software updates, etc.

intel

June, 1987
Order Number: 280432-002

PREINTEGRATED SOFTWARE, ON-SITE INSTALLATION, AND EXTENDED SUPPORT ENSURES FAST START-UP

All components of the MAP Development Starter Kit have been fully integrated by Intel, so you don't have to. On-site installation means fast start-up, and a full year of software support implementation.

The MAP Development Starter Kit allows OEMs and end users to become quickly productive in understanding, evaluating and developing MAP applications using Intel's MAP networking products. The MAP Development Starter Kit is designed for applications experts who don't have time to become broadband experts. You need no broadband expertise whatsoever to implement, tune and calibrate a development MAP network from Intel. Instead, you concentrate on your application and let Intel worry about connectivity.

COMPLETE SEVEN-LAYER MAP IMPLEMENTATION

Intel's MAP Development Starter Kit provides all seven layers of the ISO MAP model, including network management functions and application-level interfaces. The iSBC 554 provides on-board execution of all seven MAP layers in compliance with MAP networking standards. The functions that execute on-board are:

- IEEE 802.4 Physical and Media Access Control (MAC) layers
- IEEE 802.2 Class 1 Logical Link Controller (LLC)
- ISO Internet Network Layer
- ICO Class IV Transport Layer
- ISO Session Kernel
- Common Application Service Elements (CASE)
- File Transfer, Access and Management (FTAM)
- Directory Services
- Network Management

Software for layers three through seven is preconfigured by Intel to execute on the iSBC 554 board and supports downloading of network protocols and services from a MULTIBUS host running the iRMX 86 or 286 operating system. For easy connection to your application, there are full application-level interfaces for CASE, FTAM, network management and directory services. Intel's MAP software allows you to access all seven layers, independently and asynchronously.

THE HEAD-END REMODULATOR

The Head-End Remodulator is a 19-inch rack-mountable unit that serves as the central transmission facility for your 10 MBPS MAP network. The Remodulator provides:

- Adjustable output level and input attenuation
- LEDs for power, carrier sense, and data detection
- Monitoring of output level for adjusting the transmit level and calibration

"HOW TO" DOCUMENTATION WRITTEN FOR THE APPLICATIONS ENGINEER

The MAP Development Starter Kit is geared toward the applications engineer, not the communications expert. Included as part of the kit are the MAP Starter Kit Guide, the MAP User's Guide for layers 5 through 7 and the Programmer's Reference Manual for the Transport and Network layers. A wealth of additional Intel manuals, data sheets and application notes on related Intel products are available for reference or additional reading.

FULL-YEAR SOFTWARE SUPPORT

The MAP Development Starter Kit comes with 12 months of extended software support, including software updates, and phone support for application development. Intel's software experts are never more than a phone call away. Intel's application support includes regularly published hardware and software application articles; troubleshooting guides; responses to Software Problem Reports (SPRs); regular software and documentation updates; access to Intel's Insite User's Program Library and our Technical Information Phone Service (TIPS).

SOFTWARE LICENSING

Software obtained with the MAP Development Starter Kit requires the completion of an Intel Master Software License and may not be distributed either within or outside your company.

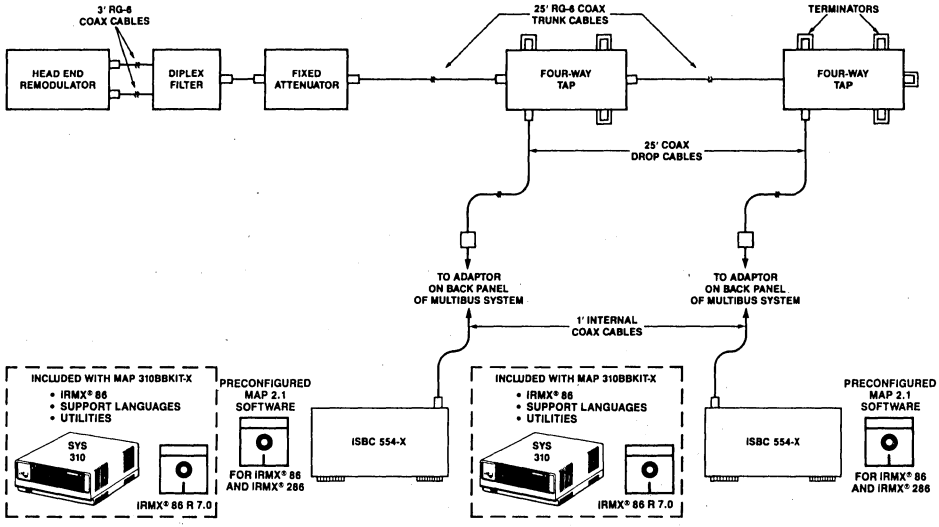


Figure 1: MAP Development Starter Kit—MAPBBKIT-1, -3

ORDERING INFORMATION

Part Number	Qty	Description
MAPBBKIT-X (X = 1 or 3)		Two-Node MAP Broadband Development Starter Kit To Retrofit with Existing MULTIBUS I Systems. Includes the following items:
	2	iSBC 554-X MAP Board with 10 MBPS, RF Modem For Layers 1 and 2. X = 1 Channel Pairs 3/4/P/Q X = 3 Channel Pairs 6/FM1/T/U
	1	License For Preconfigured Layers 3 To 7 MAP 2.1 Software (MAP21SXMRO). iRMX 86 and 286 based MAP software is included.
	2	Incorporation Fee For Layers 3 To 7 MAP 2.1 Software (MAP21SXMRF).
	1	Complete User Documentation MAP-NET™ User's Guide iNA 960 Programmer's Reference Manual MAP Starter Kit Guide
	1	19" Rack-Mountable 120 VAC Head-End Remodulator. (For a 240 VAC Head-End Remodulator order EMAPBBKIT-X).
	1	Starter Kit Network Cable Assembly*
	2	System 310 Internal Cable Assembly including the following items: 25 feet Coax Drop Cable, RG-6, for use between network tap and network node (2). 10 inches Coax Internal Cable, RG-6, for use between iSBC 554-X and Multibus System I/O panel adaptor (2). I/O Adaptor for Multibus System Back Panel (2).
		Note: 1. On-Site installation included. 2. Extended 12-Month MAP Software Support Included.
		Prerequisites: 1. Two Multibus based 310 systems 2. iRMX 86 (Release 7.0) or iRMX 286 with software support.

ORDERING INFORMATION (CONTINUED)

Part Number	Qty	Description
MAP310BBKIT-X (X = 1 or 3)		Two-Node MAP Broadband Development Starter Kit with Multibus Systems, iRMX 86 Operating System, Languages and utilities:
		Includes the following items:
	2	310-401 Multibus based systems including the following:
		System 310 Chassis — 320 KB Diskette Drive 40 MB Winchester Drive — 1 MB Memory
	1	iRMX 86 Operating System with Languages and utilities.
	3	iSBC 554-X MAP Board with 10 MBPS, RF Modem For Layers 1 and 2.
		X = 1 Channel Pairs 3′/4′/P/Q — X = 3 Channel Pairs 6′/FM1′/T/U
	1	License For Preconfigured Layers 3 To 7 MAP 2.1 Software (MAP21SXMRO). iRMX 86 and 286 based MAP software is included.
	2	Incorporation Fee For Layers 3 To 7 MAP 2.1 Software (MAP21SXMRF).
	1	Complete User Documentation
		MAP-NET User's Guide — MAP Starter Kit Guide iNA 960 Programmer's Reference Manual
	1	19″ Rack-Mountable 120 VAC Head-End Remodulator. (For a 240 VAC Head-End Remodulator order EMAP310BBKIT-X).
	1	Starter Kit Network Cable Assembly*
	2	System 310 Internal Cable Assembly including the following items:
		25 feet Coax Drop Cable, RG-6, for use between network tap and network node (2). 10 inches Coax Internal Cable, RG-6, for use between iSBC 554-X and Multibus System I/O panel adaptor (2). I/O Adaptor for Multibus System Back Panel (2).
		Note: 1. Appropriate Connectors included for all cables. 2. On-Site installation included. 3. Extended 12-Month MAP and iRMX 86 Software Support included.
Related Products		
MAP554NODEKIT-X (X = 1 or 3)		MAP Broadband Node Expansion Kit. Includes the following items:
	1	iSBC 554-X MAP Board with 10 MBPS, RF Modem For Layers 1 and 2. X = 1 Channel Pairs 3′/4′/P/Q X = 3 Channel Pairs 6′/FM1′/T/U
	1	Incorporation Fee For Layers 3 To 7 MAP 2.1 Software (MAP21SXMRF).
	1	25 feet Coax Drop Cable, RG-6, for use between network tap and network node.
	1	10 inches Coax Internal Cable, RG-6, for use between iSBC 554-X and Multibus System 310 I/O panel.
	1	I/O Adaptor for System 310 Back Panel
		Note: 1. Appropriate Connectors included for all cables. 2. Prior Purchase of License For Preconfigured MAP 2.1 Software Required (MAP21SXMRO).
		*Starter Kit Network Cable Assembly consists of: 25 feet RG-6 Coax Trunk Cables (2). 3 feet RG-6 Coax Cables between Head-End Remodulator and Diplex Filter (2). Diplex Filter (1). Four-Way Taps (2). 75 ohm Terminator for unused tap outputs (7). Fixed Attenuator (1).

WARRANTY INFORMATION

The MAP Communications Board (iSBC 554-X), Head-End Remodulator and Cable Starter Kit are covered by Intel's standard 90-day return-to-vendor warranty.

RELATED LITERATURE

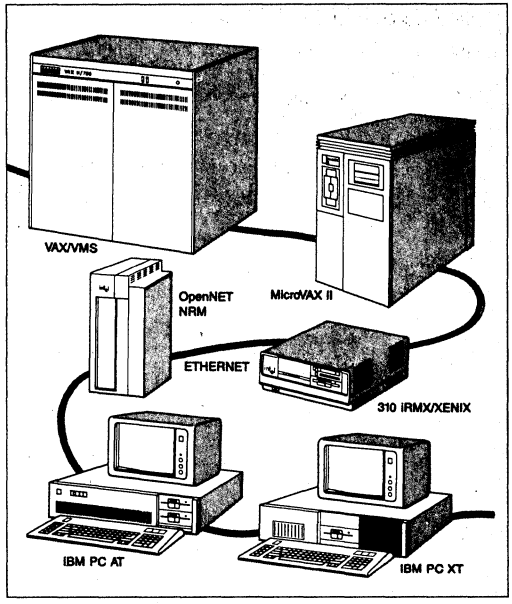
iSBC 554-X Data Sheet (Intel Order #231594-002)

iNA 960 Data Sheet (Intel Order #230777-003) for the Transport and Network Layers

iSBC 554-X Hardware Reference Manual (Intel Order #149229-001)

VAX/VMS* NETWORKING SOFTWARE
Member of the OpenNET™ Product Family

As a member of Intel's OpenNET™ family of network software, VAX/VMS* Networking software (VMSNET) lets you connect a VAX or MicroVAX II* system to other OpenNET systems. This includes the IBM PC AT, PC XT, Intel's OpenNET NRM (Network Resource Manager), NDS-II NRM (with the OpenNET upgrade kit installed), iRMX®, and XENIX* systems. VMSNET enables a (Micro)VAX system to be configured as a Server System on the OpenNET network, thus allowing any OpenNET Consumer workstation (iRMX, XENIX, MS-DOS) to transparently access files residing at remote (Micro)VAX systems. In addition, VMSNET supports bidirectional file transfer initiated from a (Micro)VAX to all other OpenNET servers.



Product Highlights

- Connects a VAX and MicroVAXII to the OpenNET Network
- Interoperation between VAX/VMS and MS-DOS, iRMX, XENIX, and iNDX systems over a Local Area Network (LAN)
- Conforms to the ISO-OSI networking standards
- Adheres to ISO 8073 Transport and Ethernet/IEEE 802.3 Standard Communication Protocols
- Uses 80186/82586 Processor-based Unibus and Qbus Network Controller Boards
- All data stored at the (Micro)VAX is visible to, and can be transparently accessed by, all consumer workstations on the OpenNET network
- Enables high speed file transfer/file copy between the (Micro)VAX and OpenNET workstations
- Compatible with DECnet*

OpenNET Overview

Intel's OpenNET product family incorporates a set of system and component level LAN products covering all seven layers of the ISO (International Standards Organization) Open Systems Interconnect (OSI) model, and the protocols on which they are based. OpenNET protocols are, whenever possible, established industry standards for each function. Therefore, OpenNET network products can interconnect and interoperate not only with each other, but with the other vendors' ISO-OSI based LANs. An OpenNET network provides a high level of interoperability between heterogenous systems: MS-DOS, VMS, iNDX, XENIX, and iRMX operating system versions are available. Thus, users can tailor their networks to meet their specific needs by incorporating any combination of these diverse systems.

*XENIX is a trademark of Microsoft Corporation. VAX/VMS, MicroVAX II, DECnet are trademarks of Digital Equipment Corp.

ORDER NUMBER 280329-001

Physical Description

The VAX/VMS Networking Software package consists of the appropriate network controller board and the software necessary for the (Micro)VAX to communicate over the OpenNET network. The following sections describe the hardware and software components of VMSNET.

VMSNET Hardware

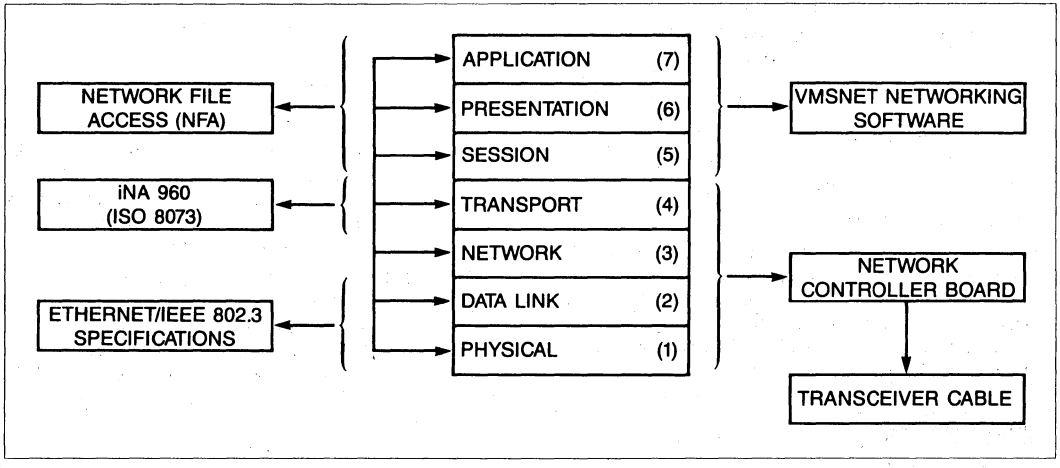
VMSNET comes with one of two types of Ethernet controller boards: a Unibus* board for the high-end VAX or a Qbus board for the MicroVAXII system. Both boards implement the industry standard ISO 8073 transport protocol and Ethernet/IEEE 802.3 physical data link technology. Both boards are high performance, intelligent communications controllers featuring onboard, dedicated Intel 80186/82586 processors which support layers 1 through 4 of the ISO OSI Reference Model. Thus, the Unibus and Qbus* boards perform the CPU tasks associated with lower layer LAN communications protocols, thereby freeing the (Micro)VAX host CPU to concentrate on applications requirements.

Power-up, self-test diagnostics are resident on both the Unibus and Qbus controller. Extended host resident diagnostics are also provided which can be loaded onto the boards to aid in problem resolution. In addition, appropriate internal cables, and chassis mounting hardware are included.

VMSNET Software

The software is supplied on either a 9 track magnetic tape (for high-end VAXs) or on both a TK50 cartridge tape and RX50 5¼-inch disk (for MicroVAXIIs). The following software components are included as part of the VAX/VMS networking software:

- A specially configured version of iNA 960 transport layer software which operates on the network controller boards
- A VMS interface driver which enables VMS programs to access the network controller board
- An implementation of the Network File Access (NFA) protocols (jointly developed by Intel, IBM, and Microsoft) which enables (Micro)VAX users to interoperate with other nodes on the OpenNET network



ISO-OSI VAX/VMS OpenNET Implementation

OpenNET, iRMX are trademarks of Intel Corporation.
* Unibus and Qbus are trademarks of Digital Equipment Corporation.

Functional Description

Transparent File Access

VMSNET provides transparent remote file access capability to the (Micro)VAX through a file server module. The server receives, interprets and executes the command acting as a user to its local file system. Consequently, a PC, iRMX, or XENIX user can work with data files and resources residing at the VAX as if they were resident on his/her system.

File Transfer

VMSNET also provides a set of file transfer utilities that allow (Micro)VAX users with the ability to transfer files that reside on other OpenNET server nodes to the (Micro)VAX or vice-versa. These utilities include copying files, deleting files, listing directories, and a help facility.

DECnet Access

VMSNET will allow consumer access to a file residing on DECnet nodes. The only protocol restriction is that the server will not allow file locking or compatibility mode opens on DECnet file access. The consumer may use logical names to define DECnet pathnames. For example, if "dev" is defined in login.com with an equivalence string of "isodev" user mypasswork"::dra 1[user]", the consumer can use "dev" as the first pathname component; the server will automatically use DECnet for the file access:

- net use vms //vms/user mypasswork
- lc //vms/dev
- cp //vms/dev/test.obj/usr/bin

Network Management

A set of network management utilities provide (Micro)VAX users with information and statistics of VMSNET along with the capability to control the execution of the VMSNET server and file transfer utility. To invoke the network utility, the user simply needs to type "NET" in response to the DCL (Digital Command Language) prompt.

Host Requirements

- VAX 750, 780, 782, 785
- VAX 8xxx family
- MicroVAXII
- (Micro)VMS operating system, version 4.2 or later

Physical Characteristics

Software

1. 9 track 1600 bpi magnetic tape
   or
2. TK50 cartridge tape and RX50 5¼-inch disk

Power Requirements

Unibus controller:	+5 vdc (±5%) at 4.5 amps typical, 6 amps maximum −15 vdc (±10%) at .5 amps, 3 amp surge
Qbus controller:	+5 vdc (±5%) at 6 amps typical +12 vdc (±10%) at .5 amps, 3 amp surge

Environmental Characteristics

Operating Temperature:	0° to 50°C (32° to 122°F)
Operating Humidity:	Maximum of 90% relative humidity, non-condensing
	Forced air cooling

Ordering Information

VMSNET	VAX/VMS Networking Software for installation on a high end VAX: consists of a Unibus network controller board with 256KB RAM, a 5 ft. and 10 ft. flat transceiver cables, software on a 9 track 1600 bpi magnetic tape, and an installation and user's guide.
MVMSNET	VAX/VMS Networking Software for installation on a MicroVAXII: consists of a Qbus network controller board with 256KB RAM, an 18 inch flat transceiver cable, software on both TK50 cartridge tape and RX50 5¼ inch disk, and an installation and user's guide.

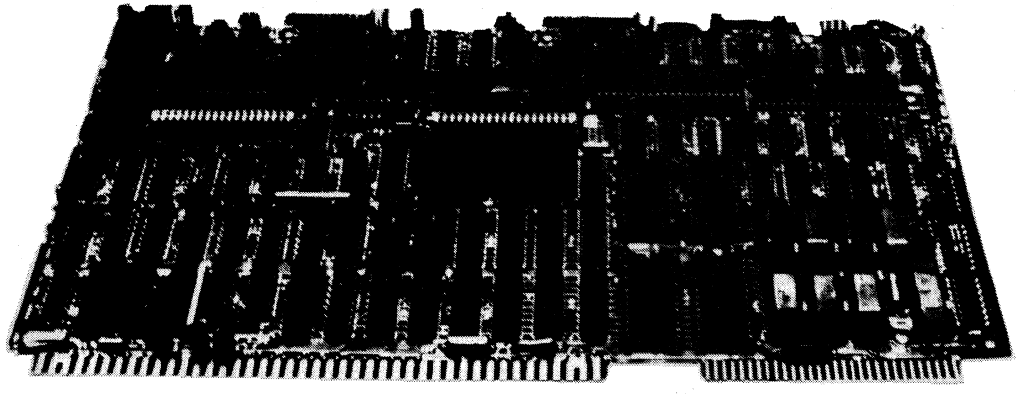
Serial Communication Boards and Software

12

iSBC® 88/45
ADVANCED DATA COMMUNICATIONS PROCESSOR BOARD

- **Three HDLC/SDLC Half/Full-Duplex Communication Channels—Optional ASYNC/SYNC on Two Channels**
- **Supports RS232C (Including Modem Support), CCITT V.24, or RS422A/449 Interfaces**
- **On-Board DMA Supports 800K Baud Operation**
- **Self-Clocking NRZI SDLC Loop Data Link Interface**
  - **— Point-to-Point**
  - **— Multidrop**
- **Software Programmable Baud Rate Generation**
- **8088 (8088-2) Microprocessor Operates at 8 MHz**
- **iSBC® 337 Numeric Data Processor Option Supported**
- **16K Bytes Static RAM (12K Bytes Dual-Ported)**
- **Four 28-Pin JEDEC Sites for EPROM/RAM Expansion; Four Additional 28-Pin JEDEC Sites Added with iSBC® 341 Board**
- **Two iSBX™ Bus Connectors**
- **MULTIBUS® Interface Supports Multimaster Configuration**

The iSBC 88/45 Advanced Data Communications Processor (ADCP) Board adds 8 MHz, 8088 (8088-2) 8-bit microprocessor-based communications flexibility to the Intel line of OEM microcomputer systems. The iSBC 88/45 ADCP board offers asynchronous, synchronous, SDLC, and HDLC serial interfaces for gateway networking or general purpose solutions. The iSBC 88/45 ADCP board provides the CPU, system clock, EPROM/RAM, serial I/O ports, priority interrupt logic, and programmable timers to facilitate higher-level application solutions.



210372-1

September 1987
Order Number: 210372-002

FUNCTIONAL DESCRIPTION

Three Communication Channels

Three programmable HDLC/SDLC serial interfaces are provided on the iSBC 88/45 ADCP board. The SDLC interface is familiar to IBM system and terminal equipment users. The HDLC interface is known by users of CCITT's X.25 packet switching interface.

One channel utilizes an Intel 8273 controller to manage the serial data transfers. Accepting the 8-bit data bytes from the local bus, the 8273 controller translates the data into the HDLC/SDLC format. The channel operates in half/full-duplex mode.

In addition to the synchronous mode, the 8273 controller operates asynchronously with NRZI encoded data which is found in systems such as the IBM 3650 Retail Store System. An SDLC loop configuration using iSBX 352 and iSBC 88/45 products is shown in Figure 1.

The two additional channels utilize the Intel 8274 Multi-Protocol Serial Controller (MPSC). The MPSC provides two independent half/full-duplex serial channels which provide asynchronous, synchronous, HDLC or SDLC protocol operations. The sync and async protocol operations are commonly used to communicate with inexpensive terminals and systems.

The three serial channels of the iSBC 88/45 ADCP board offer communications capability to manage a gateway application. The gateway application, as shown in Figure 1, manages diverse protocol requirements for data movement between channels. Typical protocol management software layers implemented by the user include SNA terminal interfaces to IBM systems.

On-Board DMA

For high-speed communications, one MPSC channel has a DMA capacity to support an 800K baud rate. The second channel attached to the MPSC is capable of simultaneous 800K baud operation when configured with DMA capability, but is connected to an RS232C interface which is defined as 20K baud maximum. Figure 2 shows an RS422A/449 multidrop application which supports high-speed operation.

Interfaces Supported

The iSBC 88/45 ADCP board provides an excellent foundation to support these electrical and diverse software drivers protocol interfaces. The control lines, serial data lines, and signal ground lines are brought out to the three double-edge connectors. Figure 3 shows the cable to connector construction. Two connectors are pre-configured for RS422A/449. All three channels are configurable for RS232C/CCITT V.24 interfaces as shown in Table 1.

Table 1. iSBC® 88/45 Supported Configurations

Connection	Synchronous		Asynchronous	
	Modem	Direct	Modem*	Direct
Point-to-Point	X**	X	X	X
Multidrop	X	X	X	X
Loop	N.A.	N.A.	C (Only)	C (Only)

*Modem should not respond to break.
**Channels A, B, and C denoted by X.

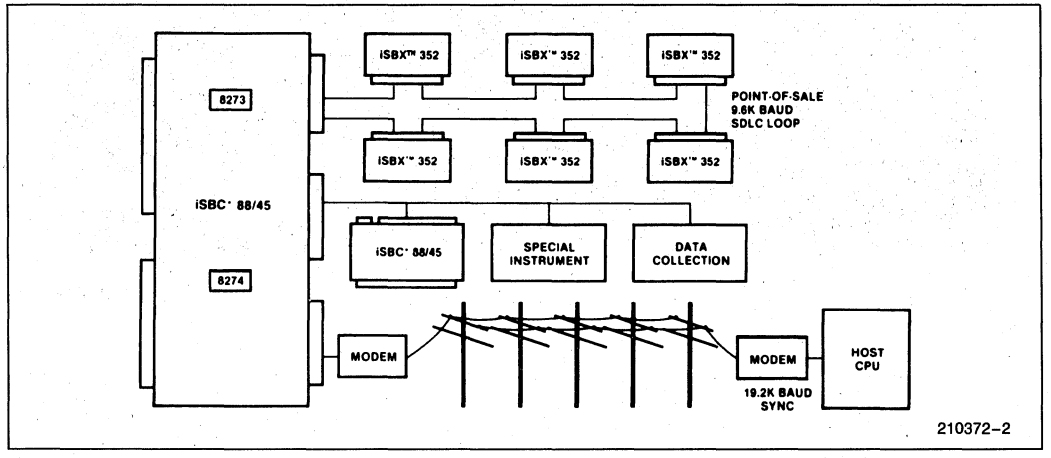
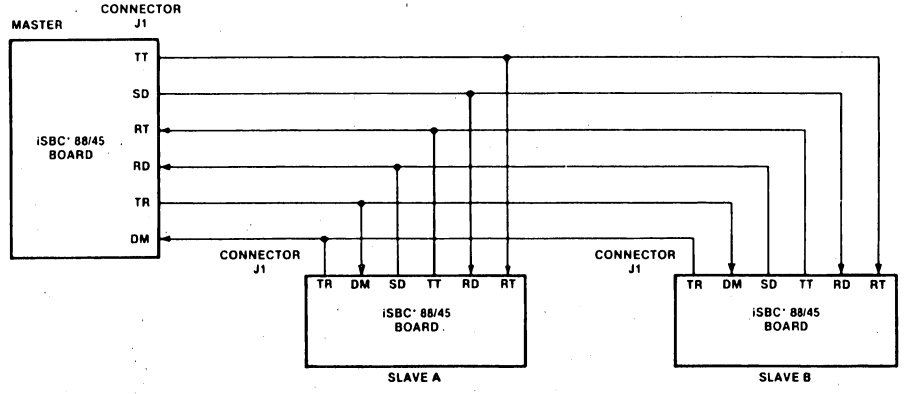


Figure 1. iSBC® 88/45 Gateway Processor Example



NOTE:
The last slave device in the system must contain termination resistors on all signal lines received by the slave board. The master device contains bias resistors on all signal lines.

Figure 2. Synchronous Multidrop Network Configuration Example—RS422A

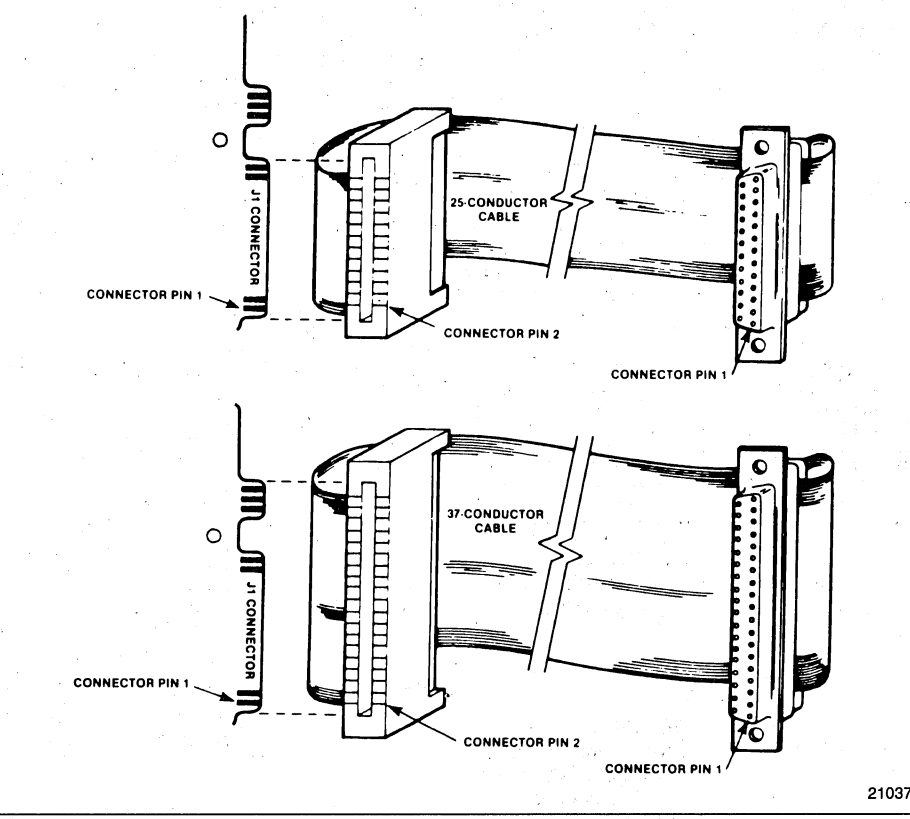


Figure 3. Cable Construction and Installation for RS232C and RS422A/449 Interface

Self Clocking Point-to-Point Interface

The iSBC 88/45 ADCP board is used in an asynchronous mode interface when configured as shown in Figure 4. The point-to-point RS232C example uses the self-clocking mode interface for NRZI encoding/decoding of data. The digital phase-lock loop allows operation of the interface in either half-duplex or full/duplex implementation with or without modems.

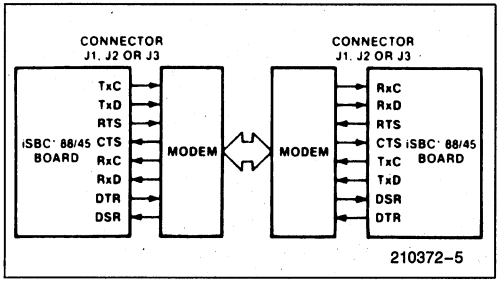


Figure 4. Self-Clocking or Asynchronous Point-to-Point Modem Interface Configuration Example—RS232C

Synchronous Point-to-Point Interface

Figure 5 shows a synchronous point-to-point mode of operation for the iSBC 88/45 ADCP board. This RS232C example uses a modem to generate the receive clock for coordination of the data transfer. The iSBC 88/45 ADCP board generates the transmit synchronizing clock for synchronous transmission.

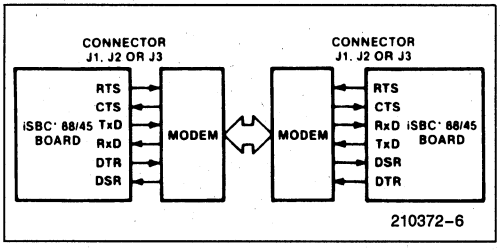


Figure 5. Synchronous Point-to-Point Modem Interface Configuration Example—RS232C

Central Processing Unit

The central processor for the iSBC 88/45 Advanced Data Communications Processor board is Intel's iAPX 8088 microprocessor operating at 8 MHz. The microprocessor interface to other functions is illustrated in Figure 6. The microprocessor architecture is designed to effectively execute the application and networking software written in higher-level languages.

This architectural support includes four 16-bit byte addressable data registers, two 16-bit memory base pointer registers and two 16-bit index registers. These registers are addressable through 24 different operand addressing modes for comprehensive memory addressing and for high-level language data structure manipulation.

The stack-oriented architecture readily supports Intel's iRMX executives and iMMX multiprocessing software. Both software packages are designed for modular application programming. Facilitating the fast inter-module communications, the 4-byte instruction queue supports program constructs needed for real-time systems.

Since programs are segmented between pure procedure and data, four segment registers (code, stack, data, extra) are available for addressing 1 megabyte of memory space. These registers contain the offset values used to address a 64K byte segment. The registers are controlled explicitly through program control or implicitly by high-level language functions and instructions.

The real-time system software can also utilize the programmable timers as shown in Table 2 and various interrupt control modes available on the ADCP board to have responsive and effective application solutions.

Table 2. Programmable Timer Functions

Function	Operation
Interrupt on Terminal Count	An interrupt is generated on terminal count being reached. This function is useful for generation of real-time clocks.
Rate Generator	Divide by N counter. Based on the input clock period, the output pulse remains low until the count is expired.
Square Wave Generator	Output remains high for one-half the count, goes low for the remainder of the count.
Software Triggered Strobe	Output remains high until count expires, then goes low for one clock period.

Numeric Data Processor Extension

The 8088 instruction set includes 8-bit and 16-bit signed and unsigned arithmetic operators for binary, BCD, and unpacked ASCII data. For enhanced numerics processing capability, the iSBC 337 MULTIMODULE Numeric Data Processor extends the 8088 architecture and data set.

The extended numerics capability includes over 60 numeric instructions offering arithmetic, trigonometric, transcendental, logarithmic, and exponential instructions. Many math-oriented applications utilize the 16-, 32-, and 64-bit integer, 32- and 64-bit floating point, 18-digit packed BCD, and 80-bit temporary data types.

16K Bytes Static Ram

The iSBC 88/45 ADCP board contains 16K bytes of high-speed static RAM, with 12K bytes dual-ported which is addressable from other MULTIBUS devices. When coupled with the high-speed DMA capability of the iSBC 88/45 ADCP board, the dual-ported memory provides effective data communication buffers. The dual-ported memory is useful for interprocessor message transfers.

Interrupt Capability

The iSBC 88/45 ADCP board provides nine vectored interrupt levels. The highest level is the NMI (Non-Maskable Interrupt) line. The additional eight interrupt levels are vectored via the Intel 8259A Programmable Interrupt Controller (PIC). As shown in Table 3, four priority processing modes are available to match interrupt servicing requirements. These modes and priority assignments are dynamically configurable by the system software.

Table 3. Programmable Interrupt Modes

Mode	Operation
Nested	Interrupt request line priorities fixed; interrupt 0 is the highest and 7 is the lowest.
Auto-Rotating	The interrupt priority rotates; once an interrupt is serviced it becomes the lowest priority.
Specific Priority	System software assigns lowest level priority. The other levels are sequenced based on the level assigned.
Polled	System software examines priority interrupt via interrupt status register.

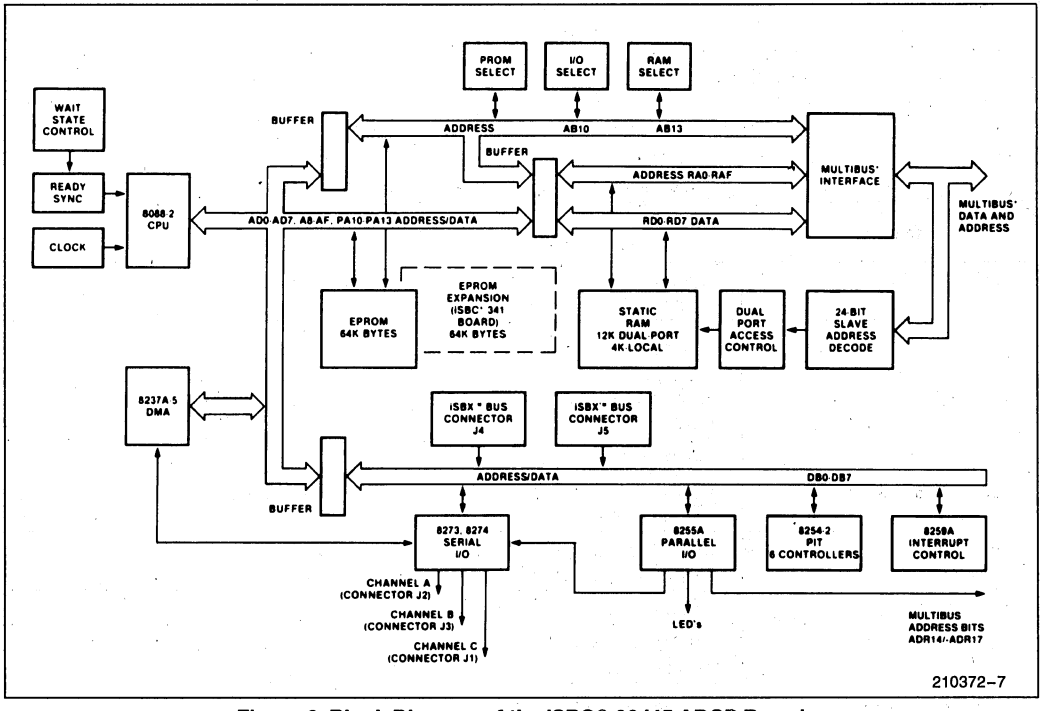


Figure 6. Block Diagram of the iSBC® 88/45 ADCP Board

Interrupt Request Generation

Listed in Table 4 are the devices and functions supported by interrupts on the iSBC 88/45 ADCP board. All interrupt signals are brought to the interrupt jumper matrix. Any of the 23 interrupt sources are strapped to the appropriate 8259A PIC request level. The PIC resolves requests according to the software selected mode and, if the interrupt is unmasked, issues an interrupt to the CPU.

EPROM/RAM Expansion

In addition to the on-board RAM, the iSBC 88/45 ADCP board provides four 28-pin JEDEC sockets for EPROM expansion. By using 2764 EPROMs, the board has 32K bytes of program storage. Three of the JEDEC standard sockets also support byte-wide static RAMs or iRAMs; using 8K x 8 static RAMs provides an additional 24K bytes of RAM.

Inserting the optional iSBC 341 MULTIMODULE EPROM expansion board onto the iSBC 88/45 ADCP board provides four additional 28-pin JEDEC sites. This expansion doubles the available program storage or extends the RAM capability by 32K bytes.

iSBX™ MULTIMODULE™ Expansion

Two 8-bit iSBX MULTIMODULE connectors are provided on the iSBC 88/45 microcomputer. Through these connectors, additional iSBX functions extend the I/O capability of the microcomputer. The iSBX connectors provide the necessary signals to interface to the local bus.

In addition to specialized or custom designed iSBX boards, the customer has a broad range of Intel iSBC MULTIMODULEs available, including parallel I/O, analog I/O, iEEE 488 GPIB, floppy disk, magnetic bubbles, video, and serial I/O boards.

The serial I/O MULTIMODULE boards include the iSBX 351 (one ASYNC/SYNC serial channel) the iSBX 352 (one HDLC/SDLC serial channel) and the iSBX 354 (two SYNC/ASYNC, HDLC/SDLC serial channels) boards. Adding two iSBX 352 MULTIMODULE boards to the iSBC 88/45 ADCP provides a total of five HDLC/SDLC channels.

MULTIBUS® Multimaster Capabilities

OVERVIEW

The MULTIBUS system is Intel's industry standard microcomputer bus structure. Both 8- and 16-bit single board computers are supported on the MULTIBUS structure with 24 address and 16 data lines. In addition to expanding functions contained on a single board computer (e.g., memory and digital I/O), the MULTIBUS structure allows very powerful distributed processing configurations with multiple processors, intelligent slaves, and peripheral boards.

Multimaster Capability

The iSBC 88/45 ADCP board provides full MULTIBUS arbitration control logic. This control

Table 4. Interrupt Request Sources

Device	Function	No. of Interrupts
MULTIBUS Interface	Select 1 interrupt from MULTIBUS resident peripherals or other CPU boards.	8
8273 HDLC/SDLC Controller	Transmit buffer empty and receive buffer full	2
8274 HDLC/SDLC SYNC/ASYNC Controller	Software examines register for status of communication operation	1
8254-Timer	Counter 2 of both PIT devices	2
iSBX Connectors	Function determined by iSBX MULTIMODULE Board (2 interrupts per socket)	4
Bus Fail Safe Timer	Indicates MULTIBUS addressed device has not responded to command within 4 msec	1
Power Line Clock	Source of 60 MHz signal from power supply	1
Bus Flag Interrupt	Flag interrupt in byte location 1000H signals board reset or data handling request	2
iSBC 337A Board	Numeric Data Processor generated status information	1
8237A-5	Signals end of 8237 DMA operation	1

logic allows up to three iSBC 88/45 ADCP boards or other bus masters, including iSBC 286, iSBC 86 and iSBC 86 family boards to share the system bus using a serial (daisy chain) priority scheme. By using an external parallel priority decoder, the MULTIBUS system bus could be shared among sixteen masters.

The Intel standard MULTIBUS Interprocessor Protocol (MIP) software, implemented as the Intel iMMX 800 package for iRMX 86 and iRMX 88 Real-Time Executives, fully supports multiple 8- and 16-bit distributed processor functions. The software manages the message passing protocol between microprocessors.

System Development Capabilities

The application development cycle for an iSBC 88/45 ADCP board is reduced and simplified through the usage of several Intel tools. The tools include the Intellec Series Microcomputer Development System, the ICE-88 In-Circuit Emulator, the iSDM 86 debug monitor software, and the iRMX 86 and iRMX 88 run-time support packages.

The Intellec Series Microcomputer Development System offers a complete development environment for the iSBC 88/45 software. In addition to the operating system, assembler, utilities and application debugger features provided with the system, the user optionally can utilize higher-level languages like PL/M, PASCAL, and FORTRAN.

The ICE-88 In-Circuit Emulator provides a link between the Intellec system and the target iSBC 88/45-based system for code loading and execution. The ICE-88 package assists the developer with the debugging and system integrating processes.

Run-Time Building Blocks

Intel offers run-time foundation software to support applications which range from general purpose to high-performance solutions. The iRMX 88 Real-time Multitasking Executive provides a multitasking structure which includes task scheduling, task management, intertask communications, and interrupt servicing for high-performance applications. The highly configurable modules make the system tailoring job easier whether one uses the compact executive or the complete executive with its variety of peripheral devices supported.

The iRMX 86 Operating System provides a very rich set of features and options to support sophisticated applications solutions. In addition to supporting real-time requirements, the iRMX 86 Operating System has a powerful, but easy-to-use human interface. When added to the sophisticated I/O system, the iRMX 86 Operating System is readily extended to support assembler, PL/M, PASCAL, and FORTRAN software development environments. The modular building block software lends itself well to customized application solutions.

SPECIFICATIONS

Word Size

Instruction: 8, 16, 24, or 32 bits
Data: 8 or 16 bits

System Clock

8 MHz: ±0.1%

NOTE:
Jumper selectable for 4 MHz operation with iSBC 337 Numeric Data Processor module or ICE-88 product.

Cycle Time

Basic Instruction Cycle at 8.00 MHz: 1.25 μs, 250 ns (assumes instruction in the queue)

NOTE:
Basic instruction cycle is defined as the fastest instruction time (i.e., two clock cycles).

Memory Cycle Time

RAM: 500 ns (no wait states)
EPROM: jumper selectable from 500 ns to 625 ns.

On-Board RAM*

K Bytes	Hex Address Range
16 (total)	0000–3FFF
12 (dual-ported)	1000–3FFF

*Four iSBC 88/45 EPROM sockets support JEDEC 24/28-pin standard EPROMs and RAMs (3 sockets); iSBC 341 (4 sockets)

Environmental Characteristics

Temperature: 0°C to +55°C, free moving air across the base board and MULTIMODULE board

Humidity: 90%, non-condensing

Physical Characteristics

Width: 30.48 cm (12.00 in)
Length: 17.15 cm (6.75 in)
Height: 1.50 cm (0.59 in)
Weight: 6.20 gm (22 oz)

Memory Capacity/Addressing

On-Board EPROM*

Device	Total K Bytes	Hex Address Range
2716	8	FE000-FFFFF
2732A	16	FC000-FFFFF
2764	32	F8000-FFFFF
27128	64	F0000-FFFFF

With optional iSBC® 341 MULTIMODULE™ EPROM

Device	Total K Bytes	Hex Address Range
2716	16	FC000-FFFFF
2732A	32	F8000-FFFFF
2764	64	F0000-FFFFF
27128	128	E0000-FFFFF

*Four iSBC 88/45 EPROM sockets support JEDEC 24/28-pin standard EPROMs and RAMs (static and iRAM, 3 sockets); iSBC 341 sockets also support EPROMs and RAMs.

Timer Input Frequency—8.00 MHz ±0.1%

Interfaces

iSBX™ Bus—All signals TTL compatible

Serial RS232C Signals—

CTS	CLEAR TO SEND
DSR	DATA SET READY
DTE TXC	TRANSMIT CLOCK
DTR	DATA TERMINAL READY
FG	FRAME GROUND
RTS	REQUEST TO SEND
RXC	RECEIVE CLOCK
RXD	RECEIVE DATA
SG	SIGNAL GROUND
TXD	TRANSMIT DATA

Serial RS422A/449 Signals—

CS	CLEAR TO SEND
DM	DATA MODE
RC	RECEIVE COMMON
RD	RECEIVE DATA
RS	REQUEST TO SEND
RT	RECEIVE TIMING
SC	SEND COMMON
SD	SEND DATA
SG	SIGNAL GROUND
TR	TERMINAL READY
TT	TERMINAL TIMING

Electrical Characteristics

DC Power Dissipation—28.3 Watts

DC Power Requirements

Configuration	Current Requirements (All Voltages ±5%) +5V	+12V	−12V
Without EPROM(1)	5.1A	20 mA	20 mA
With 8K EPROM (Using 2716)	+0.14A	—	—
With 16K EPROM (Using 2732A)	+0.20A	—	—
With 32K EPROM (Using 2764)	+0.24A	—	—
With 64K EPROM (Using 27128)	+0.24A	—	—

NOTE:
1. AS SHIPPED—no EPROMs in sockets, no iSBC 341 module. Configuration includes terminators for two RS422A/449 and one RS232C channels.

Serial Communication Characteristics

Channel	Device	Supported Interface	Max. Baud Rate
A	8274(1)	RS442A/449 RS232C CCITT V.24	800K SDLC/HDLC 125K Synchronous 50K Asynchronous
B	8274	RS232C CCITT V.24	125K Synchronous(2) 50K Asynchronous
C	8273(3)	RS442A/449 RS232C CCITT V.24	64K SDLC/HDLC(3) 9.6K SELF CLOCKING

NOTES:
1. 8274 supports HDLC/SDLC/SYNC/ASYNC multiprotocol
2. Exceed RS232C/CCITT V.24 rating of 20K baud
3. 8273 supports HDLC/SDLC

BAUD RATE EXAMPLES (Hz)

8254 Timer Divide Count N	Synchronous K Baud	Asynchronous ÷16 K Baud	÷32 K Baud	÷64 K Baud
10	800	50.0	25.0	12.5
26	300	19.2	9.6	4.8
31	256	16.1	8.06	4.03
52	154	9.6	4.8	2.4
104	76.8	4.8	2.4	1.2
125	64	4.0	2.0	1.0
143	56	3.5	1.7	0.87
167	48	3.0	1.5	0.75
417	19.2	—	—	—
833	9.6	—	—	—
EQUATION	$\frac{8{,}000{,}000}{N}$	$\frac{500K}{N}$	$\frac{250K}{N}$	$\frac{125K}{N}$

SERIAL INTERFACE CONNECTORS

Interface	Mode(1)	MULTIMODULE™ Edge Connector	Cable	Connector
RS232C	DTE	26-pin(4), 3M-3462-0001	3M(2)-3349/25	25-pin(6), 3M-3482-1000
RS232C	DCE	26-pin(4), 3M-3462-0001	3M(2)-3349/25	25-pin(6), 3M-3483-1000
RS449	DTE	40-pin(5), 3M-3464-0001	3M(3)-3349/37	37-pin(7), 3M-3502-1000
RS449	DCE	40-pin(5), 3M-3464-0001	3M(3)-3349/37	37-pin(7), 3M-3503-1000

NOTES:
1. DTE—Data Terminal Equipment Mode (male connector); DCE—Data Circuit Equipment mode (female connector) requires line swaps.
2. Cable is tapered at one end to fit the 3M-3462 connector.
3. Cable is tapered to fit 3M-3464 connector.
4. Pin 26 of the edge connector is not connected to the flat cable.
5. Pins 38, 39, and 40 of the edge connector are not connected to the flat cable.
6. May be used with the cable housing 3M-3485-1000.
7. Cable housing 3M-3485-4000 may be used wih the connector.

Line Drivers (Supplied)

Device	Characteristic	Qty	Installed
1488	RS232C	3	1
1489	RS232C	3	1
3486	RS422A	2	2
3487	RS422A	2	2

Reference Manual

143824—iSBC 88/45 Advanced Data Communications Processor Board Hardware Reference Manual (not supplied).

Reference manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051.

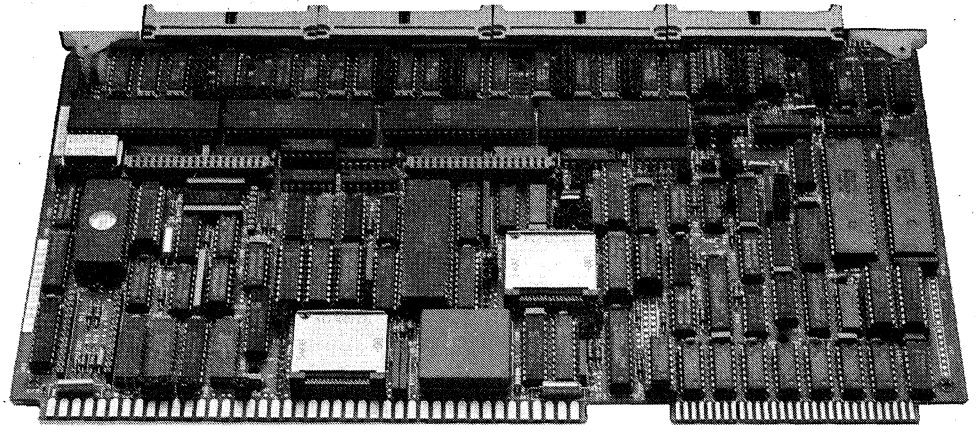
ORDERING INFORMATION

Part Number	Description
SBC 88/45	8-bit 8088-based Single Board Computer with 3 HDLC/SDLC serial channels

iSBC® 188/56
ADVANCED COMMUNICATING COMPUTER

- **iSBC® Single Board Computer or Intelligent Slave Communication Board**
- **8 Serial Communications Channels, Expandable to 12 Channels on a Single MULTIBUS® Board**
- **8 MHz 80188 Microprocessor**
- **Supports RS232C Interface on 6 Channels, RS422A/449 or RS232C Interface Configurable on 2 Channels**
- **Supports Async, Bisync HDLC/SDLC, On-Chip Baud Rate Generation, Half/Full-Duplex, NRZ, NRZI or FM Encoding/Decoding**
- **7 On-Board DMA Channels for Serial I/O, 2 80188 DMA Channels for the iSBX™ MULTIMODULE™ Board**
- **MULTIBUS Interface for System Expansion and Multimaster Configuration**
- **Two iSBX Connectors for Low Cost I/O Expansion**
- **256K Bytes Dual-Ported RAM On-Board**
- **Two 28-pin JEDEC PROM Sites Expandable to 6 Sites with the iSBC 341 MULTIMODULE Board for a Maximum of 192K Bytes EPROM**
- **Resident Firmware to Handle up to 12 RS232C Async Lines**

The iSBC 188/56 Advanced Communicating Computer (COMMputer™) is an intelligent 8-channel single board computer. This iSBC board adds the 8 MHz 80188 microprocessor-based communications flexibility to the Intel line of OEM microcomputer systems. Acting as a stand-alone CPU or intelligent slave for communication expansion, this board provides a high performance, low-cost solution for multi-user systems. The features of the iSBC 188/56 board are uniquely suited to manage higher-layer protocol requirements needed in today's data communications applications. This single board computer takes full advantage of Intel's VLSI technology to provide state-of-the-art, economic, computer based solutions for OEM communications-oriented applications.



280715-1

*IBM is a registered trademark of International Business Machines
*UNIX is a trademark of Bell Laboratories
*XENIX is a trademark of Microsoft Corporation

November 1986
Order Number: 280715-002

OPERATING ENVIRONMENT

The iSBC 188/56 COMMputer™ features have been designed to meet the needs of numerous communications applications. Typical applications include:

1. Terminal/cluster controller
2. Front-end processor
3. Stand-alone communicating computer

Terminal/Cluster Controller

A terminal/cluster controller concentrates communications in a central area of a system. Efficient handling of messages coming in or going out of the system requires sufficient buffer space to store messages and high speed I/O channels to transmit messages. More sophisticated applications, such as cluster controllers, also require character and format conversion capabilities to allow different types of terminals to be attached.

The iSBC 188/56 Advanced Communicating Computer is well suited for multi-terminal systems (see Figure 1). Up to 12 serial channels can be serviced in multi-user or cluster applications by adding two iSBX 354 MULTIMODULE boards. The dual-port RAM provides a large on-board buffer to handle incoming and outgoing messages at data rates up to 19.2K baud. Two channels are supported for continuous data rates greater than 19.2K baud. Each serial channel can be individually programmed for different baud rates to allow system configurations with differing terminal types. The firmware supplied on the iSBC 188/56 board supports up to 12 asynchronous RS232C serial channels, provides modem control and performs power-up diagnostics. The high performance of the on-board CPU provides intelligence to handle protocols and character handling typically assigned to the system CPU. The distribution of intelligence results in optimizing system performance by releasing the system CPU of routine tasks.

Front-End Processor

A front-end processor off-loads a system's central processor of tasks such as data manipulation and text editing of characters collected from the attached terminals. A variety of terminals require flexible terminal interfaces. Program code is often dynamically downloaded to the front-end processor from the system CPU. Downloading code requires sufficient memory space for protocol handling and program code. Flow control and efficient handling of interrupts require an efficient operating system to manage the hardware and software resources.

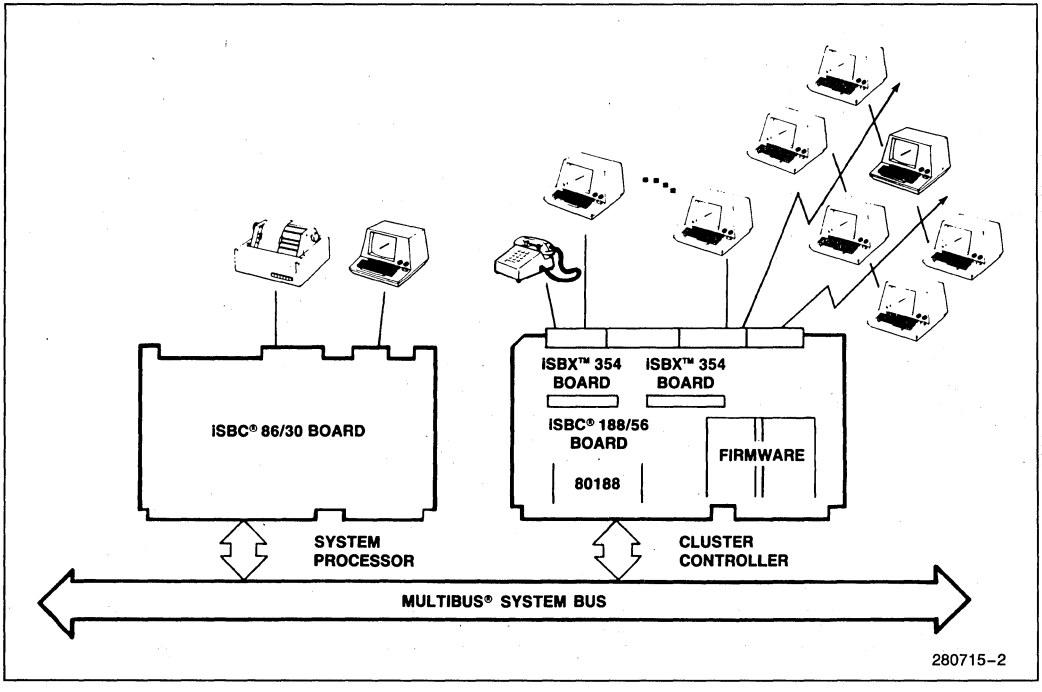


Figure 1. Terminal/Cluster Controller Application

The iSBC 188/56 board features are designed to provide a high performance solution for front-end processor applications (see Figure 2). A large amount of random access memory is provided for dynamic storage of program code. In addition, local memory sites are available for storing routine programs such as X.25, SNA or bisync protocol software. The serial channels can be configured for links to mainframe systems, point-to-point terminals, modems or multidrop configurations.

Stand-Alone COMMputer™ Application

A stand-alone communication computer is a complete computer system. The CPU is capable of managing the resources required to meet the needs of multi-terminal, multi-protocol applications. These applications typically require multi-terminal support, floppy disk control, local memory allocation, and program execution and storage.

To support stand-alone applications, the iSBC 188/56 COMMputer board uses the computational capabilities of an on-board CPU to provide a high-speed system solution controlling 8 to 12 channels of serial I/O (see Figure 3). The local memory available is large enough to handle special purpose code, execution code and routine protocol software.

The MULTIBUS interface can be used to access additional system functions. Floppy disk control and graphics capability can be added to the iSBC stand-alone computer through the iSBX connectors.

ARCHITECTURE

The four major functional areas are Serial I/O, CPU, Memory and DMA. These areas are illustrated in Figure 4.

Serial I/O

Eight HDLC/SDLC serial interfaces are provided on the iSBC 188/56 board. The serial interface can be expanded to 12 channels by adding 2 iSBX 354 MULTIMODULE boards. The HDLC/SDLC interface is compatible with IBM* system and terminal equipment and with CCITT's X.25 packet switching interface.

Four 82530 Serial Communications Controllers (SCC) provide eight channels of half/full duplex serial I/O. Six channels support RS232C interfaces. Two channels are RS232C/422/449 configurable and can be tri-stated to allow multidrop networks. The 82530 component is designed to satisfy several serial communications requirements; asynchronous,

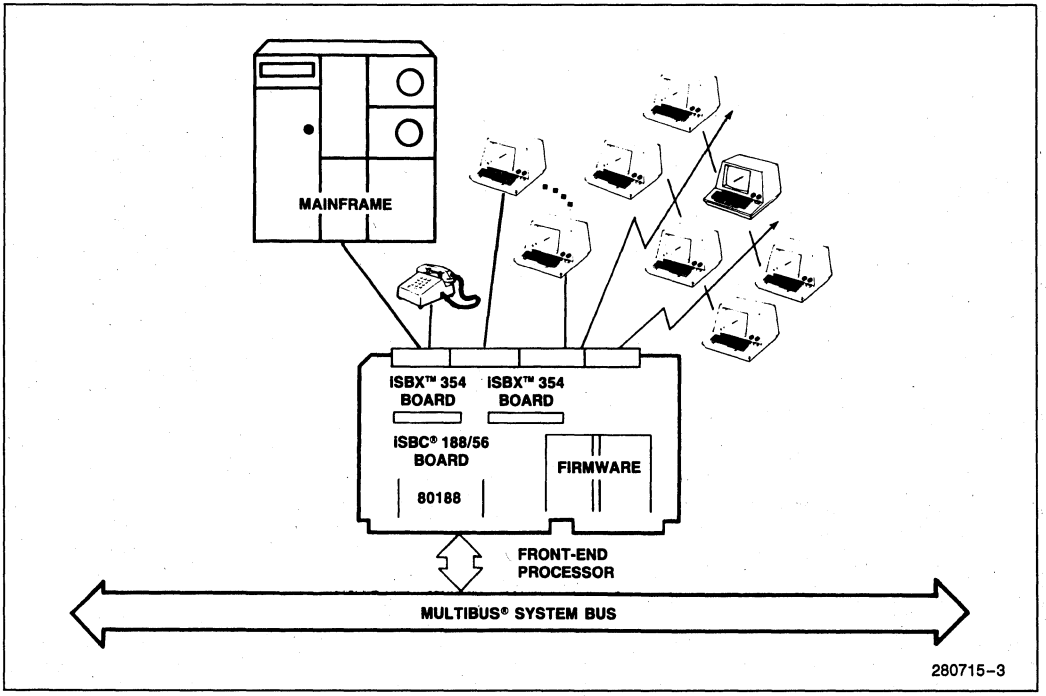


Figure 2. Front-End Processor Application

byte-oriented synchronous (HDLC/SDLC) modes. The increased capability at the serial controller point results in off-loading the CPU of tasks formerly assigned to the CPU or its associated hardware. Configurability of the 82530 allows the user to configure it to handle all asynchronous data formats regardless of data size, number of start or stop bits, or parity requirements. An on-chip baud rate generator allows independent baud rates on each channel.

The clock can be generated either internally with the SCC chip, with an external clock or via the NRZ1 clock encoding mechanism.

All eight channels can be configured as Data Terminal Equipment (DTE) or Data Communications Equipment (DCE). Table 1 lists the interfaces supported.

Table 1. iSBC® 188/56 Interface Support

Connection	Synchronous	Asynchronous
	Modem to Direct	Modem to Direct
Point-to-Point	X**	X
	Channels	Channels
Multidrop	0 and 1	0 and 1
Loop	X	N/A

**All 8 channels are denoted by X.

Central CPU

The 80188 central processor component provides high performance, flexibility and powerful processing. The 80188 component is a highly integrated microprocessor with an 8-bit data bus interface and a 16-bit internal architecture to give high performance. The 80188 is upward compatible with 86 and 186 software.

The 80188/82530 combination with on-board PROM/EPROM sites, and dual-port RAM provide the intelligence and speed to manage multi-user, multi-protocol communication operations.

Memory

There are two areas of memory on-board: dual-port RAM and universal site memory. The iSBC 188/56 board contains 256K bytes of dual-port RAM that is addressable by the 80188 on-board. The dual-port memory is configurable anywhere in a 16M byte address space on 64K byte boundaries as addressed from the MULTIBUS port. Not all of the 256K bytes are visible from the MULTIBUS bus side. The amount of dual-port memory visible to the

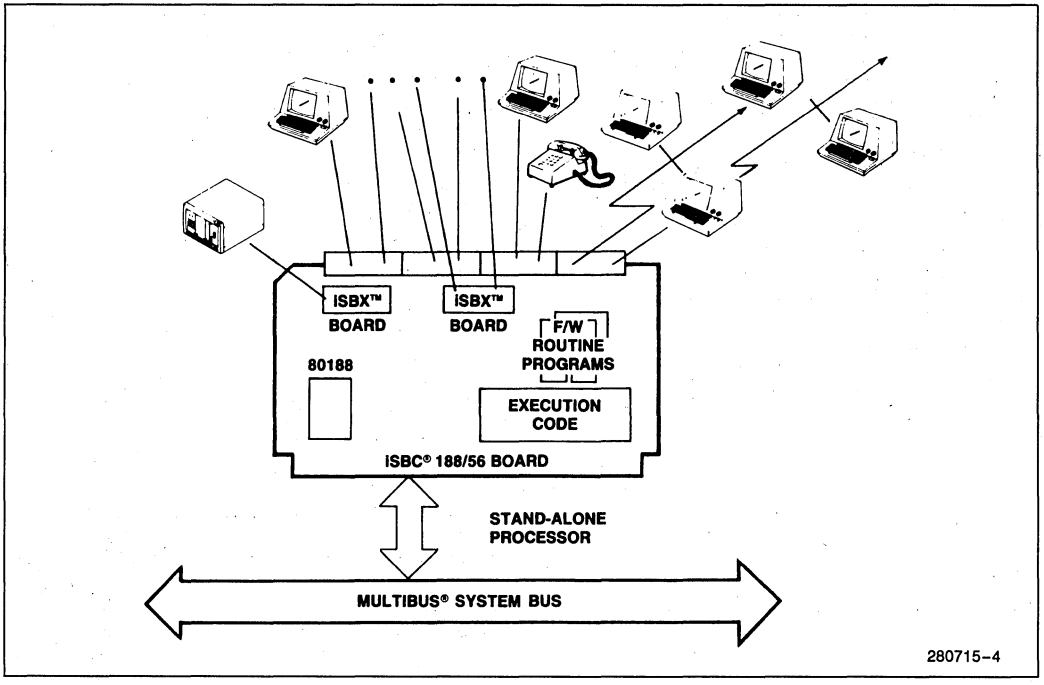


Figure 3. Stand-Alone COMMputer™ Application

MULTIBUS side can be set (with jumpers) to none, 16K bytes, or 48K bytes. In a multiprocessor system these features provide local memory for each processor and shared system memory configurations where the total system memory size can exceed one megabyte without addressing conflicts.

The second area of memory is universal site memory providing flexible memory expansion. Two 28-pin JEDEC sockets are provided. One of these sockets is used for the resident firmware as described in the FIRMWARE section.

The default configuration of the boards supports 16K byte EPROM devices such as the Intel 27128 component. However, these sockets can contain ROM, EPROM, Static RAM, or EEPROM. Both sockets must contain the same type of component (i.e. as the first socket contains an EPROM for the resident firmware, the second must also contain an EPROM with the same pinout). Up to 32K bytes can be addressed per socket giving a maximum universal site memory size of 64K bytes. By using the iSBC 341 MULTIMODULE board, a maximum of 192K bytes of universal site memory is available. This provides sufficient memory space for on-board network or resource management software.

On-Board DMA

Seven channels of Direct Memory Access (DMA) are provided between serial I/O and on-board dual port RAM by two 8237-5 components. Each of channels 0, 1, 2, 3, 5, 6, and 7 is supported by their own DMA line. Serial channels 0 and 1 are configurable for full duplex DMA. Configuring the full duplex DMA option for Channels 0 and 1 would require Channels 2 and 3 to be interrupt driven or polled. Channel 4 is interrupt driven or polled only.

Two DMA channels are integrated in the 80188 processor. These additional channels can be connected to the iSBX interfaces to provide DMA capability to iSBX MULTIMODULE boards such as the iSBX 218A Floppy Disk Controller MULTIMODULE board.

OPERATING SYSTEM SUPPORT

Intel offers run-time foundation software to support applications that range from general purpose to high-performance solutions.

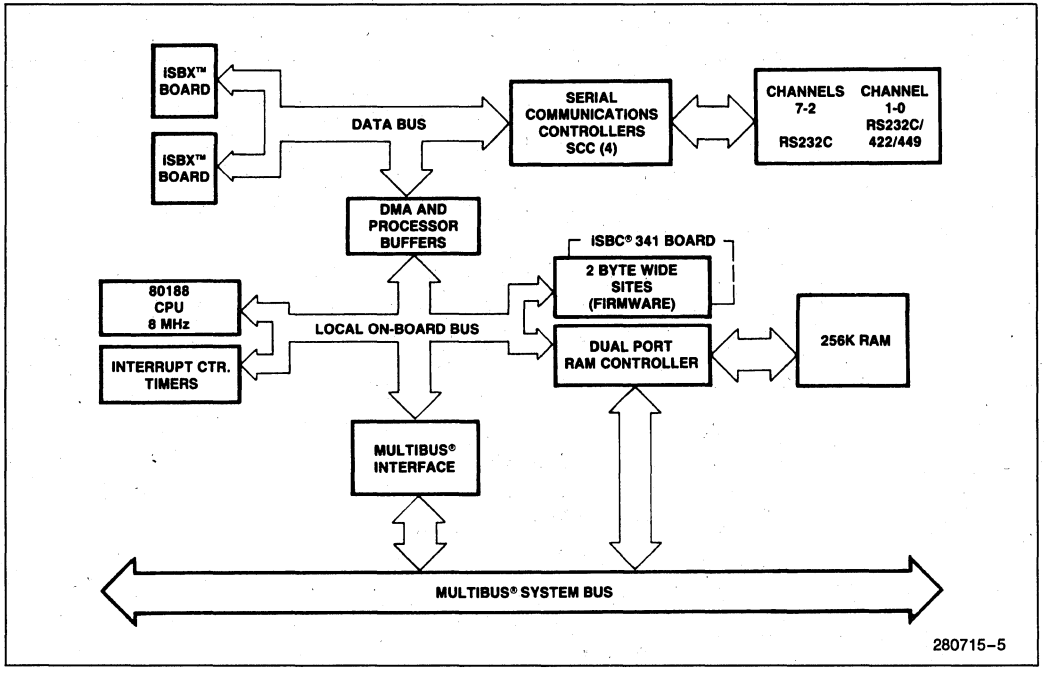


Figure 4. Block Diagram of iSBC® 188/56 Board

Release 6 of the iRMX 86 Operating System provides a rich set of features and options to support sophisticated stand-alone communications applications on the iSBC 188/56 Advanced Communicating Computer. In addition to supporting real-time requirements, the iRMX 86 Operating System Release 6 has a powerful, yet easy to use human interface. Services provided by the iRMX 86 Operating System include facilities for executing programs concurrently, sharing resources and information, servicing asynchronous events and interactively controlling system resources and utilities. The iRMX 86 Operating System is readily extended to support assembler, PL/M, PASCAL, and FORTRAN software development environments. The modular building block software lends itself well to customized application solutions. If the iSBC 188/56 board is acting as an intelligent slave in a system environment, an iRMX 86 driver resident in the host CPU can be written by following the examples in the manual "Guide to Writing Device Driven for iRMX 86 and iRMX 88 I/O Systems".

The iSDM™ 86 System Debug Monitor supports target system debugging for the iSBC 188/56 Advanced Communicating COMMputer board. The monitor contains the necessary hardware, software and documentation required to interface the iSBC 188/56 target system to an Intel microcomputer development system for debugging application software.

The XENIX* 286 Operating System, Release 3, is a fully licensed adaptation of the Bell Laboratories System III UNIX* Operating System. The XENIX system is an interactive, protected, multi-user, multitasking operating system with a powerful, flexible human interface. Release 3 of XENIX 286 includes a software driver for the iSBC 188/56 board (and up to two iSBX 354 MULTIMODULE Boards) acting as an intelligent slave for multi-user applications requiring multiple persons running independent, terminal-oriented jobs. Example applications include distributed data processing, business data processing, software development and engineering or scientific data analysis. XENIX 286 Release 3 Operating System services include device independent I/O, tree-structured file directory and task hierarchies, re-entrant/shared code and system accounting and security access protection.

Table 2. Features of the iSBC® 188/56 Firmware

Feature	Description
Asynchronous Serial Channel Support	Supports the serial channels in asynchronous ASCII mode. Parameters such as baud rate, parity generation, parity checking and character length can be programmed independently for each channel.
Block Data Transfer (On Output)	Relieves the host CPU of character-at-a-time interrupt processing. The iSBC 188/56 board accepts blocks of data for transmission and interrupts the processor only when the entire block is transmitted.
Limited Modem Control	Provides software control of the Data Terminal Ready (DTR) line on all channels. Transitions on the Carrier Detect (CD) line are sensed and reported to the host CPU.
Tandem Modem Support	Transmits an XOFF character when the number of characters in its receive buffer exceeds a threshold value and transmits an XON character when the buffer drains below some other threshold.
Download and Execute Capability	Provides a capability for the host CPU to load code anywhere in the address space of the iSBC 188/56 board and to start executing at any address in its address space.
Power Up Confidence Tests	On board reset, the firmware executes a series of simple tests to establish that crucial components on the board are functional.

FIRMWARE

The iSBC 188/56 Communicating COMMputer board is supplied with resident firmware that supports up to 12 RS232C asynchronous serial channels. In addition, the firmware provides a facility for a host CPU to download and execute code on the iSBC 188/56 board. Simple power-up confidence tests are also included to provide a quick diagnostic service. The firmware converts the iSBC 188/56 COMMputer board to a slave communications controller. As a slave communications controller, it requires a separate MULTIBUS host CPU board and requires the use of MULTIBUS interrupt line to signal the host processor. Table 2 summarizes the features of the firmware.

INTERRUPT CAPABILITY

The iSBC 188/56 board has two programmable interrupt controllers (PICs). One is integrated into the 80188 processor and the other in the 80130 component. The two controllers are configured with the 80130 controller as the master and the 80188 controller as the slave. Two of the 80130 interrupt inputs are connected to the 82530 serial controller components to provide vector interrupt capabilities by the serial controllers. The iSBC 188/56 board provides 22 interrupt levels. The highest level is the NMI (Non-Maskable Interrupt) line which is directly tied to the 80188 CPU. This interrupt is typically used for signaling catastrophic events (e.g. power failure). There are 5 levels of interrupts internal to the 80188 processor. Another 8 levels of interrupts are available from the 80130 component. Of these 8, one is tied to the programmable interrupt controller (PIC) of the 80188 CPU. An additional 8 levels of interrupts are available at the MULTIBUS interface. The iSBC 188/56 board does not support bus vectored interrupts. Table 3 lists the possible interrupt sources.

Table 3. Interrupt Request Sources

Device	Function	Number of Interrupts
MULTIBUS Interface INT0–INT7	Requests from MULTIBUS resident peripherals or other CPU boards.	8
82530 Serial Controllers	Transmit buffer empty, receive buffer full and channel errors 1 and external status.	8 per 82530 Total = 32
Internal 80188 Timer and DMA	Timer 0, 1, 2 outputs and 2 DMA channel interrupts.	5
80130 Timer Outputs	Timer 0, 1, 2 outputs of 80130.	3
Interrupt from Flag Byte Logic	Flag byte interrupt set by MULTIBUS master (through MULTIBUS® I/O Write).	1
Bus Flag Interrupt	Interrupt to MULTIBUS® (Selectable for INT0 to INT7) generated from on-board 80188 I/O Write.	1
iSBX Connectors iSBX DMA	Function determined by iSBX MULTIMODULE board. DMA interrupt from iSBX (TDMA).	4 (Two per Connector) 2
Bus Fail-Safe Timeout Interrupt.	Indicates iSBC 188/48 board timed out either waiting for MULTIBUS access or timed out from no acknowledge while on MULTIBUS System Bus.	1
Latched Interrupt	Converts pulsed event to a level interrupt. Example: 8237A-5 EOP.	1
OR-Gate Matrix	Concentrates up to 4 interrupts to 1 interrupt (selectable by stake pins).	1
Ring Indicator Interrupt	Latches a ring indicator event from serial channels 4, 5, 6, or 7.	1
NOR-Gate Matrix	Inverts up to 2 interrupts into 1 (selectable by stake pins).	1

SUPPORT FOR THE 80130 COMPONENT

Intel does not support the direct processor execution of the iRMX nucleus primitives from the 80130 component. The 80130 component provides timers and interrupt controllers.

EXPANSION

EPROM Expansion

Memory may be expanded by adding Intel compatible memory expansion boards. The universal site memory can be expanded to six sockets by adding the iSBC 341 MULTIMODULE board for a maximum total of 192K bytes of universal site memory.

iSBX™ MULTIMODULE™ Expansion Module

Two 8-bit iSBX MULTIMODULE connectors are provided on the iSBC 188/56 board. Using iSBX modules additional functions can be added to extend the I/O capability of the board. In addition to specialized or custom designed iSBX boards, there is a broad range of iSBX MULTIMODULE boards from the Intel including parallel I/O, analog I/O, IEEE 488 GPIB, floppy disk, magnetic bubbles, video and serial I/O boards.

The serial I/O MULTIMODULE boards available include the iSBX 354 Dual Channel Expansion MULTIMODULE board. Each iSBX 354 MULTIMODULE board adds two channels of serial I/O to the iSBC 188/56 board for a maximum of twelve serial channels. The 82530 serial communications controller on the MULTIMODULE board handles a large variety of serial communications protocols. This is the same serial controller as is used on the iSBC 188/56 board to offer directly compatible expansion capability for the iSBC 188/56 COMMputer board.

MULTIBUS® INTERFACE

The iSBC 188/56 Advanced COMMputer board can be a MULTIBUS master or intelligent slave in a multimaster system. The iSBC 188/56 board incorporates a flag byte signalling mechanism for use in multiprocessor environments where the iSBC 188/56 board is acting as an intelligent slave. The mechanism provides an interrupt handshake from the MULTIBUS System Bus to the on-board-processor and vice-versa.

The Multimaster capabilities of the iSBC 188/56 board offers easy expansion of processing capacity and the benefits of multiprocessing. Memory and I/O capacity may be expanded and additional functions added using Intel MULTIBUS compatible expansion boards.

SPECIFICATIONS

Word Size

Instruction—8, 16, 24 or 32 bits
Data Path—8 bits

Processor Clock	82530 Clock	DMA Clock
8 MHz	4.9152 MHz	4 MHz

Dual Port RAM

iSBC 188/56 Board—256 bytes

As viewed from the 80188—64K bytes

As viewed from the MULTIBUS System Bus—Choice: 0, 16K or 48K

EPROM

iSBC® 188/56 Board Using:	Size	On Board Capacity	Address Range
2732	4K	8K bytes	FE000–FFFFF$_H$
2764	8K	16K bytes	FC000–FFFFF$_H$
27128	16K	32K bytes	F8000–FFFFF$_H$
27256	32K	64K bytes	F0000–FFFFF$_H$
27512	64K	128K bytes	E0000–FFFFF$_H$

Memory Expansion

EPROM with iSBC® 341 Board Using:	Capacity	Address Range
2732	24K bytes	F8000–FFFFF$_H$
2764	48K bytes	F0000–FFFFF$_H$
27128	96K bytes	E0000–FFFFF$_H$
27256	192K bytes	C0000–FFFFF$_H$

I/O Capacity

Serial—8 programmable lines using four 82530 components

iSBX MULTIMODULE—2 iSBX single-wide boards

Serial Communications Characteristics

Synchronous—Internal or external character synchronization on one or two synchronous characters

Asynchronous—5–8 bits and 1, 1½, or 2 stop bits per character; programmable clock factor; break detection and generation; parity, overrun, and framing error detection.

Baud Rates

Synchronous X1 Clock	
Baud Rate	**82530 Count Value (Decimal)**
64000	36
48000	49
19200	126
9600	254
4800	510
2400	1022
1800	1363
1200	2046
300	8190
Asynchronous X16 Clock	
Baud Rate	**82530 Count Value (Decimal)**
19200	6
9600	14
4800	30
2400	62
1800	83
1200	126
300	510
110	1394

Interfaces

iSBX™ BUS

The iSBC 188/56 board meets iSBX compliance level D8/8 DMA

MULTIBUS® SYSTEM BUS

The iSBC 188/56 board meets MULTIBUS compliance level Master/Slave D8 M24 I16 VO EL.

SERIAL RS232C SIGNALS

CD	Carrier
CTS	Clear to Send
DSR	Data Set Ready
DTE TXC	Transmit Clock
DTR	Data Terminal Ready
RTS	Request to Send
RXC	Receive Clock
RXD	Receive Data
SG	Signal Ground
TXD	Transmit Data
RI	Ring Indicator

RS422A/449 SIGNALS

RC	Receive Common
RD	Receive Data
RT	Receive Timing
SD	Send Data
TT	Terminal Timing

Environmental Characteristics

Temperature: 0 to 55°C at 200 Linear Feet/Min. (LFM) Air Velocity

Humidity: to 90%, non-condensing (25°C to 70°C)

Physical Characteristics

Width: 30.48 cm (12.00 in)
Length: 17.15 cm (6.75 in)
Height: 1.04 cm (0.41 in)
Weight: 595 gm (21 oz)

Electrical Characteristics

The power required per voltage for the iSBC 188/56 board is shown below. These numbers do not include the current required by universal memory sites or expansion modules.

Voltage (Volts)	Current (Amps) typ.	Power (Watts) typ.
+5	4.56A	22.8W
+12	0.12A	1.5W
−12	0.11A	1.3W

Reference Manual

iSBC 188/56 Advanced Data Communications Computer Reference Manual Order Number 148209-001.

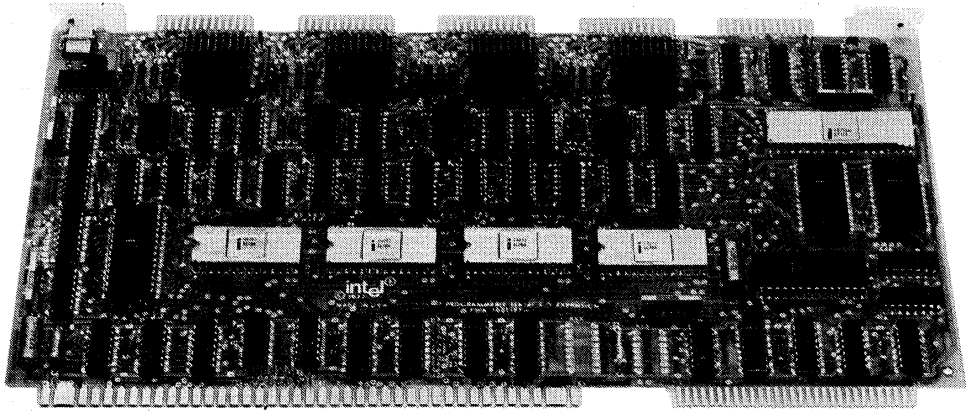
ORDERING INFORMATION

Part Number	Description
iSBC 188/56	8-Serial Channel Advanced Communicating Computer

iSBC® 534
FOUR CHANNEL COMMUNICATION EXPANSION BOARD

- **Serial I/O Expansion Through Four Programmable Synchronous and Asynchronous Communications Channels**
- **Individual Software Programmable Baud Rate Generation for Each Serial I/O Channel**
- **Two Independent Progammable 16-Bit Interval Timers**
- **Sixteen Maskable Interrupt Request Lines with Priority Encoded and Programmable Interrupt Algorithms**
- **Jumper Selectable Interface Register Addresses**
- **16-Bit Parallel I/O Interface Compatible with Bell 801 Automatic Calling Unit**
- **RS232C/CCITT V.24 Interfaces Plus 20 mA Optically Isolated Current Loop Interfaces (Sockets)**
- **Programmable Digital Loopback for Diagnostics**
- **Interface Control for Auto Answer and Auto Originate Modems**

The iSBC 534 Four Channel Communication Expansion Board is a member of Intel's complete line of memory and I/O expansion boards. The iSBC 534 interfaces directly to any single board computer via the MULTIBUS to provide expansion of system serial communications capability. Four fully programmable synchronous and asynchronous serial channels with RS232C buffering and provision for 20 mA optically isolated current loop buffering are provided. Baud rates, data formats, and interrupt priorities for each channel are individually software selectable. In addition to the extensive complement of EIA Standard RS232C signals provided, the iSBC 534 provides 16 lines of RS232C buffered programmable parallel I/O. This interface is configured to be directly compatible with the Bell Model 801 automatic calling unit. These capabilities provide a flexible and easy means for interfacing Intel iSBC based systems to RS232C and optically isolated current loop compatible terminals, cassettes, asynchronous and synchronous modems, and distributed processing networks.



280238-1

November 1986
Order Number: 280238-001

FUNCTIONAL DESCRIPTION

Communications Interface

Four programmable communications interfaces using Intel's 8251A Universal Synchronous/Asynchronous Receiver/Transmitter (USART) are contained on the board.* Each USART can be programmed by the system software to individually select the desired asynchronous or synchronous serial data transmission technique (including IBM Bisync). The mode of operation (i.e., synchronous or asynchronous), data format, control character format, parity, and baud rate are all under program control. Each 8251A provides full duplex, double buffered transmit and receive capability. Parity, overrun, and framing error detection are all incorporated in each USART. Each set of RS232C command lines, serial data lines, and signal ground lines are brought out to 26-pin edge connectors that mate with RS232C flat or round cables.

16-Bit Interval Timers

The iSBC 534 provides six fully programmable and independent BCD and binary 16-bit interval timers utilizing two Intel 8253 programmable interval timers.* Four timers are available to the systems designer to generate baud rates for the USARTs under software control. Routing for the outputs from the other two counters is jumper selectable. Each may be independently routed to the programmable interrupt controller to provide real time clocking or to the USARTs (for applications requiring different transmit and receive baud rates). In utilizing the iSBC 534, the systems designer simply configures, via software, each timer independently to meet system requirements. Whenever a given baud rate or time delay is needed, software commands to the programmable timers select the desired function. Three functions of these timers are supported on the iSBC 534, as shown in Table 1. The contents of each counter may be read at any time during system operation.

Table 1. Programmable Timer Functions

Function	Operation
Interrupt on terminal count	When terminal count is reached an interrupt request is generated. This function is used for the generation of real-time clocks.
Rate generator	Divide by N counter. The output will go low for one input clock cycle and high for N−1 input clock periods.
Square wave rate generator	Output will remain high for one-half the count and low for the other half of the count.

Interrupt Request Lines

Two independent Intel 8259A programmable interrupt controllers (PIC's) provide vectoring for 16 interrupt levels.* As shown in Table 2, a selection of three priority processing algorithms is available to the system designer. The manner in which requests are serviced may thus be configured to match system requirements. Priority assignments may be reconfigured dynamically via software at any time during system operation. Any combination of interrupt levels may be masked through storage, via software, of a single byte to the interrupt mask register of each PIC. Each PIC's interrupt request output line may be jumper selected to drive any of the nine interrupt lines on the MULTIBUS.

Table 2. Interrupt Priority Options

Algorithm	Operation
Fully nested	Interrupt request line priorities fixed at 0 as highest, 7 as lowest.
Auto-rotating	Equal priority. Each level, after receiving service, becomes the lowest priority level until next interrupt occurs.
Specific priority	System software assigns lowest priority level. Priority of all other levels based in sequence numerically on this assignment.

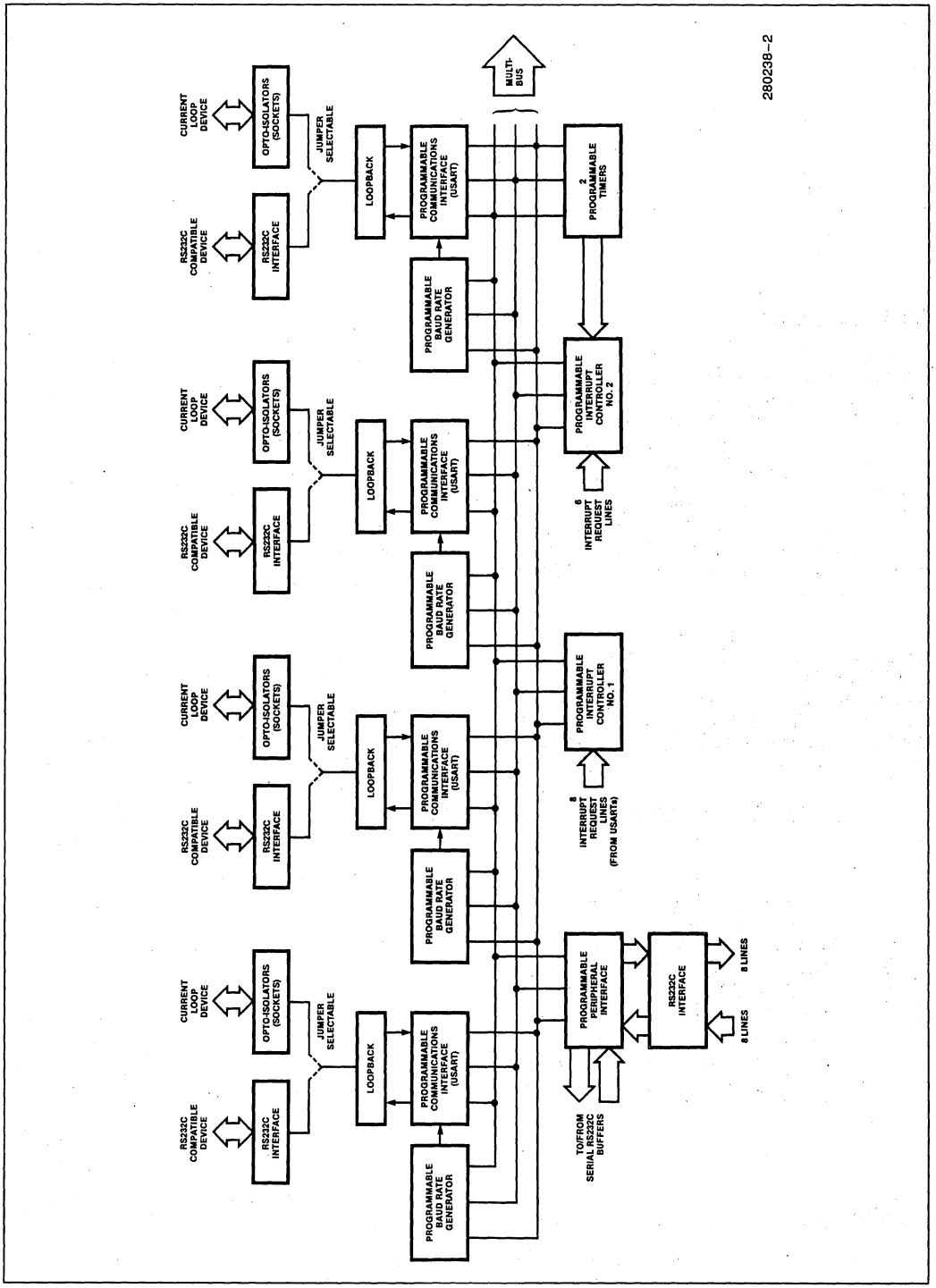


Figure 1. iSBC® 534 Four Channel Communications Expansion Board Block Diagram

Interrupt Request Generation—As shown in Table 3, interrupt requests may originate from 16 sources. Two jumper selectable interrupt requests (8 total) can be automatically generated by each USART when a character is ready to be transferred to the MULTIBUS system bus (i.e., receive buffer is full) or a character has been transmitted (transmit buffer is empty). Jumper selectable requests can be generated by two of the programmable timers (PITs), and six lines are routed directly from peripherals to accept carrier detect (4 lines), ring indicator, and the Bell 801 present next digit request lines.

Systems Compatibility

The iSBC 534 provides 16 RS232C buffered parallel I/O lines implemented utilizing an Intel 8255A programmable peripheral interface (PPI) configured to operate in mode 0.* These lines are configured to be directly compatible with the Bell 801 automatic calling unit (ACU). This capability allows the iSBC 534 to interface to Bell 801 type ACUs and up to four modems or other serial communications devices. For systems not requiring interface to an ACU, the parallel I/O lines may also be used as general purpose RS232C compatible control lines in system implementation.

***NOTE:**
Complete operational details on the Intel 8251A USART, the Intel 8253 Programmable Interval Timer, the Intel 8255A Programmable Peripheral Interface, and the Intel 8259A Programmable Interrupt Controller are contained in the Intel Component Data Catalog.

Table 3. Interrupt Assignments

Interrupt Request Line	PIC 0	PIC 1
0	PORT 0 R_X RDY	PIT 1 counter 1
1	PORT 0 T_X RDY	PIT 2 counter 2
2	PORT 1 R_X RDY	Ring Indicator (all ports)
3	PORT 1 T_X RDY	Present next digit
4	PORT 2 R_X RDY	Carrier detect port 0
5	PORT 2 T_X RDY	Carrier detect port 1
6	PORT 3 R_X RDY	Carrier detect port 2
7	PORT 3 T_X RDY	Carrier detect port 3

SPECIFICATIONS

Serial Communications Characteristics

Synchronous— 5-8 bit characters; internal or external character synchronization; automatic sync insertion.

Asynchronous— 5-8 bit characters; break character generation; 1, 1½, or 2 stop bits; false start bit detection.

Sample Baud Rates(1)

Frequency(2) (kHz, Software Selectable)	Baud Rate (Hz)		
	Synchronous	Asynchronous	
		÷ 16	÷ 64
153.6	—	9600	2400
76.8	—	4800	1200
38.4	38400	2400	600
19.2	19200	1200	300
9.6	9600	600	150
4.8	4800	300	75
6.98	6980	—	110

NOTES:
1. Baud rates shown here are only a sample subset of possible software programmable rates available. Any frequency from 18.75 Hz to 614.4 kHz may be generated utilizing on-board crystal oscillator and 16-bit programmable interval timer (used here as frequency divider).
2. Frequency selected by I/O writes of appropriate 16-bit frequency factor to Baud Rate Register.

Interval Timer and Baud Rate Generator Frequencies

Input Frequency (On-Board Crystal Oscillator)— 1.2288 MHz ± 0.1% (0.813 μs period, nominal)

Function	Single Timer		Dual/Timer Counter (Two Timers Cascaded)	
	Min	Max	Min	Max
Real-Time Interrupt Interval	1.63 μs	53.3 ms	3.26 μs	58.25 minutes
Rate Generator (Frequency)	18.75 Hz	614.4 kHz	0.0029 Hz	307.2 kHz

Interfaces—RS232C Interfaces

EIA Standard RS232C Signals provided and supported:

Carrier detect	Receive data
Clear to send	Ring indicator
Data set ready	Secondary receive data
Data terminal ready	Secondary transmit data
Request to send	Transmit clock
Receive clock	Transmit data

Parallel I/O—8 input lines, 8 output lines, all signals RS232C compatible

Bus—All signals MULTIBUS system bus compatible

I/O Addressing

The USART, interval timer, interrupt controller, and parallel interface registers of the iSBC 534 are configured as a block of 16 I/O address locations. The location of this block is jumper selectable to begin at any 16-byte I/O address boundary (i.e., 00H, 10H, 20H, etc.).

I/O Access Time

400 ns	USART registers
400 ns	Parallel I/O registers
400 ns	Interval timer registers
400 ns	Interrupt controller registers

Compatible Connectors

Interface	Pins (qty.)	Centers (in.)	Mating Connectors
Bus	86	0.156	Viking 2KH43/9 AMK12
Serial and parallel I/O	26	0.1	3m 3462-0001 or TI H312113

Compatible Opto-Isolators

Function	Supplier	Part Number
Driver	Fairchild General Electric Monsanto	4N33
Receiver	Fairchild General Electric Monsanto	4N37

Physical Characteristics

Width: 12.00 in. (30.48 cm)
Height: 6.75 in. (17.15 cm)
Depth: 0.50 in. (1.27 cm)
Weight: 14 oz. (398 gm)

Electrical Characteristics

Average DC Current

Voltage	Without Opto-Isolators	With Opto-Isolators(1)
$V_{CC} = +5V$	1.9 A, max	1.9 A, max
$V_{DD} = +12V$	275 mA, max	420 mA, max
$V_{AA} = -12V$	250 mA, max	400 mA, max

NOTE:
1. With four 4N33 and four 4N37 opto-isolator packages installed in sockets provided to implement four 20 mA current loop interfaces.

Environmental Characteristics

Operating Temperature: 0°C to +55°C

Reference Manual

502140-002—iSBC 534 Hardware Reference Manual (NOT SUPPLIED)

Reference manuals are shipped with each product only if designated SUPPLIED (see above). Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

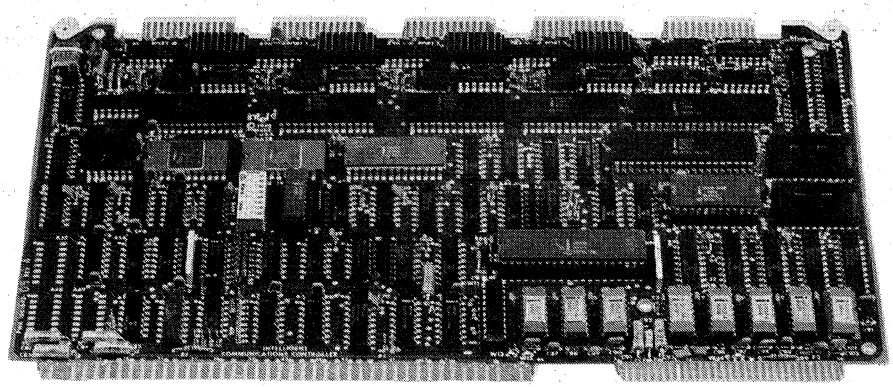
ORDERING INFORMATION

Part Number	Description
SBC 534	Four Channel Communication Expansion Board

iSBC® 544
INTELLIGENT COMMUNICATIONS CONTROLLER

- **iSBC® Communications Controller Acting as a Single Board Communications Computer or an Intelligent Slave for Communications Expansion**
- **On-Board Dedicated 8085A Microprocessor Providing Communications Control and Buffer Management for Four Programmable Synchronous/Asynchronous Channels**
- **Sockets for Up To 8K Bytes of EPROM**
- **16K Bytes of Dual Port Dynamic Read/Write Memory with On-Board Refresh**
- **Extended MULTIBUS® Addressing Permits iSBC 544 Board Partitioning into 16K-Byte Segments in a 1-Megabyte Address Space**
- **Ten Programmable Parallel I/O Lines Compatible with Bell 801 Automatic Calling Unit**
- **Twelve Levels of Programmable Interrupt Control**
- **Individual Software Programmable Baud Rate Generation for Each Serial I/O Channel**
- **Three Independent Programmable Interval Timer/Counters**
- **Interface Control for Auto Answer and Auto Originate Modem**

The iSBC 544 Intelligent Communications Controller is a member of Intel's family of single-board computers, memory, I/O, and peripheral controller boards. The iSBC 544 board is a complete communications controller on a single 6.75 x 12.00 inch printed circuit card. The on-board 8085A CPU may perform local communications processing by directly interfacing with on-board read/write memory, nonvolatile read only memory, four synchronous/asynchronous serial I/O ports, RS232/RS366 compatible parallel I/O, programmable timers, and programmable interrupts.



280239-1

November 1986
Order Number: 280239-001

FUNCTIONAL DESCRIPTION

Intelligent Communications Controller

Two Mode Operation — The iSBC 544 board is capable of operating in one of two modes: 1) as a single board communications computer with all computer and communications interface hardware on a single board; 2) as an "intelligent bus slave" that can perform communications related tasks as a peripheral processor to one or more bus masters. The iSBC 544 may be configured to operate as a standalone single board communications computer with all MPU, memory and I/O elements on a single board. In this mode of operation, the iSBC 544 may also interface with expansion memory and I/O boards (but no additional bus masters). The iSBC 544 performs as an intelligent slave to the bus master by performing all communications related tasks. Complete synchronous and asynchronous I/O and data management are controlled by the on-board 8085A CPU to coordinate up to four serial channels. Using the iSBC 544 as an intelligent slave, multichannel serial transfers can be managed entirely onboard, freeing the bus master to perform other system functions.

Architecture — The iSBC 544 board is functionally partitioned into three major sections: I/O, central computer, and shared dual port RAM memory (Figure 1). The I/O hardware is centered around the four Intel 8251A USART devices providing fully programmable serial interfacing. Included here as well is a 10-bit parallel interface compatible with the Bell 801 automatic calling unit, or equivalent. The I/O is under full control of the on-board CPU and is protected from access by system bus masters. The second major segment of the intelligent communications controller is a central computer, with an 8085A CPU providing powerful processing capability. The 8085A together with on-board EPROM/ROM, static RAM, programmable timers/counters, and programmable

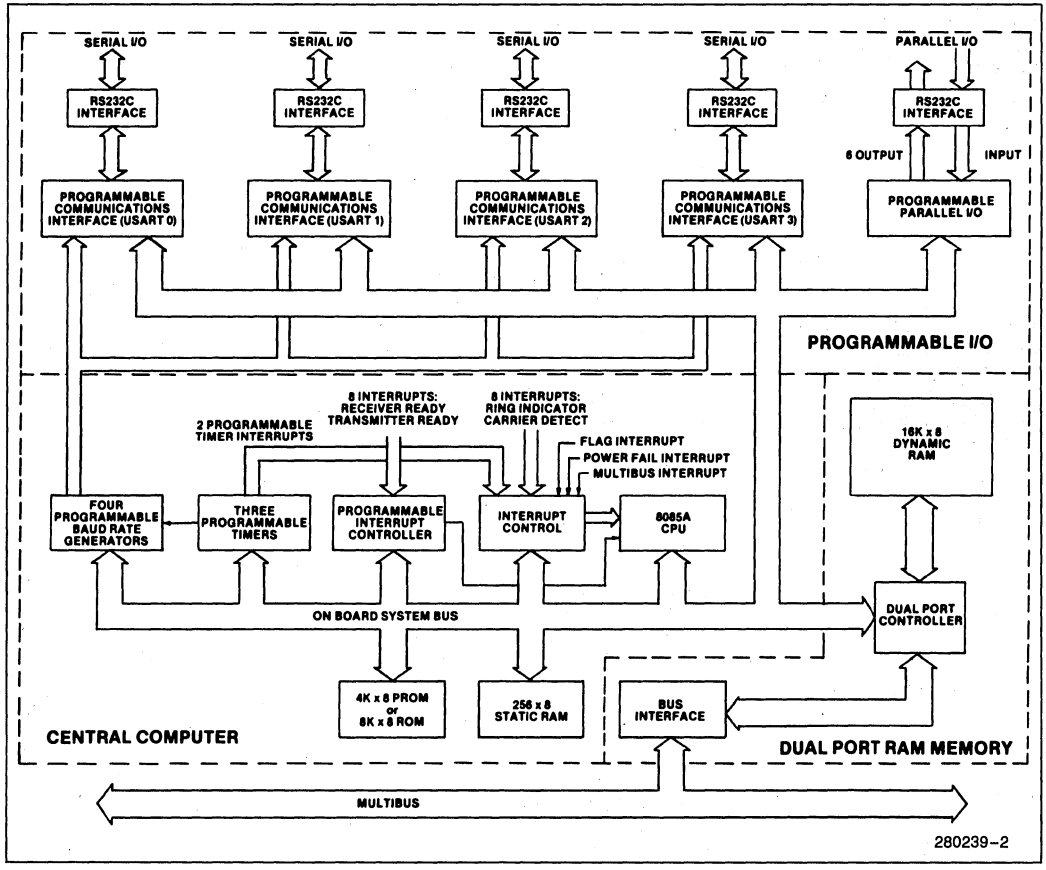


Figure 1. iSBC® 544 Intelligent Communications Controller Block Diagram

interrupt control provide the intelligence to manage sophisticated communications operations on-board the iSBC 544 board. The timer/counters and interrupt control are also common to the I/O area providing programmable baud rates to the USARTs and prioritizing interrupts generated from the USARTs. The central computer functions are protected for access only by the on-board 8085A. Likewise, the on-board 8085A may not gain access to the system bus when being used as an intelligent slave. When the iSBC 544 is used as a bus master, the on-board 8085A CPU controls complete system operation accessing on-board functions as well as memory and I/O expansion. The third major segment, dual port RAM memory, is the key link between the iSBC 544 intelligent slave and bus masters managing the system functions. The dual port concept allows a common block of dynamic memory to be accessed by the on-board 8085A CPU and off-board bus masters. The system program can, therefore, utilize the shared dual port RAM to pass command and status information between the bus masters and on-board CPU. In addition, the dual port concept permits blocks of data transmitted or received to accumulate in the on-board shared RAM, minimizing the need for a dedicated memory board.

Serial I/O

Four programmable communications interfaces using Intel's 8251A Universal Synchronous/Asynchronous Receiver/Transmitter (USART) are contained on the board and controlled by the on-board CPU in combination with the on-board interval timer/counter to provide all common communication frequencies. Each USART can be programmed by the system software to individually select the desired asynchronous or synchronous serial data transmission technique (including IBM Bisync). The mode of operation (i.e., synchronous or asynchronous), data format, control character format, parity, and baud rate are all under program control. Each 8251A provides full duplex, double-buffered, transmit and receive capability. Parity, overrun, and framing error detection are all incorporated in each USART. Each channel is fully buffered to provide a direct interface to RS232C compatible terminals, peripherals, or synchronous/asynchronous modems. Each channel of RS232C command lines, serial data lines, and signal ground lines are brought out to 26-pin edge connectors that mate with RS232C flat or round cable.

Parallel I/O Port

The iSBC 544 provides a 10-bit parallel I/O interface controlled by an Intel 8155 Programmable Interface (PPI) chip. The parallel I/O port is directly compatible with an Automatic Calling Unit (ACU) such as the Bell Model 801, or equivalent, and can also be used for auxiliary functions. All signals are RS232C compatible, and the interface cable signed assignments meet RS366 specifications. For systems not requiring an ACU interface, the parallel I/O port can be used for any general purpose interface requiring RS232C compatibility.

Central Processing Unit

Intel's powerful 8-bit n-channel 8085A CPU, fabricated on a single LSI chip, is the central processor for the iSBC 544. The 8085A CPU is directly software compatible with the Intel 8080A CPU. The 8085A contains six 8-bit general purpose registers and an accumulator. The six general purpose registers may be addressed individually or in pairs, providing both single and double precision operators. The minimum instruction execution time is 1.45 microseconds. The 8085A CPU has a 16-bit program counter. An external stack, located within any portion of iSBC 544 read/write memory, may be used as a last-in/first-out storage area for the contents of the program counter, flags, accumulator, and all of the six general purpose registers. A 16-bit stack pointer controls the addressing of this external stack. This stack provides subroutine nesting bounded only by memory size.

EPROM/ROM Capacity

Sockets for up to 8K bytes of nonvolatile read only memory are provided on the iSBC 544 board. Read only memory may be added in 2K byte increments up to a maximum of 4K bytes using Intel 2716 EPROMs or masked ROMs; or in 4K byte increments up to 8K bytes maximum using Intel 2732 EPROMs. All on-board EPROM/ROM operations are performed at maximum processor speed.

RAM Capacity

The iSBC 544 contains 16K bytes of dynamic read/write memory using Intel 2117 RAMs. Power for the on-board RAM may be provided on an auxiliary power bus, and memory protect logic is included for RAM battery backup requirements. The iSBC 544 contains a dual port controller, which provides dual port capability for the on-board RAM memory. RAM accesses may occur from either the on-board 8085A CPU or from another bus master, when used as an intelligent slave. Since on-board RAM accesses do not require the MULTIBUS, the bus is available for concurrent bus master use. Dynamic RAM refresh is accomplished automatically by the iSBC 544 for accesses originating from either the CPU or from the MULTIBUS.

Addressing — On board RAM, as seen by the on-board 8085A CPU, resides at address 8000_H–$BFFF_H$. On-board RAM, as seen by an off-board CPU, may be placed on any 4K byte address boundary. The iSBC 544 provides extended addressing jumpers to allow the on-board RAM to reside within a one megabyte address space when accessed via the MULTIBUS. In addition, jumper options are provided which allow the user to protect 8K or 12K bytes on-board RAM for use by the on-board 8085 CPU only. This reserved RAM space is not accessible via the MULTIBUS and does not occupy any system address space.

Static RAM — The iSBC 544 board also has 256 bytes of static RAM located on the Intel 8155 PPI. This memory is only accessible to the on-board 8085A CPU and is located at address $7F00_H$–$7FFF_H$.

Programmable Timers

The iSBC 544 board provides seven fully programmable and independent interval timer/counters utilizing two Intel 8253 Programmable Interval Timers (PIT), and the Intel 8155. The two Intel 8253 PITs provide six independent BCD or binary 16-bit interval timer/counters and the 8155 provides one 14-bit binary timer/counter. Four of the PIT timers (BDG0–3) are dedicated to the USARTs providing fully independent programmable baud rates.

Three General Use Timers — The fifth timer (BDG4) may be used as an auxiliary baud rate to any of the four USARTs or may alternatively be cascaded with timer six to provide extended interrupt intervals. The sixth PIT timer/counter (TINT1) can be used to generate interrupt intervals to the on-board 8085A. In addition to the timer/counters on the 8253 PITs, the iSBC 544 has a 14-bit timer available on the 8155 PPI providing a third general use timer/counter (TINT0). This timer output is jumper selectable to the interrupt structure of the on-board 8085A CPU to provide additional timer/counter capability.

Timer Functions — In utilizing the iSBC 544 board, the systems designer simply configures, via software, each timer independently to meet systems requirements. Whenever a given baud rate or interrupt interval is needed, software commands to the programmable timers select the desired function. The on-board PITs together with the 8155 provide a total of seven timer/counters and six operating modes. Mode 3 of the 8253 is the primary operating mode of the four dedicated USART baud rate generators. The timer/counters and useful modes of operation for the general use timer/counters are shown in Table 1.

Interrupt Capability

The iSBC 544 board provides interrupt service for up to 21 interrupt sources. Any of the 21 sources may interrupt the intelligent controller, and all are brought through the interrupt logic to 12 interrupt levels. Four interrupt levels are handled directly by the interrupt processing capability of the 8085A CPU and eight levels are serviced from an Intel 8259A Programmable Interrupt Controller (PIC) routing an interrupt request output to the INTR input of the 8085A (see Table 2).

Table 1. Programmable Timer Functions

Function	Operation	Counter
Interrupt on Terminal Count (Mode 0)	When terminal count is reached, an interrupt request is generated. This function is useful for generation of real-time clocks.	**8253** TINT1
Rate Generator (Mode 2)	Divide by N counter. The output will go low for one input clock cycle and high for N − 1 input clock periods.	**8253** BDG4*
Square-Wave Rate Generator (Mode 3)	Output will remain high until one-half the TC has been completed, and go low for the other half of the count. This is the primary operating mode used for generating a Baud rate clocked to the USARTs.	**8253** BDG0–4 TINT1
Software Triggered Strobe (Mode 4)	When the TC is loaded, the counter will begin. On TC the output will go low for one input clock period.	**8253** BDG4* TINT1
Single Pulse	Single pulse when TC reached.	**8155** TINT0
Repetitive Single Pulse	Repetitive single pulse each time TC is reached until a new command is loaded.	**8155** TINT0

* BDG4 is jumper selectable as an auxiliary baud rate generator to the USARTs or as a cascaded output to TINT1. BDG4 may be used in modes 2 and 4 only when configured as a cascaded output.

Table 2. Interrupt Vector Memory Locations

Interrupt Source		Vector Location	Interrupt Level
Power Fail	TRAP	24_H	1
8253 TINT1	RST 7.5	$3C_H$	2
8155 TINT0			
Ring Indicator(1)	RST 6.5	34_H	3
Carrier Detect			
Flag Interrupt	RST 5.5	$2C_H$	4
INT0/–INT7/ (1 of 8)			
RXRDY0	INTR	Programmable	5–12
TXRDY0			
RXRDY1			
TXRDY1			
RXRDY2			
TXRDY2			
RXRDY3			
TXRDY3			

NOTE:
1. Four ring indicator interrupts and four carrier detect interrupts are summed to the RST 6.5 input. The 8155 may be interrogated to inspect any one of the eight signals.

Interrupt Sources — The 22 interrupt sources originate from both on-board communications functions and the MULTIBUS. Two interrupts are routed from each of the four USARTs (8 interrupts total) to indicate that the transmitter and receiver are ready to move a data byte to or from the on-board CPU. The PIC is dedicated to accepting these 8 interrupts to optimize USART service request. One of eight interrupt request lines are jumper selectable for direct interface from a bus master via the system bus. Two auxiliary timers (TINT0 from 8155 and TINT1 from 8253) are jumper selectable to provide general purpose counter/timer interrupts. A jumper selectable Flag Interrupt is generated to allow any bus master to interrupt the iSBC 544 by writing into the base address of the shared dual port memory accessable to the system. The Flag Interrupt is then cleared by the iSBC 544 when the on-board processor reads the base address. This interrupt provides an interrupt link between a bus master and intelligent slave (see System Programming). Eight inputs from the serial ports are monitored to detect a ring indicator and carrier detect from each of the four channels. These eight interrupt sources are summed to a single interrupt level of the 8085A CPU. If one of these eight interrupts occur, the 8155 PPI can then be interrogated to determine which port caused the interrupt. Finally, a jumper selectable Power Fail Interrupt is available from the MULTIBUS to detect a power down condition.

8085 Interrupt — Thirteen of the twenty-two interrupt sources are available directly to four interrupt inputs of the on-board 8085A CPU. Requests routed to the 8085A interrupt inputs, TRAP, RST 7.5, RST 6.5 and RST 5.5 have a unique vector memory address. An 8085A jump instruction at each of these addresses then provides software linkage to interrupt service routines located independently anywhere in the Memory. All interrupt inputs with the exception of the TRAP may be masked via software.

8259A Interrupts — Eight interrupt sources signaling transmitter and receiver ready from the four USARTs are channeled directly to the Intel 8259A PIC. The PIC then provides vectoring for the next eight interrupt levels. Operating mode and priority assignments may be reconfigured dynamically via software at any time during system operation. The PIC accepts transmitter and receiver interrupts from the four USARTs. It then determines which of the incoming requests is of highest priority, determines whether this request is of higher priority than the level currently being serviced, and , if appropriate, issues an interrupt to the CPU. The output of the PIC is applied directly to the INTR input of the 8085A. Any combination of interrupt levels may be masked, via software, by storing a single byte in the interrupt mask register of the PIC. When the 8085A responds to a PIC interrupt, the PIC will generate a CALL instruction for each interrupt level. These addresses are equally spaced at intervals of 4 or 8 (software selectable) bytes. Interrupt response to the PIC is software programmable to a 32- or 64-byte block of memory. Interrupt sequences may be expanded from this block with a single 8085A jump instruction at each of these addresses.

Interrupt Output — In addition, the iSBC 544 board may be jumper selected to generate an interrupt from the on-board serial output data (SOD) of the 8085A. The SOD signal may be jumpered to any one of the 8 MULTIBUS interrupt lines (INT0/–INT7/) to provide an interrupt signal directly to a bus master.

Power-Fail Control

Control logic is also included to accept a power-fail interrupt in conjunction with the AC-low signal from the iSBC 635 Power Supply or equivalent.

Expansion Capabilities

When the iSBC 544 board is used as a single board communications controller, memory and I/O capacity may be expanded and additional functions added using Intel MULTIBUS™ compatible expansion boards. In this mode, no other bus masters may be configured in the system. Memory may be expanded to a 65K byte capacity by adding user specified combinations of RAM boards, EPROM boards, or combination boards. Input/output capacity may be increased by adding digital I/O and analog I/O expan-

sion boards. Furthermore, multiple iSBC 544 boards may be included in an expanded system using one iSBC 544 board as a single board communications computer and additional controllers as intelligent slaves.

System Programming

In the system programming environment, the iSBC 544 board appears as an additional RAM memory module when used as an intelligent slave. The master CPU communicates with the iSBC 544 board as if it were just an extension of system memory. Because the iSBC 544 board is treated as memory by the system, the user is able to program into it a command structure which will allow the iSBC 544 board to control its own I/O and memory operation. To enhance the programming of the iSBC 544 board, the user has been given some specific tools. The tools are: 1) the flag interrupt, 2) an on-board RAM memory area that is accessible to both an off-board CPU and the on-board 8085A through which a communications path can exist, and 3) access to the bus interrupt line.

Flag Interrupt — The Flag Interrupt is generated anytime a write command is performed by an off-board CPU to the base address of the iSBC 544 board's RAM. This interrupt provides a means for the master CPU to notify the iSBC 544 board that it wishes to establish a communications sequence. In systems with more than one intelligent slave, the flag interrupt provides a unique interrupt to each slave outside the normal eight MULTIBUS interrupt lines (INT0/–INT7/).

On-Board RAM — The on-board 16K byte RAM area that is accessible to both an off-board CPU and the on-board 8085A can be located on any 4K boundary in the system. The selected base address of the iSBC 544 RAM will cause an interrupt when written into by an off-board CPU.

Bus Access — The third tool to improve system operation as an intelligent slave is access to the MULTIBUS interrupt lines. The iSBC 544 board can both respond to interrupt signals from an off-board CPU, and generate an interrupt to the off-board CPU via the MULTIBUS.

System Development Capability

The development cycle of iSBC 544 board based products may be significantly reduced using the Intellec series microcomputer development systems. The Intellec resident macroassembler, text editor, and system monitor greatly simplify the design, development and debug of iSBC 544 system software. An optional ISIS-II diskette operating system provides a linker, object code locater, and library manager. A unique in-circuit emulator (ICE-85) option provides the capability of developing and debugging software directly on the iSBC 544 board.

SPECIFICATIONS

Serial Communications Characteristics

Synchronous — 5–8 bit characters; automatic sync insertion; parity.

Asynchronous — 5–8 bit characters; break character generation; 1, 1½, or 2 stop bits; false start bit detection; break character detection.

Baud Rates

Frequency (KHz)(1) (Software Selectable)	Baud Rate (Hz)(2)		
	Synchronous	Asynchronous	
		÷16	÷64
153.6	—	9600	2400
76.8	—	4800	1200
38.4	38400	2400	600
19.2	19200	1200	300
9.6	9600	600	150
4.8	4800	300	75
6.98	6980	—	110

NOTES:
1. Frequency selected by I/O writes of appropriate 16-bit frequency factor to Baud Rate Register.
2. Baud rates shown here are only a sample subset of possible software programmable rates available. Any frequency from 18.75 Hz to 614.4 KHz may be generated utilizing on-board crystal oscillator and 16-bit Programmable Interval Timer (used here as a frequency divider).

8085A CPU

Word Size — 8, 16 or 24 bits/instruction; 8 bits of data

Cycle Time — 1.45/μs ±0.01% for fastest executable instruction; i.e., four clock cycles.

Clock Rate — 2.76 MHz ± 0.1%

System Access Time

Dual port memory — 740 ns

NOTE:
Assumes no refresh contention.

Memory Capacity

On-Board ROM/PROM — 4K, or 8K bytes of user installed ROM or EPROM

On-Board Static RAM — 256 bytes on 8155

On-Board Dynamic RAM (on-board access) — 16K bytes. Integrity maintained during power failure with user-furnished batteries (optional)

On-Board Dynamic RAM (MULTIBUS access) — 4K, 8K, or 16K bytes available to bus by swtich selection

Memory Addressing

On-Board ROM/PROM — 0–0FFF (using 2716 EPROMs or masked ROMs); 0–1FFF (using 2732A EPROMs)

On-Board Static RAM — 256 bytes: 7F00–7FFF

On-Board Dynamic RAM (on-board access) — 16K bytes: 8000–BFFF.

On-Board Dynamic RAM (MULTIBUS® access) — any 4K increment 00000–FF000 which is switch and jumper selectable. 4K, 8K or 16K bytes can be made available to the bus by switch selection.

I/O Capacity

Serial — 4 programmable channels using four 8251A USARTs

Parallel — 10 programmable lines available for Bell 801 ACU, or equivalent use. Two auxiliary jumper selectable signals

I/O Addressing

On-Board Programmable I/O

Port	Data	Control
USART 0	D0	D1
USART 1	D2	D3
USART 2	D4	D5
USART 3	D6	D7
8155 PPI	E9 (Port A)	E8
	EA (Port B)	
	EB (Port C)	

Interrupts

Address for 8259A Registers (Hex notation, I/O address space)

E6 Interrupt request register
E6 In-service register
E7 Mask register
E6 Command register
E7 Block address register
E6 Status (polling register)

NOTE:
Several registers have the same physical address: Sequence of access and one data bit of the control word determines which register will respond.

Interrupt levels routed to the 8085 CPU automatically vector the processor to unique memory locations:

24 TRAP
3C RST 7.5
34 RST 6.5
2C RST 5.5

Timers

Addresses for 8253 Registers (Hex notation, I/O address space)

Programmable Interrupt Timer One

D8	Timer 0	BDG0
D9	Timer 1	BDG1
DA	Timer 2	BDG2
DB	Control register	

Programmable Interrupt Timer Two

DC	Timer 0	BDG3
DD	Timer 1	BDG4
DE	Timer 2	TINT1
DF	Control register	

Address for 8155 Programmable Timer

E8	Control	
	Timer (LSB)	TINT0
ED	Timer (MSB)	TINT0

Input Frequencies — Jumper selectable reference 1.2288 MHz ± 0.1% (0.814 μs period nominal) or 1.843 MHz ±0.1% crystal (0.542 μs period, nominal)

Output Frequencies (at 1.2288 MHz)

Function	Single Timer/Counter		Dual Timer/Counter (two timers cascaded)	
	Min	Max	Min	Max
Real-Time Interrupt Interval	1.63 μs	53.3 μs	3.26 μs	58.25 min
Rate Generator (frequency)	18.75 Hz	614.4 KHz	0.00029 Hz	307.2 KHz

Interfaces

Serial I/O — EIA Standard RS232C signals provided and supported:

Carrier Detect	Receiver Data
Clear to Send	Ring Indicator
Data Set Ready	Secondary Receive Data*
Data Terminal Ready	Secondary Transmit Data *
Request to Send	Transmit Clock
Receive Clock	Transmit Data
	DTE Transmit clock

* Optional if parallel I/O port is not used as Automatic Calling Unit.

Parallel I/O — Four inputs and eight outputs (includes two jumper selectable auxiliary outputs). All signals compatible with EIA Standard RS232C. Directly compatible with Bell Model 801 Automatic Calling Unit, or equivalent.

MULTIBUS — Compatible with iSBC MULTIBUS.

On-Board Addressing

All communications to the parallel and serial I/O ports, to the timers, and to the interrupt controller, are via read and write commands from the on-board 8085A CPU.

Auxiliary Power

An auxiliary power bus is provided to allow separate power to RAM for systems requiring battery backup of read/write memory. Selection of this auxiliary RAM power bus is made via jumpers on the board.

Connectors

Interface	Pins (qty)	Centers (in.)	Mating Connectors
Bus	86	0.156	Viking 2KH43/9AMK12
Parallel I/O	50	0.1	3M 3415-000 or AMP 88083-1
Serial I/O	26	0.1	3M 3462-000 or AMP 88373-5

Memory Protect

An active-low TTL compatible memory protect signal is brought out on the auxiliary connector which, when asserted, disables read/write access to RAM memory on the board. This input is provided for the protection of RAM contents during the system power-down sequences.

Bus Drivers

Function	Characteristic	Sink Current (mA)
Data	Tri-state	50
Address	Tri-state	15
Commands	Tri-state	32

NOTE:
Used as a master in the single board communications computer mode.

Physical Characteristics

Width:	30.48 cm (12.00 inches)
Depth:	17.15 cm (6.75 inches)
Thickness:	1.27 cm (0.50 inch)
Weight:	3.97 gm (14 ounces)

Electrical Characteristics

DC Power Requirements

Configuration	Current Requirements			
	V_{CC} = +5V ±5% (max)	V_{DD} = ±12V ±5% (max)	V_{BB} = −5V(3) ±5% (max)	V_{AA} = −12V ±5% (max)
With 4K EPROM (using 2716)	I_{CC} = 3.4A max	I_{DD} = 350 mA max	I_{BB} = 5 mA max	I_{AA} = 200 mA max
Without EPROM	3.3A max	350 mA max	5 mA max	200 mA max
RAM only(1)	390 mA max	176 mA max	5 mA max	—
RAM(2) refresh only	390 mA max	20 mA max	5 mA max	

NOTES:
1. For operational RAM only, for AUX power supply rating.
2. For RAM refresh only. Used for battery backup requirements. No RAM accessed.
3. V_{BB} is normally derived on-board from V_{AA}, eliminating the need for a V_{BB} supply. If it is desired to supply V_{BB} from the bus, the current requirement is as shown.

Environmental Characteristics

Operating Temperature: 0°C to 55°C (32°F to 131°F)

Relative Humidity: To 90% without condensation

Reference Manual

502160 — iSBC 544 Intelligent Communications Controller Board Hardware Reference Manual (NOT SUPPLIED)

Reference manuals are shipped with each product only if designated SUPPLIED (see above). Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

ORDERING INFORMATION

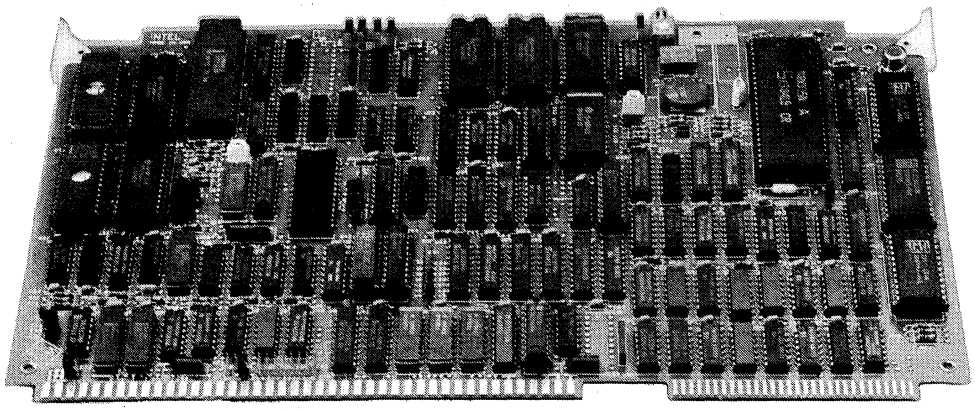
Part Number	Description
iSBC 544	Intelligent Communications Controller

iSBC® 561
SOEMI (Serial OEM Interface)
CONTROLLER BOARD

- **Dedicated I/O Controller Provides a Direct Connection of MULTIBUS®-Based Systems to an IBM 9370 or 4361 Mainframe Host or to any IBM System/370 via an IBM 3174 Subsystem Control Unit via IBM's SOEMI (Serial OEM Interface) Protocol**
- **Physical Interface is via IBM 3270 Coax with a Maximum Distance of 1.5 km**
- **Maximum Transmission Rate of 2.36 Megabits/Second**
- **Dual I/O Processors Manage Both SOEMI and MULTIBUS® Interfaces**
- **Includes a SMC-to-BNC Cable Assembly to Attach into the IBM 3270 Information Display System**
- **On-Board Diagnostic Capability Provides Operational Status of Board Function and Link with the Host**
- **Supported by a Complete Family of Single Board Computers, Memory, Digital and Analog I/O, Peripheral and Graphics Controllers' Packaging and Software**

The Intel iSBC 561 SOEMI (Serial OEM Interface) Controller Board is a member of Intel's family of single board computers, memory, I/O, peripheral and graphics controller boards. It is a dedicated intelligent I/O controller on a MULTIBUS form-factor printed circuit card. The board allows OEMs of MULTIBUS-based systems a direct, standard link to an IBM 9370 Information System, to an IBM System 4361, or to any IBM System/370 attached to an IBM 3174 Subsystem Control Unit via the SOEMI (Serial OEM Interface). The iSBC 561 Controller also provides IBM System/370 users access to the broad range of applications supported by hundreds of MULTIBUS vendors.

The SOEMI interface is comprised of an IBM System/370 programming interface and an IBM 3270 coax interface. It is a flexible, high speed, point-to-point serial interface offered as a feature on the IBM 9370 and 4361 processor families and on the 3174 Subsystem Control Unit. The iSBC 561 SOEMI Controller Board contains two processors and provides the necessary intelligence for conversion, control functions, and buffer management between the IBM mainframe and the MULTIBUS system. This board allows an IBM user to distribute control and information to MULTIBUS compatible systems for a variety of applications including factory automation, data acquisition, measurement, control, robotics, process control, communications, local area networking, medical instrumentation, and laboratory automation.



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*IBM is a trademark of International Business Machine Corp.

October 1987
Order Number: 280114-002

SOEMI INTERFACE OVERVIEW

The Serial OEM Interface (SOEMI) is a new means of connecting Original Equipment Manufacturer (OEM) MULTIBUS-based systems and subsystems to an IBM System/370 mainframe. Previously, the only low-cost way to attach non-IBM equipment into the IBM mainframe environment was to use 3270 emulation software and hardware adaptors. This type of interface is low-speed (approx. 19.6K bits/sec.) and not very flexible as to the type and format of data that can be transferred. The 3270 emulators must mimic the device formats of the displays and printers that are typically attached on this interface; stripping out command characters, carriage return andl line feed characters, etc. The SOEMI interface is available on; the IBM 9370, the IBM 4361, and the 3174 Subsystem Control Unit model 1L. The SOEMI Protocol is much faster and more flexible, in that any type of raw data or formatted data may be sent across the connecting coax cable.

The SOEMI attachment into the MULTIBUS system architecture, via the iSBC 561 SOEMI Controller Board, extends the attachment capabilities of the IBM 9370, 4361 and 3174 to a variety of systems, boards, and I/O devices provided by other manufacturers. Figure 1 is an example of the variety achievable on Intel's MULTIBUS (IEEE 796) system architecture.

The SOEMI interface utilizes the System/370 Programming Interface on the IBM 9370, 4361 and 3174 to create the protocols and formats required by a given application for connection to and communication with virtually any type of OEM device.

The System/370 Programming Interface provides the standard System/370 I/O instructions for exchanging data between the host and the MULTIBUS-based system. System/370 applications see MULTIBUS system memory as one or more entities called "spaces." The System/370 host system program writes to and reads from these spaces. The user can define the number of spaces or the layout of fields in the SOEMI interface at his discretion and as required by the application and the MULTIBUS system configuration.

The 3270 coax interface provides the physical connection between the OEM MULTIBUS system and the IBM host. The coax cable (type RG62AU) can operate over a distance of 1.5 kilometers at a maximum transfer rate of 2.3587 Mbits/second. The distance of 1.5 kilometers can be increased to a maximum of 3 kilometers by installing an IBM 3299 Terminal Multiplexer (repeater) between the IBM 9370, 4361 or 3174 and the MULTIBUS system. The protocol at the coax interface includes a polling mechanism, a set of Write and Read commands, and requires a buffer with an address register at the OEM controller end.

The connection to the IBM 4361 is made via the IBM 3270 Information Display System's Display/Printer Adapter (DPA) and/or Work Station Adapter (WSA) coax ports. The DPA can drive up to sixteen 3270/SOEMI coax ports, and is the standard configuration. The WSA is an optional add-on to the IBM 4361 that increases the total number coax ports supported to 40. The connection to the IBM 9370 is made via the Workstation Subsystem Controller feature, and a workstation adapter which can connect up to

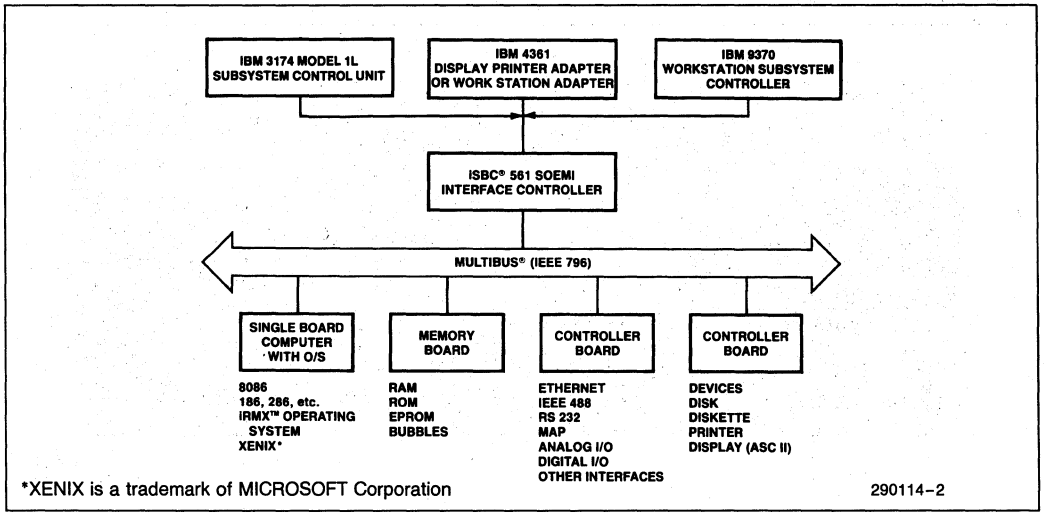


Figure 1. IBM 4361-to-MULTIBUS® Attachment Capability Block Diagram

6 SOEMI ports. This can be increased to 32 ports using optional terminal multiplexers. The connection to the IBM 3174 model 1L is made via IBM dual-purpose connectors (DPC) which can connect up to 4 SOEMI ports. This can be increased to 32 ports using terminal multiplexer adapters. A typical configuration can support an aggregate data rate of approximately 45K Bytes/second (approx. 360K bits/second).

OPERATING ENVIRONMENT

The iSBC board functions as a slave to the host mainframe, reacting and executing under System/370 program control as as mainframe resource. In addition, it has a full multimaster MULTIBUS interface that allows the board to arbitrate for bus ownership, generate bus clocks, respond to and generate interrupts, etc. With the iSBC 561 controller connected to the mainframe, all MULTIBUS system resources are available to the IBM host program/controller. From the IBM side, the mainframe is capable of accessing the entire 16 MBytes of MULTIBUS system memory, 64K Bytes of I/O space, and all on-board resources of the iSBC 561 board. Other intelligent MULTIBUS boards access iSBC 561 controller services through normal interrupt mechanisms.

Using the SOEMI interface in a relatively low-level application may simply require the user to write System/370 application control programs that reside in the IBM mainframe. A more elaborate implementation would also involve application programs that reside in the MULTIBUS system under its "native" op-

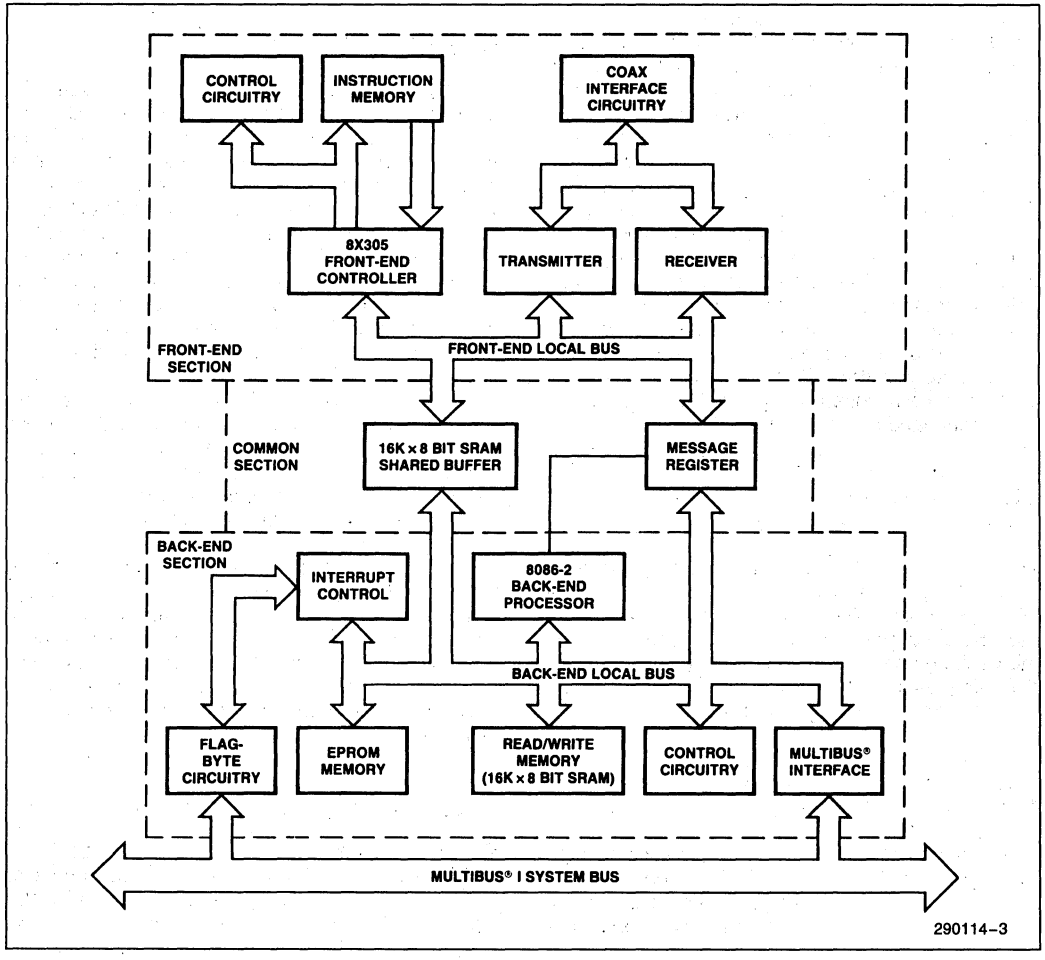


Figure 2. iSBC® 561 SOEMI (Serial OEM Interface) Controller Board Functional Block Diagram

erating environment (i.e., iRMX or XENIX operating systems) and an end-to-end protocol that ties both sets of application programs together.

ARCHITECTURE

The iSBC 561 board is functionally partitioned into three major sections: the front-end section, the common section, and the back-end section (see Figure 2).

Front-End Processor Section: IBM Host Interface

The front-end section of the iSBC 561 Controller board interfaces with the IBM mainframe via the IBM 3270 Information Display System, and consists of an 8X305 Signetics microcontroller, the 8X305 instruction memory, and the coaxial interface. The 8X305 executes the coax commands and places the structured field's instructions in shared memory buffers for subsequent execution by the back-end processor. The front-end instruction memory consists of three 2K x 8-bit PROMs which provide the instruction code for the 8X305 processor and the information needed to generate the various control signals required by the 8X305 to elicit system functions. The information contained in each PROM is not modifiable by the user. The coaxial interface is based on a DP8340 transmitter component that converts 8-bit parallel data received from the front-end processor to a 12-bit serial stream, and a DP8341 receiver component, that converts a 12-bit serial stream of data from the mainframe to parallel data with separated command and parity bits.

Common Section: Shared Memory Buffer

The common section of the iSBC 561 board consists of two 8-bit, bi-directional message registers and a 16K x 8-bit static RAM shared buffer. This shared memory buffer between the front-end processor and the back-end processor is the resource for transferring information and control messages between the IBM host and the MULTIBUS system.

Back-End Processor Section: MULTIBUS® Interface

The back-end section of the board provides an intelligent interface to the MULTIBUS system bus, and consists of the 8086-2 microprocessor, local memory, bus interface circuitry, and memory-mapped logic. The 8086 processor is capable of either retrieving information the 8X305 placed in the shared buffer, or placing information in the shared buffer, depending on the direction of the transfer and type of operation or task to be performed. The information is stored in the shared buffer as a set(s) of structured fields. The back-end processor transfers this information by performing 8- or 16-bit data transfers to or from the MULTIBUS system bus, the shared buffer, and the local memory.

The control program for this high-speed, back-end processor is resident in two local ROM sites. The processor also has access to 16K bytes of static RAM for local data storage.

The back-end section interfaces to other MULTIBUS boards through two bus controllers, a bus arbiter, and the address, data, and command buffers for access over the 24 address lines and 16 data lines of the MULTIBUS system bus.

OPERATION FLOW

The commands and information passed along the coax by the IBM host to the iSBC 561 controller represent what is known as a "structured field." The iSBC 561 front-end processor strips out the 12-bit protocol header deposits the remaining structured field(s) in the shared memory buffer, and notifies the back-end processor. The back-end processor then processes these structured fields in order to access the proper MULTIBUS memory space and I/O ports. It then deposits the information or task in the space and notifies the MULTIBUS subsystem master that a transfer has occurred and is awaiting service.

When requiring service, the MULTIBUS system application sends an interrupt to the iSBC 561 board. The board then issues an attention to the mainframe. At this point, the mainframe is under no obligation or time constraint to service the interrupt, and its response is application dependent.

The mainframe issues commands to service the interrupt. The information concerned with the interrupt is then passed through the shared memory and serialized by the iSBC 561 board before being sent to the mainframe. The exact communications protocol used for this end-to-end transfer is defined by the user application programs running in both operating environments.

Interface Connector/Cable Assembly

The cable assembly used to connect the iSBC 561 SOEMI Controller Board to the IBM mainframe or 3174 control unit cable assembly consists of RG180 type cable having an SMC connector on one end (which mates to the iSBC 561 board right angle SMC connector) and a BNC connector on the other end (which mates to the IBM cable assembly connector).

SPECIFICATIONS

Operational Characteristics

Back-end processor— Intel 8086-2/5 MHz
— 20-bit address path; 8/16 bit data path

Front-end processor— Signetics 8X305/8 MHz
— 16-bit instruction path; 8-bit data path

Serial Transfer Rate— 2.3587 Mbits/second (max. bit rate)
— 360K bits/second (approx. aggregate throughput)

Serial Transfer Rate— Binary dipulse (with 12-bit serial stream)

Memory Capacity — All iSBC 561 controller board memory is available to on-board firmware only.

Common memory — 16K Bytes of Shared Buffer memory (SRAM @ 0 wait state access)

8086-2 memory — 16K Bytes of EPROM;
— 16K Bytes of SRAM

8X305 memory — 4K Bytes of Instruction memory (EPROM)
— 2K Bytes of Control memory (EPROM)

Physical Characteristics

Width: 30.48 cm (12.00 in)
Height: 17.15 cm (6.75 in)
Depth: 1.78 cm (0.70 in)
Weight: 510 gm (18 oz)

Electrical Characteristics

DC Power Requirements:
Voltage—+5V
Current (Max)—6.28A
Current (Typ)—5.46A
Power Dissipation (Max)—35.5VA

ORDERING INFORMATION

Part Number	Description
iSBC 561	SOEMI (Serial OEM Interface) Controller board

Cable Characteristics

Impedance: coax connector—50 ohms (nominal)
external cable (user furnished)—95 ohms (nominal)

Capacitance: 35 pF/ft

Propagation: 1.6 ns/ft

Environmental Characteristics

Operating Temperature: 0° to 55°C at 200 LFM air velocity

Operating Humidity: 10 to 85% non-condensing (0° to 55°C)

Non-Operating Temperature: −40°C to 75°C

Shock: 30G for a duration of 11 ms with ½ sinewave shape.

Vibration: 0 to 55 Hz with 0.0 to 0.010 inches peak to peak excursion.

Reference Manuals

147048-001— iSBC 561 SOEMI (Serial OEM Interface) Controller Board Hardware Reference Manual (NOT SUPPLIED)

Reference manual may be ordered from any Intel sales representative, distributor office, or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

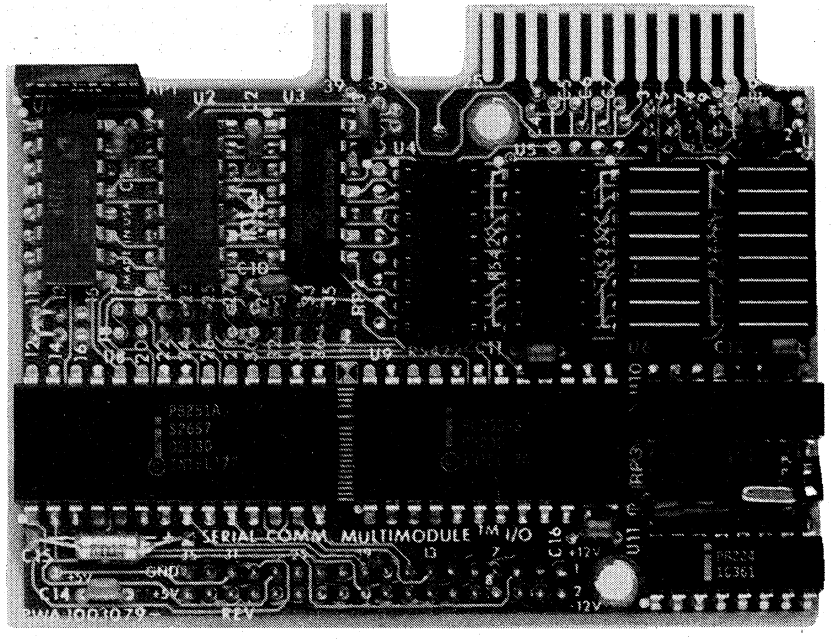
GA33-1585-0 (File No. S370-03—IBM Serial OEM Interface (SOEMI) Reference Manual (NOT SUPPLIED)

Reference manual may be ordered from IBM Advanced Technical Systems; Dept. 3291, 7030-16; Schoenaicherstr. 220; 7030 Boeblingen. Federal Republic of Germany.

iSBX™ 351
SERIAL I/O MULTIMODULE™ BOARD

- **iSBX™ Bus Compatible I/O Expansion**
- **Programmable Synchronous/ Asynchronous Communications Channel with RS232C or RS449/422 Interface**
- **Software Programmable Baud Rate Generator**
- **Two Programmable 16-Bit BCD or Binary Timer/Event Counters**
- **Four Jumper Selectable Interrupt Request Sources**
- **Accessed as I/O Port Locations**
- **Low Power Requirements**
- **Single +5V when Configured for RS449/422 Interface**
- **iSBX Bus On-Board Expansion Eliminates MULTIBUS® System Bus Latency and Increases System Throughput**

The Intel iSBX 351 Serial I/O MULTIMODULE board is a member of Intel's new line of iSBX bus compatible MULTIMODULE products. The iSBX MULTIMODULE board plugs directly into any iSBX bus compatible host board offering incremental on-board I/O expansion. The iSBX 351 module provides one RS232C or RS449/422 programmable synchronous/asynchronous communications channel with software selectable baud rates. Two general purpose programmable 16-bit BCD or binary timers/event counters are available to the host board to generate accurate time intervals under software control. The iSBX board is closely coupled to the host board through the iSBX bus, and as such, offers maximum on-board performance and frees MULTIBUS system traffic for other system resources. In addition, incremental power dissipation is minimal requiring only 3.0 watts (assumes RS232C interface).



280236-1

September 1986
Order Number: 280236-001

FUNCTIONAL DESCRIPTION

Communications Interface

The iSBX 351 module uses the Intel 8251A Universal Synchronous/Asynchronous Receiver/Transmitter (USART) providing one programmable communications channel. The USART can be programmed by the system software to individually select the desired asynchronous or synchronous serial data transmission technique (including IBM Bi-Sync). The mode of operation (i.e., synchronous or asynchronous), data format, control character format, parity, and baud rate are all under program control. The 8251A provides full duplex, double buffered transmit and receive capability. Parity, overrun, and framing error detection are all incorporated in the USART. The command lines, serial data lines, and signal ground lines are brought out to a double edge connector configurable for either an RS232C or RS449/422 interface (see Figure 3). In addition, the iSBX 351 module is jumper configurable for either point-to-point or multidrop network connection.

16-Bit Interval Timers

The iSBX 351 module uses an Intel 8253 Programmable Interval Timer (PIT) providing 3 fully programmable and independent BCD and binary 16-bit interval timers. One timer is available to the system designer to generate baud rates for the USART under software control. Routing for the outputs from the other two counters is jumper selectable to the host board. In utilizing the iSBX 351 module, the systems designer simply configures, via software, each timer independently to meet system requirements. Whenever a given baud rate or time delay is needed, software commands the programmable timers to select the desired function. The functions of the timers are shown in Table 1. The contents of each counter may be read at any time during system operation.

Interrupt Request Lines

Interrupt requests may originate from four sources. Two interrupt requests can be automatically generated by the USART when a character is ready to be transferred to the host board (i.e., receive buffer is full) or a character has been transmitted (i.e., transmit buffer is empty). In addition, two jumper selectable requests can be generated by the programmable timers.

Installation

The iSBX 351 module plugs directly into the female iSBX connector on the host board. The module is then secured at one additional point with nylon hardware to insure the mechanical security of the assembly (see Figures 1 and 2).

Table 1. Programmable Timer Functions

Function	Operation
Interrupt on Terminal Count	When terminal count is reached, an interrupt request is generated. This function is useful for generation of real-time clocks.
Programmable One-Shot	Output goes low upon receipt of an external trigger edge and returns high when terminal count is reached. This function is retriggerable.
Rate Generator	Divide by N counter. The output will go low for one input clock cycle, and the period from one low going pulse to the next is N times the input clock period.
Square-Wave Rate Generator	Output will remain high until one-half the count has been completed, and go low for the other half of the count.
Software Triggered Strobe	Output remains high until software loads count (N). N counts after count is loaded, output goes low for one input clock period.
Hardware Triggered Strobe	Output goes low for one clock period N counts after rising edge counter trigger input. The counter is retriggerable.
Event Counter	On a jumper selectable basis, the clock input becomes an input from the external system. CPU may read the number of events occurring after the counting "window" has been enabled or an interrupt may be generated after N events occur in the system.

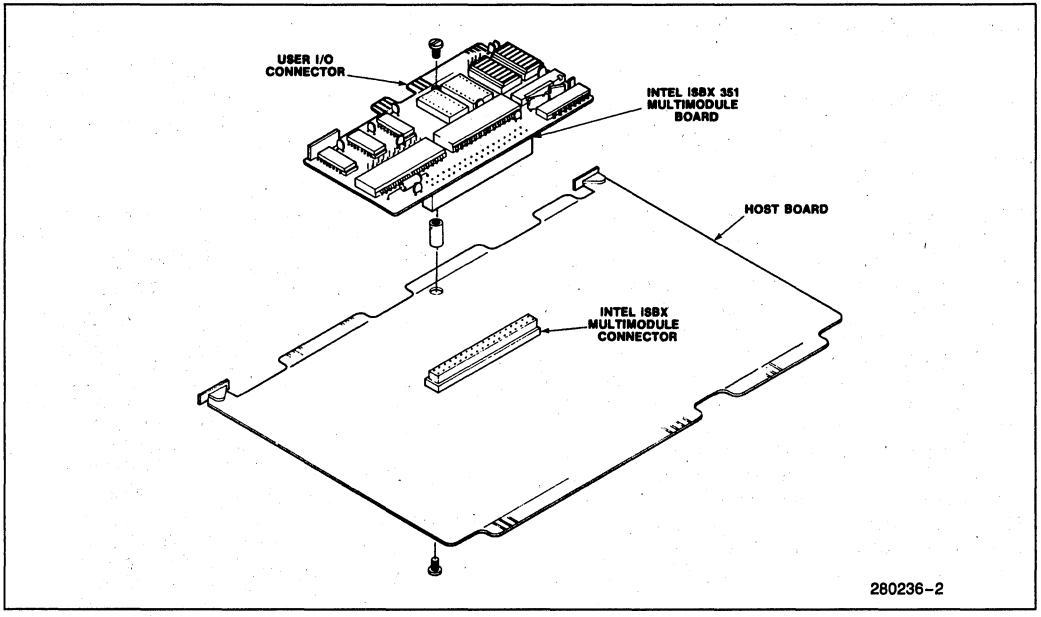


Figure 1. Installation of iSBC® 351 Module on a Host Board

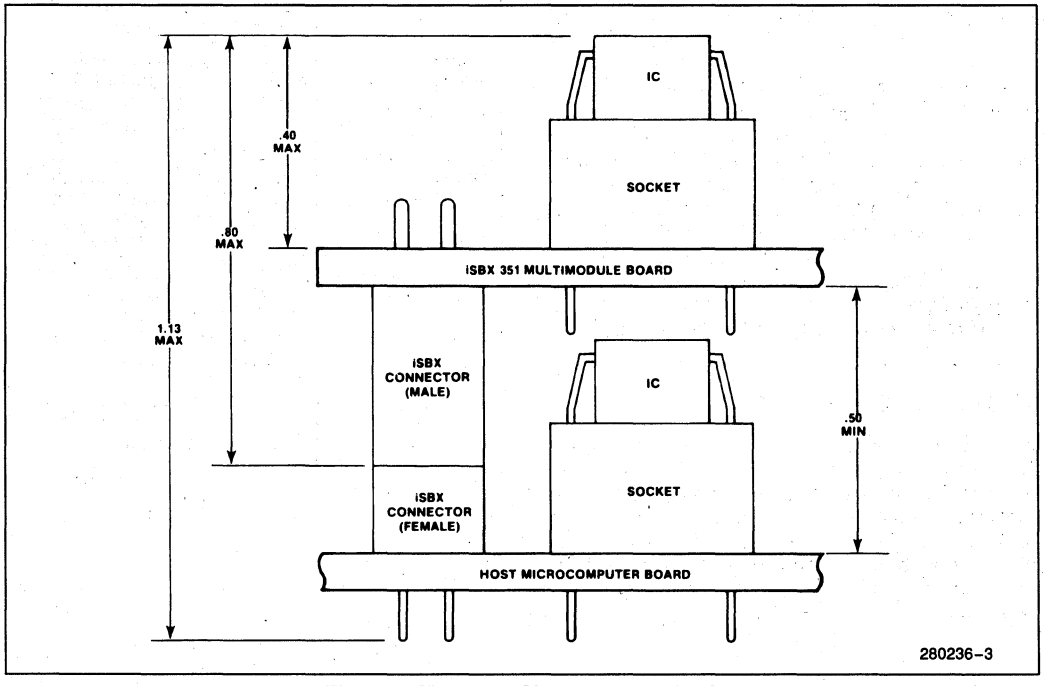


Figure 2. Mounting Clearances (Inches)

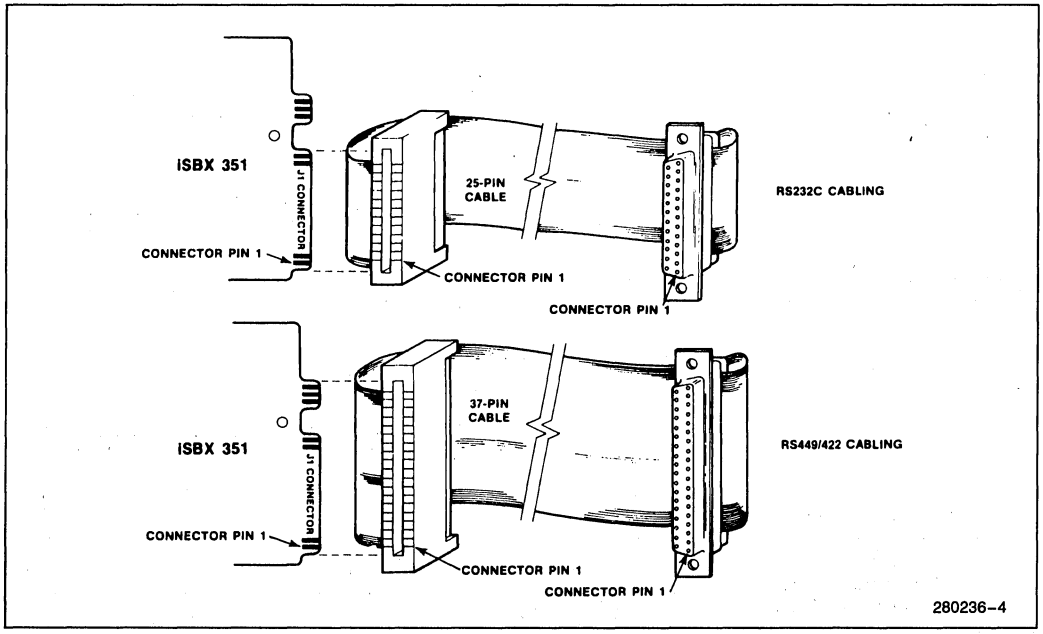


Figure 3. Cable Construction and Installation for RS232C and RS449/422 Interface

SPECIFICATIONS

I/O Addressing

I/O Address for an 8-Bit Host	I/O Address for a 16-Bit Host	Chip Select	Function
X0, X2, X4 or X6	Y0, Y4, Y8 or YC	8251A USART	Write: Data Read: Data
X1, X3, X5 or X7	Y2, Y6, YA or YE	MCS0/ Activated (True)	Write: Mode or Command Read: Status
X8 or XC	Z0 or Z8	8253 PIT	Write: Counter 0 Load: Count (N) Read: Counter 0
X9 or XD	Z2 or ZA	MSC1/Activated (True)	Write: Counter 1 Load: Count N Read: Counter 1
XA or XE	Z4 or ZC		Write: Counter 2 Load: Count (N) Read: Counter 2
XB or XF	Z6 or ZE		Write: Control Read: None

NOTE:
X = The iSBX base address that activates MCS0 & MSC1 for an 8-bit host.
Y = The iSBX base address that activates MCS0 for a 16-bit host.
Z = The iSBX base address that activates MCS1 for a 16-bit host.
The first digit, X, Y or Z, is always a variable, since it will depend on the type of host microcomputer used. Refer to the Hardware Reference Manual for your host microcomputer to determine the first digit of the I/O base address.
The first digit of each port I/O address is listed as "X" since it will change depending on the type of host iSBC microcomputer used. Refer to the Hardware Reference Manual for your host iSBC microcomputer to determine the first digit of the I/O address.

Word Size

Data—8 bits

Access Time

Read—250 ns max
Write—300 ns max

NOTE:
Actual transfer speed is dependent upon the cycle time of the host microcomputer.

Serial Communications

Synchronous—5–8-bit characters; internal character synchronization; automatic sync insertion; even, odd or no parity generation/detection.

Asynchronous—5–8-bit characters; break character generation and detection; 1, 1½, or 2 stop bits; false start bit detection; even, odd or no parity generation/detection.

Interval Timer and Baud Rate Generator

Input Frequency (selectable):

1.23 MHz ±0.1% (0.813 μs period nominal)
153.6 kHz ±0.1% (6.5 μs period nominal)

Sample Baud Rate

8253 PIT(1) Frequency (kHZ, Software Selectable)	8251 USART Baud Rate (Hz)(2)		
	Synchronous	Asynchronous	
		÷16	÷64
307.2	—	19200	4800
153.6	—	9600	2400
76.8	—	4800	1200
38.4	38400	2400	600
19.2	19200	1200	300
9.6	9600	600	150
4.8	4800	300	75
2.4	2400	150	—
1.76	1760	110	—

NOTES:
1. Frequency selected by I/O writes of appropriate 16-bit frequency factor to Baud Rate Register.
2. Baud rates shown here are only a sample subset of possible software-programmable rates available. Any frequency from 18.75 Hz to 614.4 kHz may be generated utilizing on-board crystal oscillator and 16-bit Programmable Interval Timer (used here as frequency divider).

Output Frequency

	Rate Generator (Frequency)		Real-Time Interrupt (Interval)	
	Min	Max	Min	Max
Single Timer(1)	18.75 Hz	614.4 kHz	1.63 μs	53.3 ms
Single Timer(2)	2.34 Hz	76.8 kHz	13.0 μs	426.7 ms
Dual Timer(3) (Counters 0 and 1 in Series)	0.000286 Hz	307.2 kHz	3.26 μs	58.25 min
Dual Timer(4) (Counters 0 and 1 in Series)	0.0000358 Hz	38.4 kHz	26.0 μs	7.77 hrs

NOTES:
1. Assuming 1.23 MHz clock input.
2. Assuming 153.6 kHz clock input.
3. Assuming Counter 0 has 1.23 MHz clock input.
4. Assuming Counter 0 has 153.6 kHz clock input.

Interrupts

Interrupt requests may originate from the USART (2) or the programmable timer (2).

Interfaces

iSBX Bus—all signals TTTL compatible.

Serial—configurable of EIA Standards RS232C or RS449/422

EIA Standard RS232C signals provided and supported.

Clear to Send (CTS)
Data Set Ready (DSR)
Data Terminal Ready (DTR)
Request to Send (RTS)
Receive Clock (RXC)
Receive Data (RXD)
Transmit Clock (DTE TXC)
Transmit Data (TXD)

EIA Standard RS449/422 signals provided and supported.

Clear to Send (CS)
Data Mode (DM)
Terminal Ready (TR)
Request to Send (RS)
Receive Timing (RT)
Receive Data (RD)
Terminal Timing (TT)
Send Data (SD)

Physical Characteristics

Width: 7.24 cm (2.85 inches)

Length: 9.40 cm (3.70 inches)

Height*: 2.04 cm (0.80 inches)
iSBX 351 Board
2.86 cm (1.13 inches)
iSBX 351 Board and Host Board

Weight: 51 grams (1.79 ounces)
*(See Figure 2)

Serial Interface Connectors

Configuration	Mode(2)	MULTIMODULE™ Edge Connector	Cable	Connector(8)
RS232C	DTE	26-pin(5), 3M-3462-0001	3M(3)-3349/25	25-pin(7), 3M-3482-1000
RS232C	DCE	26-pin(5), 3M-3462-0001	3M(3)-3349/25	25-pin(7), 3M-3483-1000
RS449	DTE	40-pin(6), 3M-3464-0001	3M(4)-3349/37	37-pin(1), 3M-3502-1000
RS449	DCE	40-pin(6), 3M-3464-0001	3M(4)-3349/37	37-pin(1), 3M-3503-1000

NOTES:
1. Cable housing 3M-3485-4000 may be used with the connector.
2. DTE—Data Terminal mode (male connector), DCE—Data Set mode (female connector).
3. Cable is tapered at one end to fit the 3M-3462 connector.
4. Cable is tapered to fit 3M-3464 connector.
5. Pin 26 of the edge connector is not connected to the flat cable.
6. Pins 37, 39, and 40 of the edge connector are not connected to the flat cable.
7. May be used with cable housing 3M-3485-1000.
8. Connectors compatible with those listed may also be used.

Electrical Characteristics

DC Power Requirements

Mode	Voltage	Amps (Max)
RS232C	+5V ±0.25V	460 mA
	+12V ±0.6V	30 mA
	−12V ±0.6V	30 mA
RS449/422	+5V ±0.25V	530 mA

Environmental Characteristics

Temperature: 0°C–55°C, free moving air across the base board and MULTIMODULE board.

Reference Manual

9803190-01— iSBX 351 Serial I/O MULTIMODULE Manual (NOT SUPPLIED)

Reference Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Ave., Santa Clara, California, 95051.

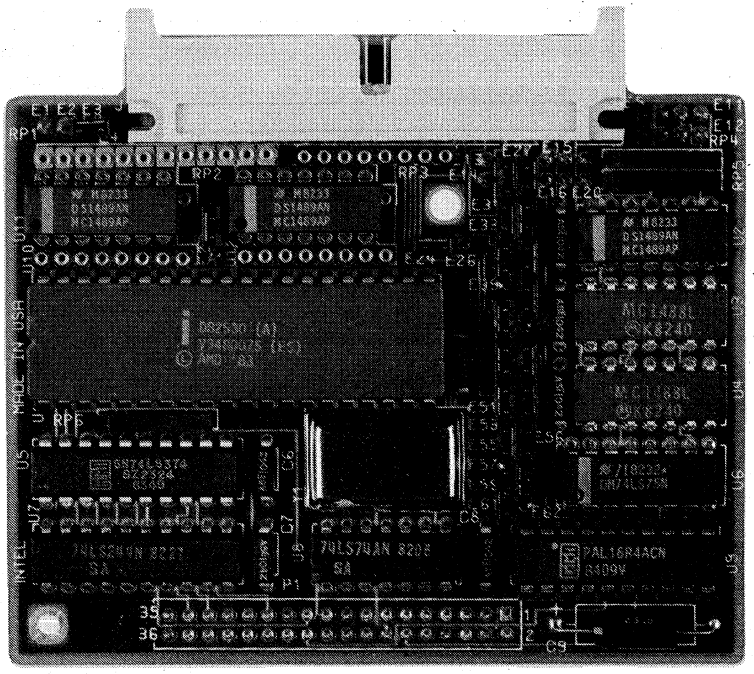
ORDERING INFORMATION

Part Number	Description
SBX 351	Serial I/O MULTIMODULE Board

iSBX™ 354 DUAL CHANNEL SERIAL I/O MULTIMODULE™ BOARD

- **Two RS232C or RS422A/449 Programmable Synchronous/ Asynchronous Communications Channels**
- **Programmable Baud Rate Generation for Each Channel**
- **Full Duplex Operation**
- **iSBX™ Bus Compatible I/O Expansion**
- **Supports HDLC/SDLC, NRZ, NRZI or FM Encoding/Decoding**
- **Three Interrupt Options for Each Channel**
- **Low Power Requirements**

The Intel iSBX 354 Serial I/O MULTIMODULE board is a member of Intel's line of iSBX compatible MULTIMODULE products. The iSBX MULTIMODULE board plugs directly into any iSBX bus compatible host board offering incremental on-board I/O expansion. Utilizing Intel's 82530 Serial Communications Controller component, the iSBX 354 module provides two RS232C or RS422A/449 programmable synchronous/asynchronous communications channels. The 82530 component provides two independent full duplex serial channels, on chip crystal oscillator, baud-rate generator and digital phase locked loop capability for each channel. The iSBX board connects to the host board through the iSBX bus. This offers maximum on-board performance and frees the MULTIBUS® System bus for use by other system resources.



280045-1

September 1987
Order Number: 280045-008

FUNCTIONAL DESCRIPTION

Communications Interface

The iSBX 354 module uses the Intel 82530 Serial Communications Controller (SCC) component providing two independent full duplex serial channels. The 82530 is a multi-protocol data communications peripheral designed to interface high speed communications lines using Asynchronous, Byte-Synchronous and Bit-Synchronous protocols to Intel's microprocessor based board and system level products. The mode of operation (i.e. asynchronous or synchronous), data format, control character format, and baud-rate generation are all under program control. The 82530 SCC component can generate and check CRC codes in any Synchronous mode and can be programmed to check data integrity in various modes. The command lines, serial data lines, and signal ground lines are brought out to a double edge connector.

The iSBX 354 module provides a low cost means to add two serial channels to iSBC® boards with 8 or 16 bit MULTIMODULE interfaces. In the factory default configuration, the iSBX 354 module will support two RS232C interfaces. With user supplied drivers and termination resistors, the iSBX 354 module can be reconfigured to support RS422A/449 communication interfaces with support on Channel A only for multidrop control from the base board. Both channels can be configured as DTE or DCE with RS232C interfaces.

Interrupt Request Line

The 82530 SCC component provides one interrupt to the MINTRO signal of the iSBX interface. There are six sources of interrupts in the SCC component (Transmit, Receive and External/Status interrupts in both channels). Each type of interrupt is enabled under program control with Channel A having higher priority than Channel B, and with Receive, Transmit

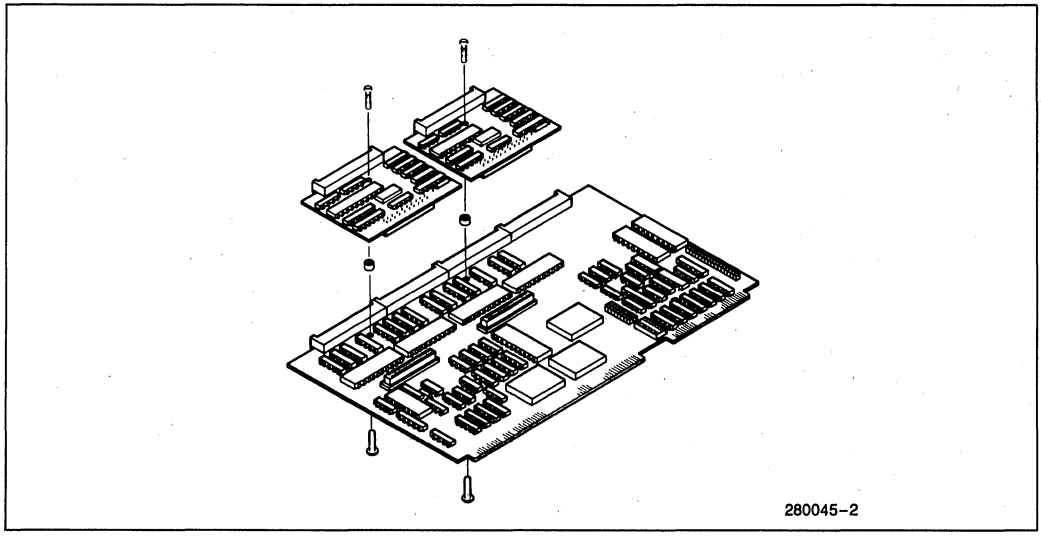


Figure 1. Installation of 2 iSBX™ 354 MULTIMODULE™ Boards on an iSBC® Board

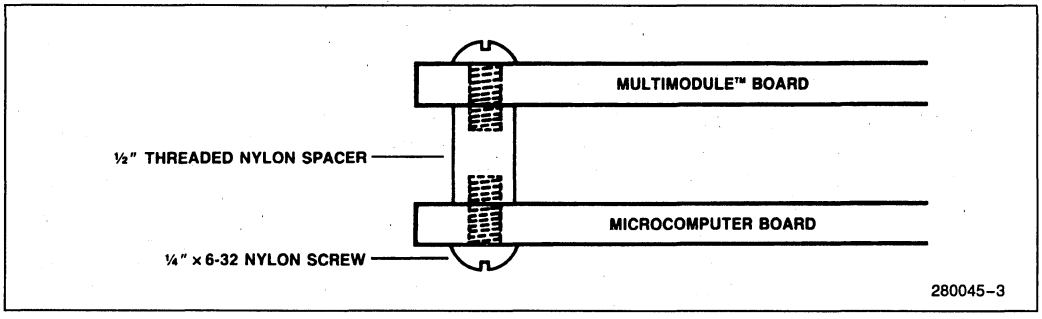


Figure 2. Mounting Technique

and External/Status interrupts prioritized in that order within each channel.

Installation

The iSBX 354 module plugs directly into the female iSBX connector on the host board. The module is then secured at one additional point with nylon hardware to insure the mechanical security of the assembly. Figures 1 and 2 demonstrate the installation of the iSBX 354 MULTIMODULE board on a Host Board. Figures 3 and 4 provide cabling diagrams.

Programming Considerations

The Intel 82530 SCC component contains several registers that must be programmed to initialize and control the two channels. Intel's iSBX 354 Module Hardware Reference Manual (Order #146531-001) describes these registers in detail.

RS232C DB-25 CONNECTORS

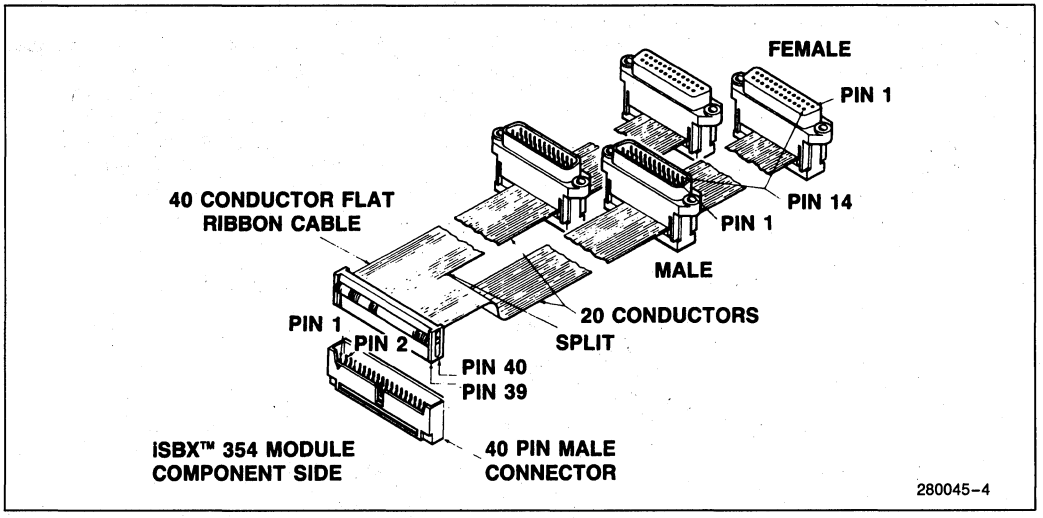


Figure 3. RS232C Cable Construction

RS422A/449 DB-37 CONNECTORS

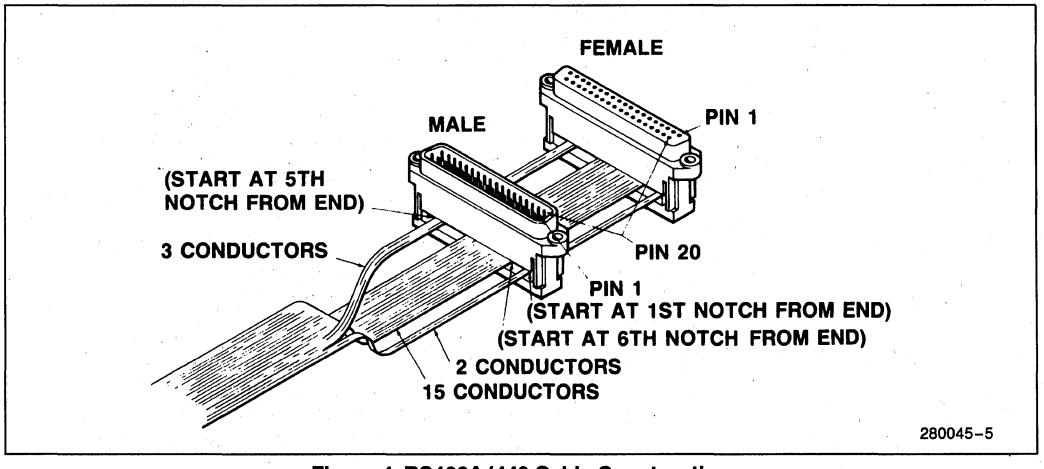


Figure 4. RS422A/449 Cable Construction

SPECIFICATIONS

Word Size

Data—8 bits

Clock Frequency

4.9152 MHz

Serial Communications

Synchronous—Internal or external character synchronization on one or two synchronous characters

Asynchronous—5–8 bits and 1, 1½ or 2 stop bits per character; programmable clock factor; break detection and generation; parity, overrun, and framing error detection

Sample Baud Rate:

Synchronous X1 Clock	
Baud Rate	**82530 Count Value (Decimal)**
64000	36
48000	49
19200	126
9600	254
4800	510
2400	1022
1800	1363
1200	2046
300	8190
Asynchronous X16 Clock	
Baud Rate	**82530 Count Value (Decimal)**
19200	6
9600	14
4800	30
2400	62
1800	83
1200	126
300	510
110	1394

INTERFACES

iSBX™ Bus: Meets the iSBX Specification, Compliance Level: D8 F

Serial: Meets the EIA RS232C standard on Channels A and B. Meets the EIA RS422A/449 standard on Channels A and B, Multi-drop capability on Channel A only.

Signals Provided

RS232C DTE

-Transmit Data
-Receive Data
-Request to Send
-Clear to Send
-Data Set Ready
-Signal Ground
-Carrier Detect
-Transmit Clock (2)
-Receive Clock
-Data Terminal Ready
-Ring Indicator

RS232C DCE

-Transmit Data
-Receive Data
-Clear to Send
-Data Set Ready
-Signal Ground
-Carrier Detect
-Transmit Clock (2)
-Receive Clock
-Ring Indicator

RS422A/449

-Send Data
-Receive Timing
-Receive Data
-Terminal Timing
-Receive Common

I/O Port Addresses

Port Address		Function
8-Bit	16-Bit	
X0		Read Status Channel B Write Command Channel B
X2		Read Data Channel B Write Data Channel B
X4		Read Status Channel A Write Command Channel A
X6		Read Data Channel A Write Data Channel A
Y0		Read Disable RS422A/449 Buffer Write Enable RS422A/449 Buffer

NOTES:
1. The "X" and "Y" values depend on the address of the iSBX interface as viewed by the base board.
2. "X" corresponds with Activation of the MCS0/interface signal; "Y" corresponds with Activation of the MCS1/interface signal.

Power Requirements

+5V at 0.5A
+12V at 50 mA
−12V at 50 mA

Physical Characteristics

Width: 2.85 inches
Length: 3.70 inches
Height: 0.8 inches
Weight: 85 grams

ENVIRONMENTAL CHARACTERISTICS

Temperature: 0°C to 55°C operating at 200 linear feet per minute across baseboard and MULTIMODULE board

Humidity: To 90%, without condensation

ORDERING INFORMATION

Part Number	Description
iSBX 354	Dual Channel I/O MULTIMODULE

REFERENCE MANUAL

146531-001—iSBX 354 Channel Serial I/O Board Hardware Reference Manual

Reference manuals may be ordered from any Intel sales representative, distributor office, or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051.

FEATURES

- Connects a System/370 or compatible multiplexer channel to the MULTIBUS® architecture
- Operates as a multidevice control unit on a block multiplexer channel
- Supports three megabytes per second data streaming through the block multiplexer channel
- Implements dynamic speed matching buffer for efficient channel utilization
- Supports up to 6 IEEE 796 Multibus compatible application adapter boards
- Implements a remote maintenance facility
- Provides standard control unit personalities
- Facilitates development of custom control unit personalities
- Designed as a completely integrated system controller
- Available in a single or dual controller configuration
- Available as system modules designed to fit into a standard 19" rack mount
- Worldwide service, support and training

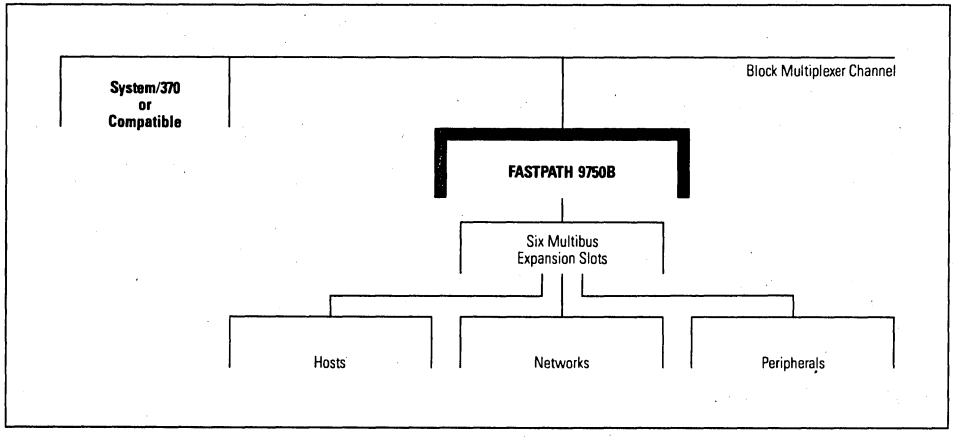
DESCRIPTION

The 9750B control unit is an open standardized connectivity platform that allows connections of Multibus-based application modules with an IBM* System/370 or compatible mainframe. Its hardware and software subsystems connect to the System/370 block multiplexer channel and the IEEE-796 Multibus interface.

The hardware and software interface is a front-end processor that performs the System/370 block multiplexer protocol management functions and presents the 9750B to the mainframe and its application software as a standard control unit. A choice of control unit personalities is provided with the 9750B. Custom personalities are easily developed and incorporated into the 9750B control unit. Multibus compatible application adapters are integrated into the 9750B connectivity platform and are addressed by the mainframe through standard subchannel addressing methods.

The 9750B maximizes throughput with its modular design implementing a speed matching buffering scheme supporting offset and data streaming protocols at the full three megabytes per second rate.

With this flexible connectivity platform, System/370 mainframes can connect to local area networks, wide area networks, hosts or specialized peripherals. The 9750B connectivity platform brings the open architecture



ORDER NUMBER: 270359-01

of Multibus to the System/370.

MODULAR DESIGN

The single controller 9750B consists of a logic module made up of a channel adapter, a control processor and adapter board connections. Up to two controllers can be configured into a single integrated rack-mount chassis.

The **Channel Adapter** is the interface between the Multibus and the System/370 compatible block multiplexer channels. Supporting up to 256 subchannel addresses which are mapped to the integrated adapter boards, the channel adapter is dynamically configurable for multiple concurrent device attachments through a single channel connection.

The **Control Processor** performs such functions as sending status, controlling data transfer between the channel adapter and the adapter boards, handling resets and managing on-line/off-line transitions.

Adapter Boards are selected from the set of board products that are electronically compatible with the IEEE 796 Multibus specification. Up to six adapter boards can be integrated into a single 9750B controller. Adapter boards are used to move data from the channel adapter out to the external application environment. Adapter boards can implement local area network protocols or perform specialized high-speed device-to-device data transfer. Multiple similar and multiple diverse applications can be supported simultaneously in a single 9750B controller chassis.

PERSONALITIES

The 9750B emulates standard System/370 mainframe control unit personalities. The mainframe operating environment is configured to recognize and address the 9750B as a standard control unit. Custom personalities can be created for the 9750B.

BSAM. When the mainframe is configured to address the 9750B as an "undefined device" (a valid device type), the Basic Sequential Access Method (BSAM) is used for data transfer between the host and the adapter boards via the standard System/370 block multiplexer channel.

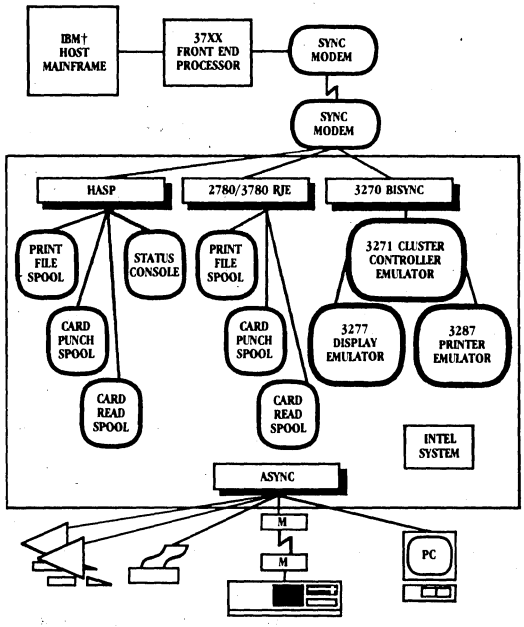
CETI. When the mainframe is configured to address the 9750B as a 3088 channel-to-channel device, the Continuously Executing Transfer Interface (CETI) protocol is used to transfer data to and from the adapter boards acting as communication ports. This allows communication with local area networks or other host-based applications. This interface provides the maximum possible throughput between the System/370 and the application by minimizing the number of I/O interrupts required to exchange data.

DIAGNOSTICS

The 9750B supports a continuously resident host addressable diagnostic emulation mode as well as a remotely accessible diagnostic service port for maintenance and problem diagnosis.

SPECIFICATIONS

		Single Controller	Dual Controller
Power Requirements:	Voltage:	110/U.S.; 230/Europe	110/U.S.; 230/Europe
	Frequency:	60 Hz/U.S.; 50-60 Hz/Europe	60 Hz/U.S.; 50-60 Hz/Europe
Operating Environment:	Temperature:	15-35° Centigrade	15-35° Centigrade
	Relative Humidity:	70-80% non-condensing	70-80% non-condensing
	Altitude:	10,000 feet maximum	10,000 feet maximum
Connectors:	Channel:	System/370 Bus and Tag	System/370 Bus and Tag
Dimensions:	Size:	15.75" x 22.25" x 19.00"	19.25" x 22.25" x 19.00"
	Weight:	407 lbs.	456 lbs.
Maximum Number of Application Adapters:		6	12
Interfaces:	Channel:	FIPS 60 and System/370 Compatible Block Multiplexer Channel	
	Adapter Boards:	IEEE 796 and Multibus Compatible	
Control Unit Personalities:		Undefined Device (BSAM Access) 3088 Device (CETI Access)	
Agencies:		UL, CSA, VDE and FCC	



VPM 188 ASYNC/BISYNC COMMUNICATION SUBSYSTEM

- *Virtual Protocol Machine delivers asynchronous and bisynchronous lines and protocols for Intel XENIX* systems and networks*
- *Mainframe link for host data, application, and report access provided by IBM protocol emulation of HASP, 2780/3780 RJE and 3270 bisync protocols*
- *Async communications support for terminal multiplexing, serial printers, async modems and serial system-to-system links*
- *Single hybrid subsystem for very cost effective and flexible multiple service communication support*
- *Full menu-driven installation, administration and user interface for ease of use*

■ VPM 188 ASYNC/BISYNC COMMUNICATION SERVICES

The VPM 188 Async/Bisync Communication Subsystem delivers a wide variety of communication services. IBM mainframe access is provided via emulation of IBM bisync network protocols and devices:

- 3271 Model 2 Cluster Controller, 3277/78 Displays, and 3287 Printers for interactive host access
- 2780/3780 Remote Job Entry (RJE) Workstation for batch host access
- Multileaving HASP RJE Workstation for batch host access

Comprehensive asynchronous communication support is provided, including:

- Async terminal multiplexing either directly attached or remotely connected via dial-up async modems
- Serial printer control
- System-to-system link support through serial async line using UUCP; either directly attached or remotely connected via async modem

■ FLEXIBLE MULTILINE CONTROL AND CONFIGURATION

The subsystem controls 8, 10 or 12 communication lines in a wide set of user selected configurations. It allows dynamic selection of line types at install and boot time; the number of bisync lines and protocols and the number of async lines can be configured for specific application requirements. Both interactive and batch mainframe access is supported via emulation of IBM's most popular network and device protocols.

■ MENU-DRIVEN INTERFACE FOR INTEGRATION AND EASE OF USE

The VPM subsystem's flexibility and power is delivered to users and administrators through a comprehensive menu system. The menus lead users and administrators through installation, generation, administration, and use of the subsystem in a nonconfrontive, easy to use manner. Rapid productivity gains results.

JANUARY, 1987
ORDER NUMBER: 270216-001

■ ADVANCED SUBSYSTEM FEATURES.

Support for simultaneous operation of multiple mixed line types and bisync protocol emulations is enabled using VPM's dynamic line configuration and protocol downloading features.

OpenNET™ compatible network operation allows bisync emulation services and async communication services to be accessed by remote XENIX and DOS users across OpenNET for cost-effective gateway operation. May require OpenNET Virtual Terminal.

Screen and print data can be moved to any system or network file for subsequent processing by standard XENIX and/or DOS applications. Addition of custom applications can enable IBM compatible distributed DP.

■ A SINGLE WORKSTATION FOR ALL PROCESSING AND COMMUNICATION NEEDS

With Intel's powerful VPM communication subsystem, users no longer require multiple workstations for their various tasks. Local department processing, personal computing, mainframe application processing and reporting and inter-user communication can all be accomplished from a single PC or terminal.

■ THE VIRTUAL PROTOCOL MACHINE STANDARD

VPM 188 implements AT&T's specification for a Virtual Protocol Machine for UNIX* systems. Intel's version for XENIX systems goes beyond the VPM standard with hybrid protocol services.

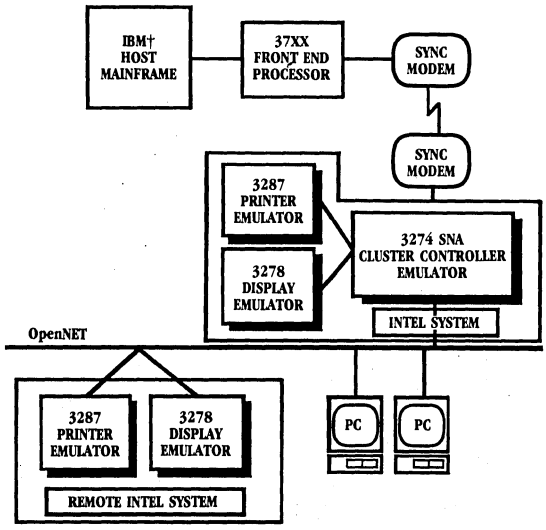
*REGISTERED TRADEMARK OF AT&T

TECHNICAL SPECIFICATIONS

3270 Bisync Emulation — 3271 Model 2 Cluster Control Unit, 3277/78 Display, 3287 Printer
HASP Emulation — Multileaving HASP RJE Workstations
2780/3780 RJE Emulation — 2780/3780 RJE Workstation Emulation
9600 bps full and half-duplex line support

ORDERING INFORMATION

VPM188DK	The base Virtual Protocol Machine for 188/48 and 188/56 controllers in Intel XENIX systems. Controls 8, 10 or 12 RS232 lines to be async and/or bisync. All async support included. Package includes software and documentation. Prerequisite is XENIX system with iBASE.
HASP188DK	Multileaving HASP RJE workstation emulator. Supports both transparent and non-transparent mode HASP protocols. Package includes HASP emulation software, installation instructions, user guide and administrator guide. Prerequisite is VPM188DK.
RBTE188DK	2780/3780 RJE workstation emulator for Remote Batch Terminal Emulation (RBTE) across bisync lines/networks. Package includes RBTE emulation software, installation instructions, user guide and administrator guide. Prerequisite is VPM188DK.
3270BSC188DK	3270 bisync emulator for interactive IBM host access. Emulates a 3271 Model 2 Cluster Control Unit and up to seven devices: 3277/78 Model 2 Displays and one 3287 Model 2 Printer. Compatible with OpenNET for cross-net gateway oriented service. Package includes all emulation software, installation instructions, 3277/78 function key templates, user guide and administrator guide. Prerequisite is VPM188DK.
SXM18848	Eight line communication system extension module hardware. Used when no 188/48 or 188/56 exists in system already. Includes all necessary hardware, cabling and documentation.
SXM354	Additional two line communication system extension module hardware. Used to add 2 async lines to 188 based subsystem via daughter board. Includes all necessary hardware, cabling and documentation. Prerequisite is SBC or SXM 188/48.



3270 SNA COMMUNICATION SUBSYSTEM

- *3270 SNA/SDLC emulator for Intel XENIX* systems and networks*
- *Mainframe data and application access*
- *SNA gateway for OpenNET™ LAN users*
- *3274 cluster controller (PU.T2), 3278 display (LU.T2) and 3287 printer (LU.T2) emulation*
- *Complete menu driven interface and administration delivers ease of use*
- *72 nodes and 16 simultaneous sessions supported*

■ 3270 SNA COMMUNICATION SERVICES

The 3270 Communication Subsystem allows multiple XENIX system users and IBM PC compatibles on an OpenNET network to operate on IBM SNA networks. The subsystem installs in a single non-dedicated XENIX system and runs SNA emulations for system users and OpenNET users. It provides emulation of a 3274 Type 2 Cluster Controller, 3278 Model 2 Displays and 3287 Model 2 Printers. Up to 72 XENIX-NET nodes are supported from a single gateway with 16 simultaneous Logical Unit sessions.

■ SNA COMMUNICATION ENVIRONMENT

This subsystem communicates with the host over dial-up, leased, point-to-point, and multidrop lines, coexisting with IBM equipment. Line speeds up to 9600 bps are supported. The subsystem communicates with a variety of IBM hosts (370, 303X, 308X, 43XX), communication front ends (3705, 3725), access methods (VTAM, TCAM) and applications (CICS, CMS, DSPRINT, ISPF, TSO/SPF). No change is required to the host software for connection and operation of the Intel 3270 SNA Subsystem.

■ OpenNET-SNA CONTROLLER AND DEVICE EMULATION GATEWAY

The 3270 SNA Communication Subsystem can be distributed across an OpenNET network for optimal gateway services. One network node contains the actual SNA communication processor for 3274 Cluster Controller emulation while other nodes have copies of the device emulators. The dispersed device emulators all access the one gateway node for mainframe SNA communication. Up to 16 users can establish and use SNA sessions simultaneously.

■ A SINGLE WORKSTATION FOR ALL PROCESSING AND COMMUNICATION NEEDS

With Intel's 3270 SNA Subsystem, users will no longer require multiple workstations for their various tasks. A single terminal or PC can be used to access local applications and data as well as access mainframe data, applications and reports. Intel's SNA emulator is optimized for very cost effective department automation.

DECEMBER, 1986
ORDER NUMBER: 270215-002

■ ADVANCED SUBSYSTEM FEATURES

Session hold allows a user to temporarily exit or suspend an SNA session to perform other tasks, while maintaining the host connection, and return to the same connection later.

Multiple gateways can exist on a single OpenNET network in those cases where greater than 16 concurrent sessions are required.

Screen and print capture features allow users to easily log screen data from the current session into any file on the network, and spool printer output to any file. Users can process the captured data files further using standard DOS and XENIX applications.

Printer sharing enables the "local copy" device to be specified as any network printer attached to a node with 3287 Printer Emulation.

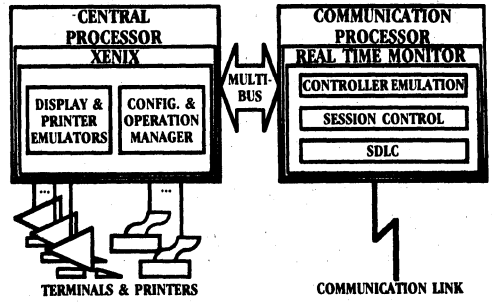
Complete menu-driven user and administration interface reduces installation and maintenance time and enhances user productivity due to low confrontation.

Interactive configuration and terminal definition utilities are included for flexibility in configuring the subsystem for target environments.

For coexistence with Intel's other advanced communication subsystem, VPM188 Async/Bisync Communication Subsystem, assures that a combination of SNA, Bisync and Async lines can be configured and used.

■ HIGH PERFORMANCE MULTI-PROCESSOR SUBSYSTEM ARCHITECTURE

The functions of the 3270 SNA Communications Subsystem are optimally distributed across the system bus. The system's central processor offloads the majority of communication tasks to an advanced communication processor which handles most of the emulation. Printer and display emulation, and configuration and operation administration are done by the central CPU while 3274 SNA Cluster Controller emulation, session control and SDLC are implemented in the communication processor. The net result is higher system performance.



■ A COMPLETE, INTEGRATED SNA COMMUNICATION SOLUTION

The 3270 SNA Communication Subsystem is a fully integrated hardware, firmware and software solution which is ready to install and operate in an Intel XENIX system. Complete installation instructions, administrator's guide and user's guide for both XENIX only and Intel's XENIX enhanced with iBASE are included.

TECHNICAL SPECIFICATIONS

3270 Base Datastream (3270 DSC)
SNA Character String (SCS)
1920 Character Device Buffers
SNA Communication Protocols
SDLC Link Protocols
9600 bps full and half-duplex

SNA PU Type 2
SNA LU Types 1, 2 and 3
Requires synchronous modem and system to modem cabling in addition to leased or dial-up communication line.

ORDERING INFORMATION

3274SNA88	Complete 3270 SNA Communication Subsystem including: iSBC 88/45-based communication controller (double high) with 256K memory and SDLC firmware, 3274 Cluster Controller emulator firmware for single system or OpenNET network SNA gateway operation, 3270 printer support software, 3278 display emulator software, 3287 printer emulator software and complete documentation.

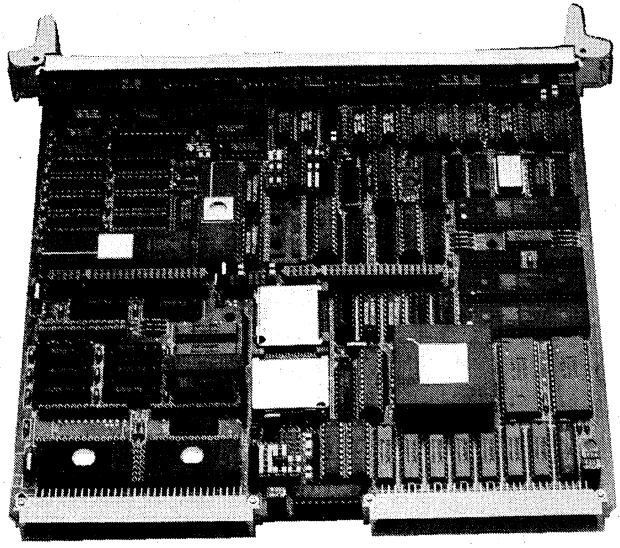
MULTIBUS® II Serial Communication Boards

13

iSBC® 186/410 MULTIBUS® II SERIAL COMMUNICATIONS COMPUTER

- **Six Serial Communication Channels on a Single MULTIBUS® II Board, Expandable to 10 Channels via iSBX™ Bus Connectors**
- **High Integration 8 MHz 80186 Microprocessor**
- **82258 Advanced DMA Controller Provides 4 Independent High Performance DMA Channels**
- **Supports RS232C-Only on 4 Channels, RS422A or RS232C Interface Configurable on 2 Channels**
- **512K Bytes DRAM Provided**
- **MULTIBUS® II iPSB (Parallel System Bus) Interface with Full Message Passing Capability**
- **Four 28-Pin JEDEC Sites, Expandable to 8 Sites with iSBC® 341 MULTIMODULE™ for a Maximum of 512K Bytes EPROM**
- **Two iSBX™ Connectors for Low Cost I/O Expansion**
- **MULTIBUS® II Interconnect Space for Software Configurability and Diagnostics**
- **Resident Firmware to Support Host-to-Controller Download Capability and Built-In-Self-Test (BIST) Diagnostics**

The iSBC 186/410 MULTIBUS II Serial Communications Computer is an intelligent 6-channel communications processor implementing the full, high performance message passing interface of the MULTIBUS II (iPSB) Parallel System Bus. This iSBC board combines an 8 MHz 80186 16-bit microprocessor, with six serial channels (expandable to 10 serial channels on-board via iSBX connectors), up to 512K bytes of DRAM, four 28-pin JEDEC sites, two iSBX connectors, and an 82258 ADMA controller on a single 220 mm x 233 mm (8.7 in. x 9.2 in.) Eurocard printed circuit board. The iSBC 186/410 board supports asynchronous, byte synchronous, and bit-synchronous (HDLC/SDLC) communications protocols on the two full/half duplex RS232C/RS422A channels, and asynchronous-only on the four full/half duplex RS232C-only channels. Acting as a terminal controller or front-end processor, this board adds significant data communications flexibility to an OEM's MULTIBUS II design.



280268-1

October 1987
Order Number: 280268-002

OPERATING ENVIRONMENT

The iSBC 186/410 MULTIBUS II Serial Communications Computer is a powerful data communications sub-system specifically designed to operate in and support the message-based, multi-processor system configurations being implemented on the MULTIBUS II architecture. The board's on-board CPU, an 8 MHz 80186 microprocessor, provides significant intelligence to off-load and distribute the serial communications functions away from one or all of a system's processor boards.

The iSBC 186/410 board was designed with a set of features to address several communications application areas: terminal/cluster controller, or front-end processor.

Terminal/Cluster Controller

A terminal/cluster controller concentrates communications in a central area of a system. Efficient handling of messages coming in or going out of the system requires sufficient buffer space to store messages along with high speed I/O channels to transmit and receive those messages. Sophisticated cluster controller applications also require character and format conversion capabilities to allow attachment of different types of terminals.

The iSBC 186/410 MULTIBUS II Serial Communications Computer is well suited for multi-terminal system applications (see Figure 1). Up to 10 serial channels can be serviced in multi-user or cluster configurations by adding two iSBX 354 Dual Serial Channel MULTIMODULE boards. The on-board 512K byte (expandable to 512K bytes) DRAM array is the buffer area designed to handle incoming and outgoing messages at data rates up to 19.2K baud (asynch). Each serial channel can be individually programmed for different baud rates to allow system configurations with differing terminal types. The on-board 80186 CPU handles the protocols and character manipulation tasks traditionally performed by a system host.

Front-end Processor

A front-end processor off-loads a system's central processor of bandwidth-draining tasks such as data manipulation and text editing of characters collected from the attached serial I/O devices. Since most ter-

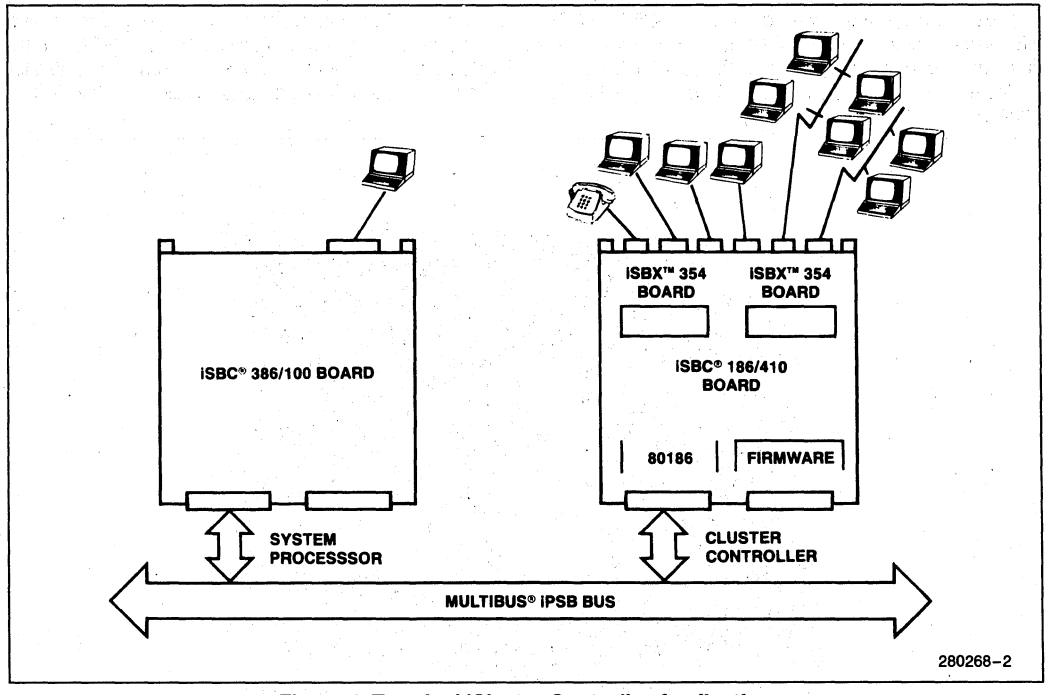


Figure 1. Terminal/Cluster Controller Application

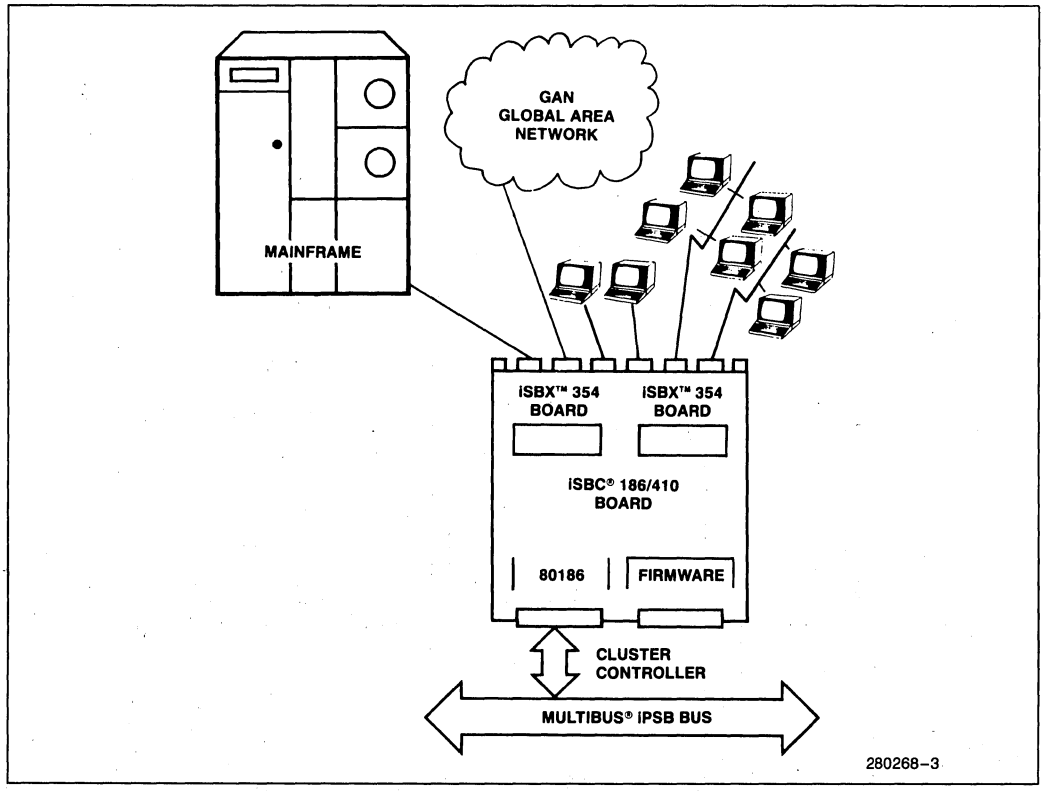


Figure 2. Front-End Processor Application

minal and serial I/O devices require flexible interfaces, program code is often dynamically downloaded to the front-end processor from a system CPU. Downloading code requires sufficient memory space for protocol handling and program code. Flow control and interrupt handling requirements need an efficient real time operating software environment to manage the hardware and software resources on the board.

The iSBC 186/410 board features are designed to provide a high performance solution for front-end processor applications (see Figure 2). A large amount of memory is provided for dynamic storage of program code. Two serial channels (as well as four iSBX expansion serial channels) can be configured for links to mainframe systems, point-to-point terminals, modems or multi-drop designs and four serial channels are for terminal communication, asynchronous RS232C operation only.

ARCHITECTURE

The iSBC 186/410 MULTIBUS II Serial Communications Computer consists of six major subsystem areas: Processor, Serial I/O, Memory, General I/O, iPSB bus interface, and Interconnect (see Figure 3).

Processor Subsystem

80186 PROCESSOR

The central processor unit on the iSBC 186/410 board is Intel's 16-bit 8 MHz 80186 microprocessor. The highly integrated 80186 CPU combines several system components onto a single chip (i.e., two Direct Memory Access lines, three Interval Timers, Clock Generator, and Programmable Interrupt Controller). The 80186 instruction set is a superset of the 8086 and maintains object code compatibility while adding additional instructions.

This high performance component manages the board's multi-user, multi-protocol communications operations. Refer to the Microsystem Components Handbook, Order Number 230843-00X, for more detailed information on the hardware operation and requirements of the 80186 microprocessor component.

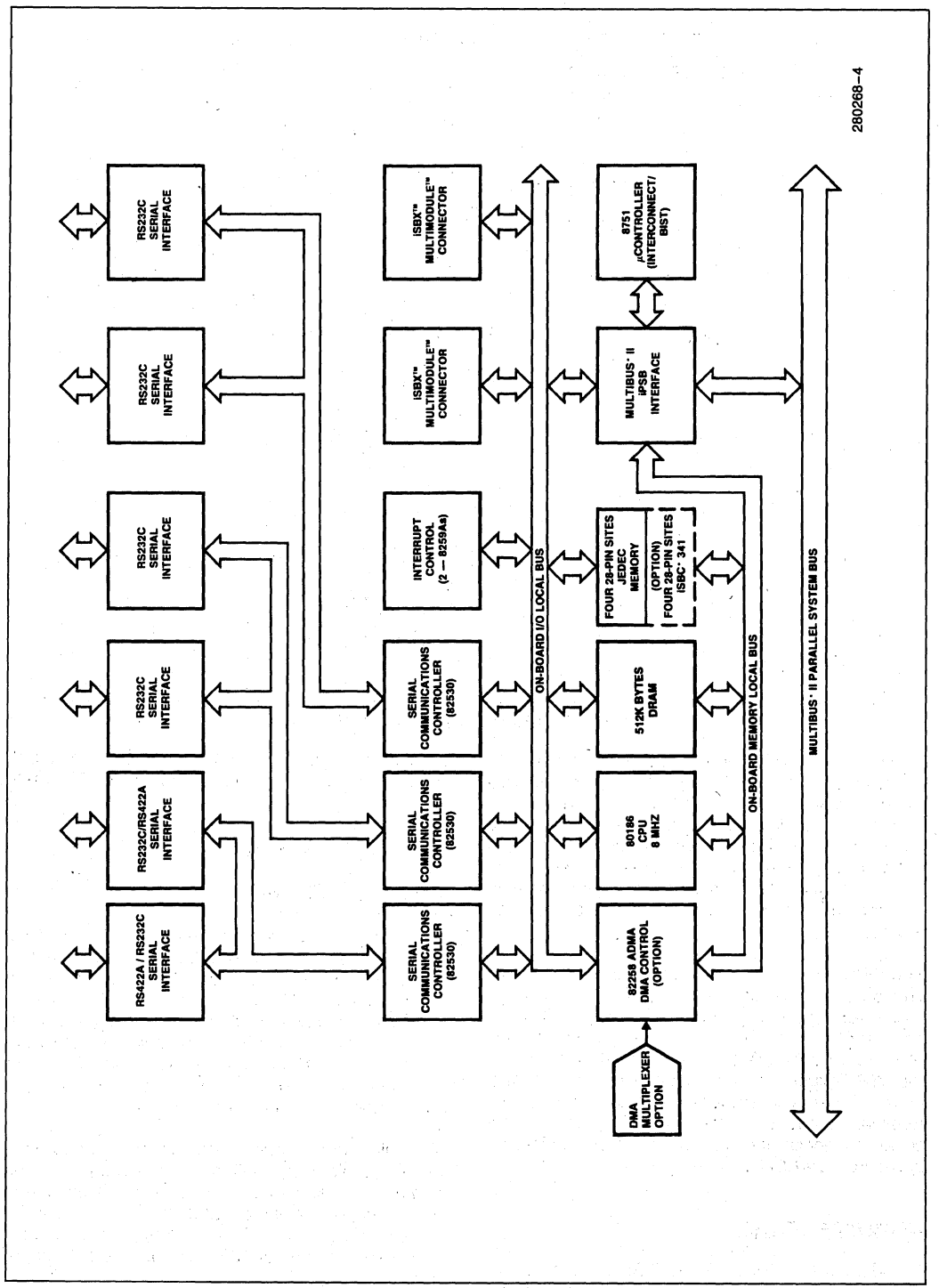


Figure 3. iSBC® 186/410 Board Functional Block Diagram

DIRECT MEMORY ACCESS (DMA) FUNCTION

The iSBC 186/410 board provides 13 channels of DMA to support serial I/O, iPSB interface, and/or iSBX bus transfer operations. The 80186 microprocessor provides two DMA channels, the 82258 Advanced (ADMA) controller supports three "direct" channels of DMA, and the ADMA multiplexer circuit uses the fourth 82258 ADMA channel providing eight additional multiplexed DMA channels. The allocation of the board's DMA channels to on-board resources is listed in Table 1.

SERIAL I/O SUBSYSTEM

Six serial interfaces are provided on the iSBC 186/410 board: two interfaces support full asynchronous, byte-synchronous, and bit-synchronous (HDLC/SDLC) communication and four interfaces support asynchronous-only communication. The two RS422A configurable ports can also be tri-stated to allow multi-drop networks. The board's serial capability can be expanded to 10 channels by adding two iSBX 354 Dual Channel Serial I/O MULTIMODULE boards. Each added iSBX 354 board uses an

Table 1. iSBC® 186/410 Board DMA Channel Allocation

Channel Count		Channel Number	DMA Configuration Local Bus Resource
80186			
1	DMA Channel	0	Half-Duplex High Speed Serial Interface (SCC1 Channel A) (—High Density 15-Pin Connector)
2	DMA Channel	1	Full-Duplex Serial Interface (SCC1 Channel A) or SBX1 DMA Request
82258 ADMA			
3	DMA Channel	0	Input DMA from MPC (Message Passing Coprocessor)
4	DMA Channel	1	Output DMA to MPC
5	DMA Channel	2	Half-Duplex High Speed Serial Interface (SCC1 Channel B) (—High Density 15-Pin Connector) or SBX1 DMA REQ
	DMA Channel	3	Full-Duplex High Speed Serial Interface (SCC1 Channel B) or INT2 DMA REQ from DMA Multiplexer
DMA Multiplexer*			
6	DMA Channel	0	Half-Duplex Serial Interface (SCC2 Chan. A, 9-pin conn.)
7	DMA Channel	1	Full-Duplex Serial Interface (SCC2 Chan. A)
8	DMA Channel	2	Half-Duplex Serial Interface (SCC2 Chan. B, 9-pin conn.)
9	DMA Channel	3	Full-Duplex Serial Interface (SCC2 Chan. B) or SBX1 DMA Request or Half-Duplex SCC1 Channel B.
10	DMA Channel	4	Half-Duplex Serial Interface (SCC3 Chan. A, 9-pin conn.)
11	DMA Channel	5	Full-Duplex Serial Interface (SCC3 Chan. A) or SBX2 DMA Request
12	DMA Channel	6	Half-Duplex Serial Interface (SCC3 Chan. B, 9-pin conn.)
13	DMA Channel	7	Full-Duplex Serial Interface (SCC3 Chan. B) or INT1 SBX1 for SBX344

NOTE:
*ADMA Channel 3 is used to add the DMA Multiplexer.

82530 SCC component to provide two independent full duplex serial channels configurable as either RS232C or RS422A interfaces. It also supports both asynchronous or programmable byte and bit synchronous (HDLC/SDLC) protocols. The HDLC/SDLC interface is compatible with IBM system and terminal equipment and with CCITT's X.25 packet switching interface.

Three 82530 Serial Communications Controllers (SCCs) provide six channels of half/full serial I/O. Two channels are configurable as either RS232C or RS422 on two high density 15-pin female D-shell connectors. Four more channels are RS232C-only using IBM standard 9-pin male D-shell connectors. All six channels directly support the Data Terminal Equipment (DTE) configuration, with the Data Communication Equipment (DCE) pin-out supported by changes in the cable wiring.

The 82530 component is designed to satisfy several serial communications requirements; asynchronous, byte-synchronous, and bit-synchronous (HDLC/SDLC) modes. The increased capability at the serial controller point results in off-loading a CPU of tasks normally assigned to the CPU or its associated hardware. Configurability of the 82530 allows the user to configure it to handle all asynchronous data formats regardless of data size, number of start or stop bits, or parity requirements. An on-chip baud rate generator allows independent baud rates on each channel.

Memory Subsystem

The iSBC 186/410 board's on-board memory subsystem consists of a large DRAM array and a set of universal memory sites. Access to the on-board memory subsystem resources, as well as off-board iPSB bus access, is accomplished by observing the iSBC 186/410 board memory map (see Figure 4). The mapping occurs within the 1 megabyte memory space of the 80186 microprocessor, and is split into three main areas: DRAM reserved, iPSB window, and EPROM reserved. The first 0 to 512K bytes is always reserved for local DRAM, the next 128K or

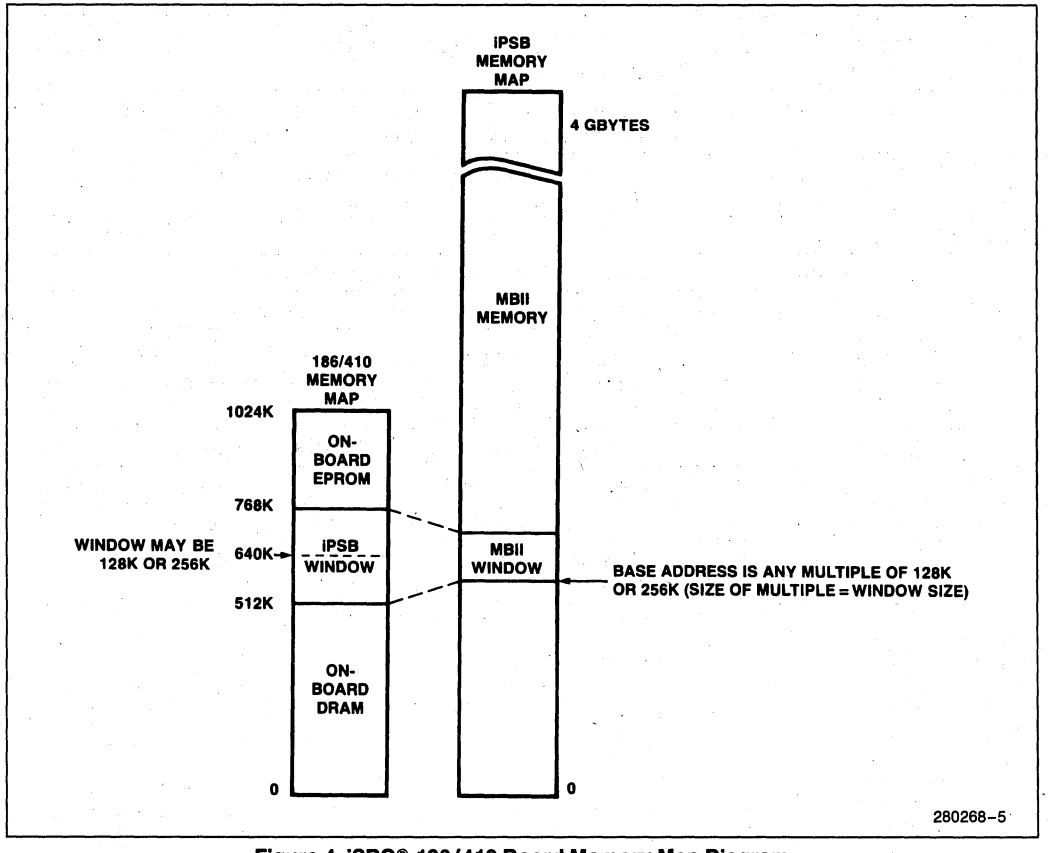


Figure 4. iSBC® 186/410 Board Memory Map Diagram

256K bytes (or up to 768K) is the iSPB window, and the remaining 384K or 256K byte area is reserved for local EPROM. The iPSB window maps a 128K or 256K byte local memory area into the 4 gigabyte global physical address range of the MULTIBUS II iPSB bus. This window is programmable and allows the 80186 processor to access the complete 4 gigabyte memory space of the iPSB bus.

The board's memory map also supports a 64K byte access window for I/O space between local and iPSB bus access. The 64K bytes of local I/O space is mapped 1-to-1 to the iPSB bus' 64K byte I/O space and is not programmable. The upper 32K bytes access the iPSB bus I/O space, and the lower 32K bytes are reserved for local on-board I/O.

DRAM CAPABILITIES

The iSBC 186/410 board comes standard with a 512K byte DRAM memory array on-board.

EPROM MEMORY

A total of four 28-pin JEDEC universal sites reside on the iSBC 186/410 board. These sockets support addition of byte-wide ROM and EPROM devices in densities from 8K bytes (2764) to 64K bytes (27512) per device. Two of the four sockets contain a pair of 27812 EPROM devices installed at the factory(1). These devices contain 128K bytes of firmware providing both the Host-to-controller download routine and the Built-In-Self-Test (BIST) power-up diagnostics routine. The remaining two sockets allow the user to add either two additional devices or an iSBC 341 EPROM MULTIMODULE for a maximum of 512K bytes.

NOTE:
(1) These devices may be removed by the user for access to the two 28-pin sites.

General I/O Subsystem

The I/O subsystem provides timers, interrupt control and two IEEE P959 iSBX connectors for I/O expansion or customization.

PROGRAMMABLE TIMERS AND INTERRUPT CONTROL

The 80186 microprocessor on the iSBC 186/410 board provides three independent, fully programmable 16-bit interval timers/event counters for use by the systems designer to generate accurate time intervals under software control. The outputs may be independently routed to a PIC to count external events. The system software configures each timer independently and can read the contents of each counter at any time during system operation.

In a MULTIBUS II system, external interrupts (interrupts originating from off-board) are interrupt type messages over the iPSB bus rather than signals on individual lines. Interrupt type messages are handled by the bus interface logic, the MPC Message Passing Coprocessor chip. The MPC component interrupts the 80186 processor via an 8259A Programmable Interrupt Controller (PIC) indicating a message has been received. This means that 1 Interrupt line can handle interrupts from up to 255 sources.

Two on-board 8259A PICs are used in a master-slave configuration for processing on-board interrupts. One of the interrupt lines handles the interrupt messages received from the iPSB bus. Table 2 includes a list of devices and functions supported.

iSBX™ BUS I/O EXPANSION

Two 8/16-bit iSBX bus (IEEE P959) connectors are provided for modular, low-cost I/O expansion. The iSBC 186/410 board supports both 8-bit and 16-bit iSBX MULTIMODULEs through these mating, gas-tight pins and socket connectors. DMA is also supported to the iSBX connectors and can be configured by programming the DMA multiplexor attached to the 82258 ADMA component. The iSBX connectors on the iSBC 186/410 board support a wide variety of standard iSBX compatible boards from Intel and other independent vendors providing add-on functions such as, floppy control, ¼" tape control, bubble memory, parallel/serial I/O, BITBUS™ interface, math, graphics, IEEE 488, and analog I/O. Custom iSBX module designs are also supported as per the IEEE P959 iSBX bus specification.

iPSB Bus Interface Subsystem

This subsystem's main component is the Message Passing Coprocessor chip. Subsystem services provided by the MPC bus interface component include full message passing support and memory, I/O, and interconnect access to the iPSB bus by the 80186 processor. The single-chip Message Passing Coprocessor is a highly integrated CHMOS device implementing the full message passing protocol and performing all the arbitration, transfer, and exception cycle protocols specified in the MULTIBUS II Architecture Specification Rev. C., Order Number 146077.

Table 2. iSBC® 186/410 Board Interrupt Devices and Functions

Device	Function	Number of Interrupts
iPSB Bus Interface (MPC)	Message-Based Interrupt Requests from the iPSB bus via MPC Message Passing Coprocessor	1 interrupt for up to 255 sources
8751 Interconnect Controller	Interconnect Space	1
80186 Timers & Interrupt	Timers 0 and 1 and Interrupt Acknowledge 1	3
82530 SCCs (3 devices)	SCC #1 and SCC #2 or SCC #3 for Transmit Buffer Empty, Receive Buffer Full, and Channel Errors	2
iPSB Bus Interface (MPC)	Indicates Transmission Error on iPSB Bus	1
82258 ADMA	DMA Transfer Complete	1
IEEE P959 iSBX Bus Connectors (2)	Functions Determined by iSBX Bus MULTIMODULE Boards	4 (2/connector)
IEEE P959 iSBX Bus Connectors (2)	DMA Interrupt from iSBX (TDMA)	2

Interconnect Subsystem

MULTIBUS II interconnect space is a standardized set of software configurable registers designed to hold and control board configuration information as well as system and board level diagnostics and testing information. Interconnect space is implemented with the 8751 microcontroller and the MPC silicon resident on the iSBC 186/410 board.

The read-only registers store information such as board type, vendor I.D., firmware rev. level, etc. The software configurable registers are used for auto-software configurability and remote/local diagnostics and testing.

Firmware Capability

HOST/CONTROLLER SOFTWARE DOWNLOAD ROUTINE

Resident in ROM on this controller is a host-to-controller software download routine to support the downloading of communication firmware into the iSBC 186/410 Serial Communication Computer. This loader adheres to the MULTIBUS II Download Protocol and responds to commands issued by software running on a host CPU board. The host CPU passes these commands to the loader via registers defined in the board's interconnect space. A download function, a commence execution function, and an examine local memory function are all provided in the routine. Data transfers are supported by both shared memory systems and message based systems. The top 1K of DRAM on the board is reserved for the exclusive use of the download program. Host CPUs must not overwrite this area with download commands.

Software on the host is responsible for accessing the iSBC 186/410 board's firmware on disk or from ROM visible to the host and translating it into linear sequences of bytes suitable for downloading (see Figure 5). After downloading the firmware, the host issues a command for the loader routine on the controller to begin execution of the downloaded software.

BUILT-IN SELF-TEST DIAGNOSTICS

On-board built-in self-test (BIST) diagnostics provide a customer confidence test of the various functional areas on the iSBC 186/410 board. The initialization checks are performed by the 8751 microcontroller, while the BIST package is executed by the 80186 microprocessor. On-board tests included in the BIST package are: DRAM, EPROM, 80186, 82530 SCCs, and the MPC.

Additional activities performed include initialization at power-up using the Initialization and Diagnostics Executive and a program table check, a feature allowing users to add custom code in EPROM while still maintaining full use of factory supplied BISTs. Immediately after power-up and initialization of the 8751 microcontroller, the 80186 microprocessor begins its own initialization and on-board diagnostics. Upon successful completion of these activities, the Initialization and Diagnostics Executive invokes the user-defined program table. A check is made of the program table which then executes user-defined custom programs.

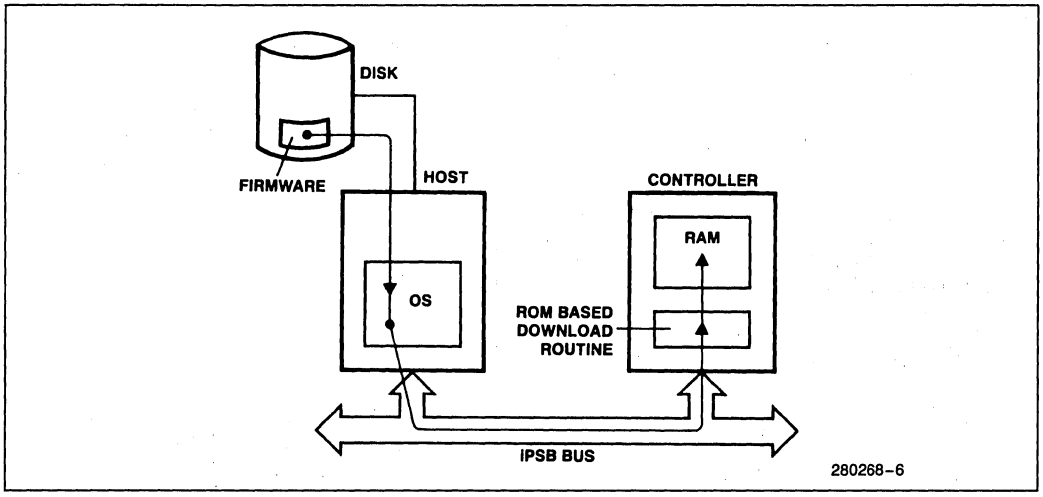


Figure 5. Download Routine

The BIST package provides a valuable testing, error reporting and recovery capability on MULTIBUS II boards enabling the OEM to reduce manufacturing and maintenance costs. An LED on the board's front panel indicates the status of power-up diagnostics. It is on when BIST diagnostics start running and is turned off upon successful completion of the BISTs.

SPECIFICATIONS

Word Size

Instruction: 8-, 16-, 24-, 32-, 40-, or 48-bits

Data: 8- or 16-bits

System Clock

CPU: 8.0 MHz

Cycle Time

Basic Instruction: 8.0 MHz—500 ns

NOTE:
Basic instruction cycle is defined as the fastest instruction time (i.e., 4 clock cycles).

Memory Capacity

Local Memory

DRAM—512K bytes on-board (64K x 4-bit devices); 8 sockets provided to support additional 256K bytes

EPROM—Number of sockets—four 28-pin JEDEC sites

EPROM	Device Size (Bytes)	Max. Memory Capacity
2764	8K	32K bytes
27128	16K	64K bytes
27256	32K	128K bytes
27512	64K	256K bytes

NOTE:
**EPROM Expansion to up to a maximum of 512K bytes is achieved via attachment of the iSBC 341 EPROM (256K byte) MULTIMODULE board.

I/O Capability

Serial—Six programmable serial channels using three 82530 Serial Communications Controller components.

I/O Expansion—Two 8/16-bit IEEE P959 iSBX connectors (DMA supported). (The board supports either two single wide or one double-wide form factor iSBX module(s).)

Timers—Three programmable timers on the 80186 microprocessor.

Input Frequencies—Frequencies supplied by the internal 80186 16 MHz crystal; 82530 SCCs: crystal driven at 9.8304 MHz div. by two; iSBX Connector: crystal driven at 9.8304 MHz.

Serial Communications Characteristics

Synchronous—Internal or external character synchronization on one or two synchronous characters.

Asynchronous—5—8 data bits and 1, 1½ or 2 stop bits per character; programmable clock factor; break detection and generation; parity, overrun, and framing error detection.

Baud Rates

Synchronous X1 Clock (Channels 0, 1)	
Baud Rate	**82530 Count Value (Decimal)**
64000	36
48000	49
19200	126
9600	254
4800	510
2400	1022
1800	1363
1200	2046
300	8190
Asynchronous X16 Clock (Channels 0–5)	
Baud Rate	**82530 Count Value (Decimal)**
19200	6
9600	14
4800	30
2400	62
1800	83
1200	126
300	510
110	1394

Serial Signals/Pin-Outs

RS232C Interface Pin Assignment for High Density 15-Pin Connectors

J2 Pin	RS-232C Pin Number	RS-232C Signal Name	RS-232C Signal Function
1	1	TXD	Transmit Data
2	2	RTS	Request To Send
3	3	RXD	Receive Data
4	4	CTS	Clear To Send
5	5	RXC	Receive Clock
6	6	DSS	Data Signal Select
7	7	DTR	Data Terminal Ready
8	8	DSR	Data Set Ready
9	9	DCD	Carrier Detect
10	10	STXC	Transmit Clock
11	11	SGD	Signal Ground
12	12	LCLPBK	Local Loopback
13	13	RMLPBK	Remote Loopback
14	14	TSTMD	Test Mode Indicator
15	15	RNG	Not Supported

RS422A Interface Pin Assignment for High Density 15-Pin Connectors

J1 Pin	Signal Name On Board	RS-422A Signal Name	RS-422A Signal Function
1	RS42211	TR (a)	Transmit Data
2		(a)	Control
3	RS4229	RD (a)	Receive Data
4		(a)	Indication
5		(a)	Signal Timing
6	RS42212	TR (b)	Transmit Data
7		(b)	Control
8	RS42290	RD (b)	Receive Data
9		(b)	Indication
10		(b)	Signal Timing
11			Signal Ground
12			Not Used
13			Not Used
14			Not Used
15			Chassis Ground

NOTE:
The iSBC® 186/40 board does not support the unused signals.

RS232C Interface Pin Assignment for IBM® Compatible 9-Pin Connectors

Pin Number	Signal Name	Function	In/Out
1	CD	Carrier Detect	In
2	RXD	Received Data	In
3	TXD	Transmit Data	Out
4	DTR	Data Terminal Ready	Out
5	SG	Signal Ground	
6	DSR	Data Set Ready	In
7	RTS	Request To Send	Out
8	CTS	Clear To Send	In
9	RI	Ring Indicator	Not Supported

Interrupt Capability

Potential Interrupt Sources from iPSB Bus—255 individual and 1 Broadcast

Interrupt Levels—12 vectored requests using two 8259As and 1 input to the master PIC from the slave PIC

Interrupt Requests—All levels TTL compatible

Interfaces

iPSB Bus—Compliance Level RQA/RPA D16M32

iSBX Bus—Compliance Level D8/16 DMA

Serial I/O—2 ch. RS232C or RS422A compatible, configured DTE only; 4 ch. RS232C IBM compatible only, configured DTE only.

Connectors

Interface	Connector	Part #
iPSB bus (P1)	96-pin DIN, right angle female	603-2-IEC-C096-F
RS232C/ RS422A	15-pin high density, D type, right angle female (see note)	
RS232C-only	9-pin IBM compatible, D type, right angle male (see note)	

NOTE:
The manufacturers below provide connectors which will mate with the connectors supplied on the iSBC 186/410 board front-panel.

Mating Connectors, Shells and Cables

Connectors and Shells	Manufacturer	Pins	Part No.
High Density D-type Plug (male)	AMP	15	204501-1
High Density D-type Plug (male)	Positronic	15	DD-15M
D-type Receptacle (female)	AMP	9	205203-3
D-type Receptacle (female)	ITT-Cannon	9	DE-9S
Connector Shells	AMP	(For 15 or	745171-X
	ITT-Cannon	9-pin connect.	DE-51218
	3M	above).	358-2100
Cable Description	**Manufacturer**		**Part No.**
15 Conductor—Shield, Round	Alpha		5120/15
15 Conductor—Shield, Round	Beldon		9541
10 Conductor—Shield, Round	Alpha		5120/10
9 Conductor—Shield, Round	Beldon		9539

NOTE:
All cable referenced is available in 100 ft. minimum lengths.

PHYSICAL DIMENSIONS

The iSBC 186/410 board meets all MULTIBUS II mechanical specifications as presented in the MULTIBUS II Architecture Specification Handbook (#146077, Rev. C)

Eurocard Form Factor

Depth: 220 mm (8.7 inches)

Height: 233 mm (9.2 inches)

Front Panel Width: 20 mm (0.76 inches)

Weight: 822 gm (29 ounces)

ENVIRONMENTAL CHARACTERISTICS

Temperature

Inlet air at 200 LFM airflow over all boards
Non-operating: −40°C to +75°C
Operating: 0° to +55°C

Humidity

Non-operating—95% Relative Humidity @ +55°C, non-condensing

Operating—90% Relative Humidity @ +55°C, non-condensing

ELECTRICAL CHARACTERISTICS

The maximum power required per voltage is shown below.

Voltage (volts)	Max. Current (amps)	Max. Power (watts)
+5V	8.22A	43.16W
+12V	150 mA	1.89W
−12V	150 mA	1.89W

REFERENCE MANUALS

iSBC 186/410 Serial Communications Computer User's Guide (#148941-001)

Intel MULTIBUS II Architecture Specification Handbook (#146077)

Manuals may be ordered from any Intel Sales Representative, Distribution Office, or from the Intel Literature Department, 3065 Bowers Avenue, Santa Clara, CA 95051.

ORDERING INFORMATION

Part Number	Description
iSBC 186/410	MULTIBUS II Serial Communications Computer

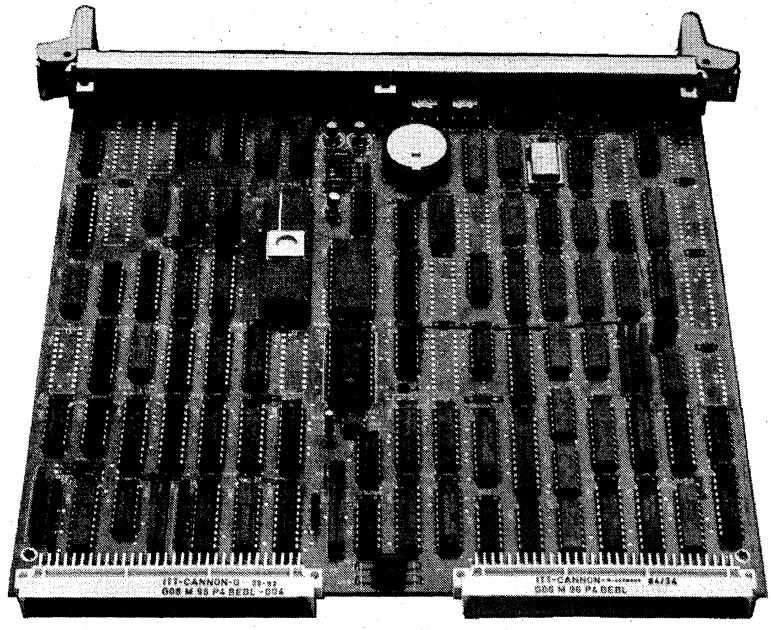
MULTIBUS® II System Development and Support Software

14

iSBC® CSM/001
CENTRAL SERVICES MODULE

- **iSBC® CSM/001 Central Services Module Integrates MULTIBUS® II Central System Functions on a Single Board**
- **MULTIBUS® II Parallel System Bus Clock Generation for all Agents Interfaced to the MULTIBUS II iPSB Bus**
- **System-wide Reset Signals for Power-up, Warm Start, and Power Failure/ Recovery**
- **System-wide Time-out Detection and Error Generation**
- **Slot I.D. and Arbitration I.D. Initialization**
- **MULTIBUS II Interconnect Space for Software Configurability and Diagnostics**
- **Built-In Self Test (BIST) Power-up Diagnostics with LED Indicator and Error Reporting Accessible to Software via Interconnect Space**
- **General Purpose Link Interface to Other Standard (MULTIBUS I) or Proprietary Buses**
- **Time-of-day Clock Support with Battery Back-up on Board**
- **Double-high Eurocard Standard Form Factor, Pin and Socket DIN Connectors**

The iSBC CMS/001 Central Services Module is responsible for managing the central system functions of clock generation, power-down and reset, time-out, and assignment of I.D.s defined by the MULTIBUS II specification. The integration of these central functions in a single module improves overall board area utilization in a multi-board system since these functions do not need to be duplicated on every board. The iSBC CMS/001 module additionally provides a time-of-day clock and the general purpose link interface to the other standard (MULTIBUS I) or proprietary buses.



280070-1

November 1986
Order Number: 280070-002

FUNCTIONAL DESCRIPTION

Overall

The iSBC CMS/001 Central Services Module integrates MULTIBUS II central system functions on a single board. Each MULTIBUS II system requires management of these central system functions as defined in the MULTIBUS II specification. Figure 1 illustrates a typical multiprocessing MULTIBUS II system configuration. To perform its central system functions, the iSBC CSM/001 Central Services Module has a fixed slot I.D. and location in the backplane. The iSBC CSM/001 board additionally provides an interface to the MULTIBUS I Link board and a time-of-day clock.

Architecture

The iSBC CSM/001 board is functionally partitioned into 6 major subsystems. The Central System Wide Control subsystem includes MULTIBUS II iPSB bus clock generation and system wide reset signal generation. The Time-Out Control subsystem provides system wide time out detection and error generation. The System Interconnect Space subsystem controls I.D. initialization and software configurable interconnect space. The Link Board interface subsystem provides an interface to the MULTIBUS I Link board or links to other buses. The last two subsystems are of the Time-of-Day clock and the iPSB bus interface. These areas are illustrated in Figure 2.

CENTRALIZED SYSTEM-WIDE CONTROL SUBSYSTEM

Parallel System Bus Clock Generation

The CSM generates the Parallel System Bus clocks. The Bus Clock (BCLK*) 10 MHz signal and the Constant Clock (CCLK*) 20 MHz signal are supplied by CSM to all boards interfaced to the Parallel System Bus. These boards use the Bus Clock 10 MHz signal for synchronization, system timing, and arbitration functions. The Constant Clock is an auxiliary clock. The frequency of the Bus Clock and Constant Clock can be halved via jumpers for diagnostic purposes.

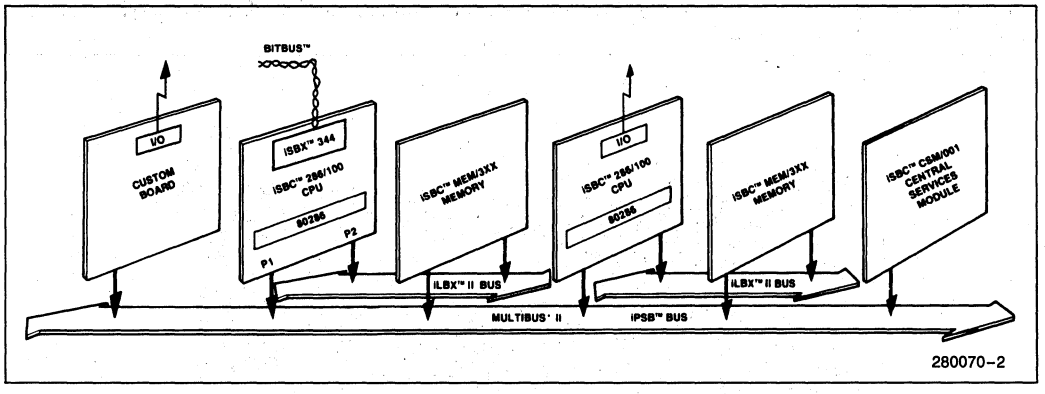


Figure 1. Typical MULTIBUS® II System Configuration

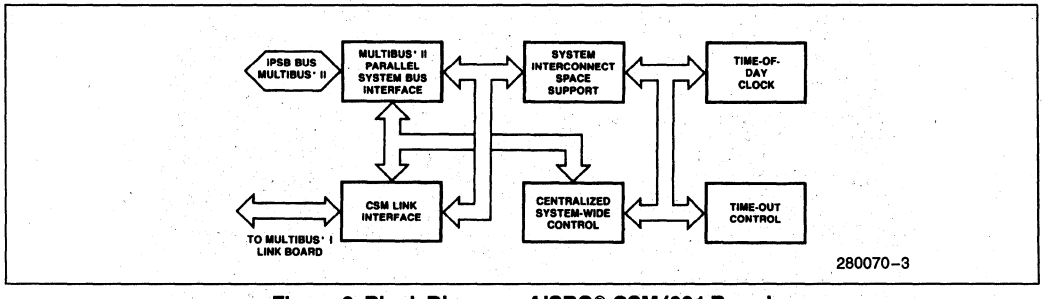


Figure 2. Block Diagram of iSBC® CSM/001 Board

Reset Control and Power-Fail/ Recovery

The CSM sends a system-level reset/initialization signal to all boards interfaced to the Parallel System Bus. The CSM assigns slot I.D. and arbitration I.D. to these boards during this initialization process. It provides this signal upon pressing of the reset switch, restoration of system power or a software request for reset received via the CSM interconnect space. The reset switch may be jumper-configured to cause a power-up or warm reset, with cold reset the default configuration. The reset switch is located on the front panel. Additionally, warm reset and cold reset signals can be input through the P2 connector.

The CSM power supply interface is accomplished via the ACLO input of the P2 connector. ACLO is an open collector input from the power supply which provides advance warning of imminent power fail. If battery backup is not required, a jumper is provided on the CSM to disable the power fail signal ACLO.

TIME-OUT SUBSYSTEM

The TIMOUT* (Time-Out) signal is provided by the CSM whenever it detects the failure of a module to complete a handshake. This TIMOUT* signal is received by all boards interfaced to the iPSB bus and may be disabled via the interconnect space.

INTERCONNECT SUBSYSTEM

The CSM Interconnect subsystem provides arbitration I.D., and slot I.D. initialization, software configurable interconnect space, and on-board diagnostics capability.

At reset, the CSM supplies each board interfaced to iPSB bus with its slot I.D. and its arbitration I.D. The slot I. D. assignment allows user or system software to address any board by its physical position in the backplane.

The interconnect space has both read-only and software configurable facilities. The read-only registers hold information such as vendor number and board type, so that this information is available to the system software. The CSM software configurable interconnect space allows write operations to support board configuration and diagnostics under software control. The CSM also uses interconnect space for system wide functions such as providing a time/date record (from time-of-day clock), software access to diagnostics and software control of the system wide functions.

BUILT-IN-SELF-TEST (BIST) DIAGNOSTICS

Self-test/diagnostics have been built into the heart of the MULTIBUS II system. These confidence tests and diagnostics improve reliability and reduce manufacturing and maintenance costs. LED 1 (labeled BIST) is used to indicate the status of the Built-In-Self-Test. It is turned on when the BIST starts running and is turned off when the BIST completes successfully. In addition, all error information is recorded in interconnect space so it is accessible to software for error reporting.

The Built-In-Self-Tests performed by the on-board microcontroller at power-up or at software command are:

1. PROM Checksum Test—Verifies the contents of the 8751 microcontroller.
2. RAM Test—Verifies that each RAM location of the 8751 microcontroller may store 0's and 1's by complementing and verifying twice each RAM location.
3. Real Time Clock Chip RAM Test—Verifies that reads and writes to the RAM locations on Real Time Clock Chip are functional.
4. Real Time Clock Test—Reads and writes all RAM locations of the RTC chip. Not run at power-up due to destructive nature.
5. Arbitration/Slot I.D. Register Test—Verifies that arbitration and slot I.D.s can be read and written from on-board.
6. 8751 Status Test—Verifies that input pins of the 8751 are at correct level.
7. Clock Frequency Test—Tests accuracy of Real Time Clock to 0.2% against bus clock.

CSM LINK INTERFACE

The CSM Link Interface and the MULTIBUS I iSBC LNK/001 board provides a bridge between MULTIBUS I and MULTIBUS II systems. Hybrid systems can be built for development or target. The CSM Link Interface uses the P2 connector on the iSBC CSM/001 module for transferring commands and data from MULTIBUS II to a MULTIBUS I Link board. The MULTIBUS I Link board (iSBC LNK/001) is purchased separately from the iSBC CSM/001 board and includes the cable which connects the iSBC CSM/001 board and the MULTIBUS I Link board (see Figure 3).

The CSM Link Interface supports 8- or 16-bit transfers via a 16-bit address/data path. The iSBC LNK/001 board resides in the MULTIBUS I system and provides a memory and I/O access window to MULTIBUS I from the MULTIBUS II Parallel System Bus. Only one iSBC LNK/001 board can be connected to the iSBC CSM/001 module.

TIME-OF-DAY CLOCK SUBSYSTEM

The Time-Of-Day Clock subsystem consists of a clock chip, battery, and interface circuitry. The clock provides time keeping to 0.01% accuracy of fractions of seconds, seconds, minutes, hours, day, day of week, month, and year. This information is accessible via the interconnect space. The battery backup for the clock chip provides 2 years of operation.

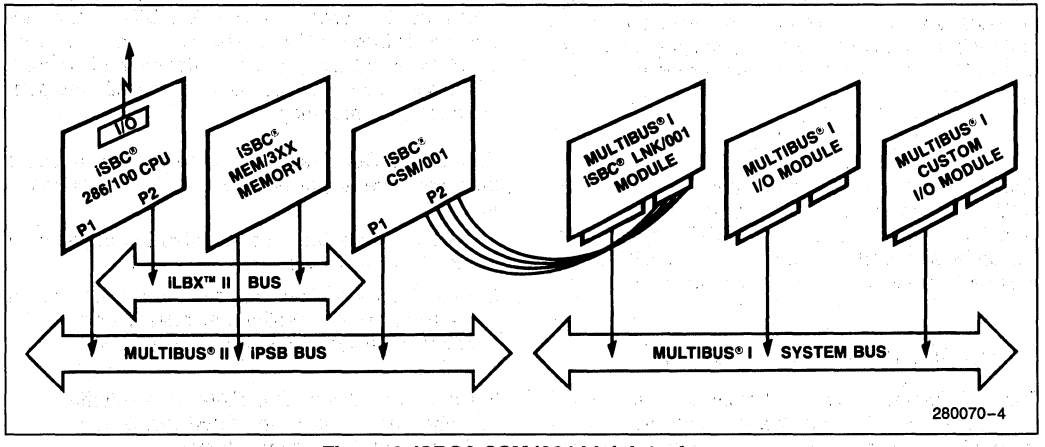


Figure 3. iSBC® CSM/001 Link Interface

SPECIFICATIONS

System Clocks

BCLK* (Bus Clock)	10 MHz
CCLK* (Constant Clock)	20 MHz
LCLK* (Link Clock)	10 MHz

Jumper option available to divide these frequencies in half

Interface Compliance

MULTIBUS II Bus Architecture Specification (#146077)

Link Cable

The Link cable uses a 64-conductor ribbon cable for interconnecting the CSM board to the Link Board. The maximum length for the cable is 1 meter.

Interface Specifications

Location	Function	Part #
P1	iPSB Bus	603-2-IEC-C096F
P2	Link and Remote Services	603-2-IEC-C064-F

PHYSICAL DIMENSIONS

The iSBC CSM/001 board meets all MULTIBUS II mechanical specifications as presented in the MULTIBUS II specification (#146077).

Double-High Eurocard Form Factor:

Depth:	220 mm. (8.7 in.)
Height:	233 mm. (9.2 in.)
Front Panel Width:	20 mm. (0.78 in.)
Weight:	4820 gm. (16.5 oz.)

ENVIRONMENTAL REQUIREMENTS

Temperature: (inlet air) at 200 LFM airflow over boards

Non-operating: −40 to +70°C
Operating: 0 to +55°C

Humidity: Non-operating: 95% RH @ 55°C
Operating: 90% RH @ 55°C

POWER REQUIREMENTS

Voltage (volts)	Current (amps)
+5	6A (max.)
+5 VBB	1A (max.)

BATTERY CHARACTERISTICS

3V nominal voltage; capacity of 160 milliamp hours minimum.

BATTERY DIMENSIONS

Outside dimension	20 mm–23 mm
Height	1.6 mm–3.2 mm

REFERENCE MANUALS

iSBC CSM/001 Board Manual (#146706-001)

Intel MULTIBUS II Bus Architecture Specification (#146077)

Manuals may be ordered from any Sales Representative, Distributor Office, or from the Intel Literature Department, 3065 Bowers Ave., Santa Clara, CA 95051.

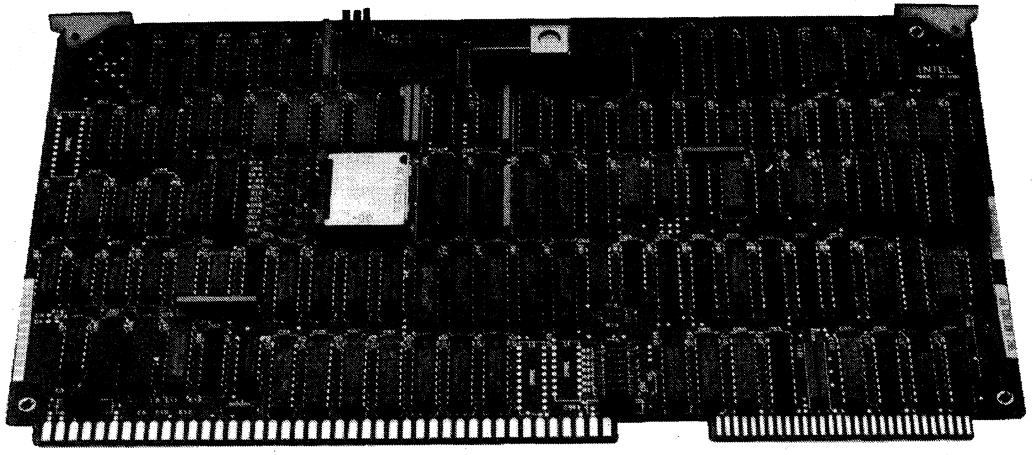
ORDERING INFORMATION

Part Number	Description
iSBC CSM/001	MULTIBUS II Central Services Module

iSBC® LNK/001 BOARD
MULTIBUS® II TO MULTIBUS® I Link Board

- **Development Vehicle Making MULTIBUS® I iSBC® Boards Accessible to MULTIBUS® II Board Designers**
- **On Board 128K Byte Dual Port DRAM Memory**
- **16M Bytes of MULTIBUS® I Memory Mapped into MULTIBUS® II Memory Space Configurable from MULTIBUS® II Interconnect Space**
- **32K Bytes of MULTIBUS® I I/O Mapped into MULTIBUS® II I/O Space Configurable from MULTIBUS® II Interconnect Space**
- **Conversion of MULTIBUS® I Interrupts to MULTIBUS® II Interrupt Messages**
- **MULTIBUS® I Form Factor Board**
- **Connects to MULTIBUS® II Central Services Module (iSBC CSM/001 Board) via a 3 Foot Flat Ribbon Cable**

The iSBC LNK/001 board maps MULTIBUS I memory and I/O space into the MULTIBUS II iPSB bus and converts MULTIBUS I interrupts into MULTIBUS II interrupt messages. Up to 16M Bytes of MULTIBUS I memory and up to 32K Bytes of MULTIBUS I I/O is addressable from MULTIBUS II through the iSBC LNK/001 board. Additionally, 128K Bytes of dual port DRAM memory resides on the iSBC LNK/001 board for use by both MULTIBUS I and MULTIBUS II systems. MULTIBUS II OEM product designers can now speed hardware and software development efforts by using the iSBC LNK/001 board to access standard or custom MULTIBUS I products.



280135-1

October 1986
Order Number: 280135-002

GENERAL DESCRIPTION

The iSBC LNK/001 board makes MULTIBUS I products accessible to MULTIBUS II designers. The iSBC LNK/001 board resides in the MULTIBUS I system and connects to the Central Services Module (iSBC CSM/001 board) via a 3 foot flat ribbon cable. The ribbon cable connects the P2 connector of the iSBC LNK/001 board to the P2 connector on the Central Services Module. The iSBC LNK/001 board supports:

a. 128K Bytes of Dual Port DRAM,

b. 16- and 24-bit addressing into 16M Bytes of MULTIBUS I memory with 8- and 16-bit data paths,

c. 8- and 16-bit addressing into 32K Bytes of MULTIBUS I I/O with 8- and 16-bit data paths,

d. MULTIBUS I interrupt to MULTIBUS II interrupt message conversions of up to eight levels of non bus-vectored interrupts via an 8259A programmable interrupt controller, and

e. initialization tests and Built-In-Self-Test (BIST) using interconnected address space.

APPLICATIONS

The primary application of the iSBC LNK/001 board is in the design development environment. The iSBC LNK/001 board allows designers to start their development efforts by leveraging existing MULTIBUS I products or to begin modular design efforts and preserve investments in custom products. In either case, the use of leverage with existing MULTIBUS I hardware and software allows designers to begin their MULTIBUS II product designs.

MEMORY AND I/O READ/WRITE SEQUENCE

The iSBC LNK/001 board establishes a master/slave relation between a MULTIBUS II system and a MULTIBUS I system. A MULTIBUS II agent requesting a memory transfer involving the iSBC LNK/001 board is directed through the CSM to the iSBC LNK/001 Dual Port memory or a MULTIBUS I slave. If the access address is within the MULTIBUS II Dual Port window, the transaction is acknowledged by the iSBC LNK/001 board and returned to the MULTIBUS II iPSB through the CSM. In the event the address is outside the MULTIBUS II Dual Port window, the transaction is directed to the MULTIBUS I system. Here the iSBC LNK/001 board enters arbitration for the MULTIBUS I system bus to complete the requested transaction. Once the iSBC LNK/001 board is the owner of the MULTIBUS I system bus, data is transferred to or from the iSBC LNK/001 board/Central Services Module connection. The MULTIBUS I slave acknowledges the transfer and the iSBC LNK/001 board passes the acknowledge on through the Central Services Module to the MULTIBUS II iPSB.

MULTIBUS II I/O operations are always directed to the MULTIBUS I I/O slaves and consequently require arbitration for the MULTIBUS I system bus.

INTERCONNECT MAPPING

The function record of the iSBC LNK/001 board, a function record within the Central Services Module interconnect template, appears as a board within a board (see Table 1). The actual iSBC LNK/001 board configuration is done through unique interconnect registers using the same slot ID as the Central Services Module. The iSBC LNK/001 function record begins at an offset of 256 from the start of the CSM template and the EOT (End Of Template) byte is attached as the last function of the iSBC LNK/001 function record.

Dual Port 128K Byte DRAM Memory

A dynamic RAM Dual Port, resident on the iSBC LNK/001 board, provides a 128K Byte media for

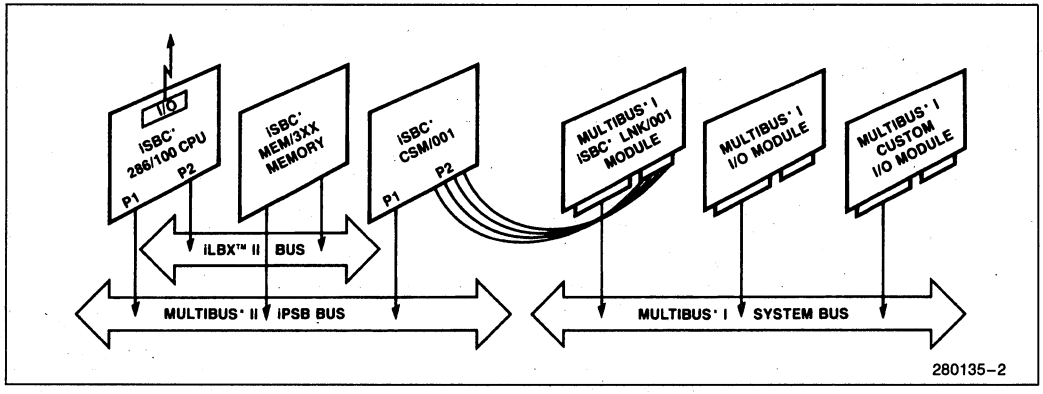


Figure 1. Sequence Diagram

MULTIBUS I and MULTIBUS II agents to pass data efficiently. With both buses sharing the Dual Port memory the need for the MULTIBUS II system to continuously arbitrate for MULTIBUS I system access is eliminated. Consequently, each bus can continue operating at its respective speed when accessing the iSBC LNK/001 Dual Port memory.

MULTIBUS® I Memory Addressability

The MULTIBUS I system views the iSBC LNK/001 Dual Port as a contiguous 128K Byte memory block mapped into the 16M Bytes of MULTIBUS I memory address space starting at the Dual Port Start Address register value. This memory block, configurable on any 64K Byte boundary within the MULTIBUS I memory address space, is set via interconnect accesses to the iSBC LNK/001 function records from the MULTIBUS II system (see Table 1). The first 16M Bytes of MULTIBUS II memory space can be mapped in the 16M Bytes of MULTIBUS I memory address space (see Figure 3).

MULTIBUS® I I/O Addressability

Up to eight 4K Byte blocks of MULTIBUS II I/O space can be mapped into MULTIBUS I I/O space

Table 1. Function Record Overview iSBC® LNK/001 Board

Offset	Description	Offset	Description
0–255	iSBC CSM/001 Header and Function Record	271	MBI Dual Port End Address
		272	MBII Dual Port Start Address
256	Board Specific Record Type	273	MBII Dual Port End Address
257	Record Length	274	MBII Memory Start Address
258	Vendor ID, Low Byte	275	MBII Memory End Address
259	Vendor ID, High Byte	276	I/O 4K Segment Control
260	Link Version Number	277	MBI Interrupt Enable
261	Hardware Revision Test Number	278	Link Interrupt 0 Destination Address
262	Link General Status	279	Link Interrupt 1 Destination Address
263	Link General Control	280	Link Interrupt 2 Destination Address
264	Link BIST Support Level	281	Link Interrupt 3 Destination Address
265	Link BIST Data In	282	Link Interrupt 4 Destination Address
266	Link BIST Data Out	283	Link Interrupt 5 Destination Address
267	Link BIST Slave Status	284	Link Interrupt 6 Destination Address
268	Link BIST Master Status	285	Link Interrupt 7 Destination Address
269	Link BIST Test ID	286	Interrupt Source Address
270	MBI Dual Port Start Address	287	Link Status Register
		288	EOT (End of Template)

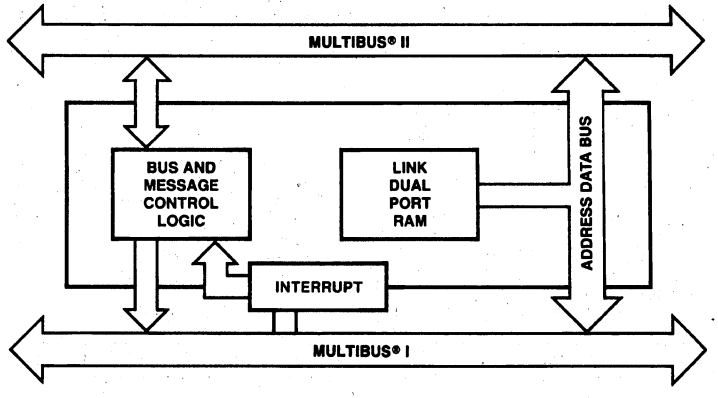


Figure 2. Link Board Dual Port Drawing

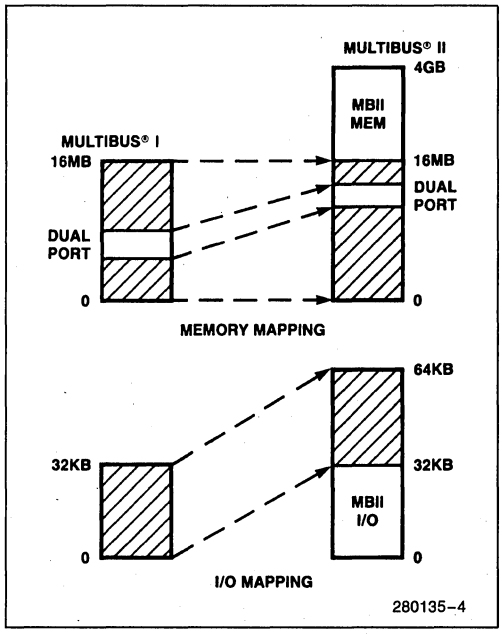


Figure 3. MULTIBUS® I Memory and I/O Mapping Diagram

(see Figure 3). MULTIBUS II I/O accesses must be from 32K Byte to 64K Byte in order to be mapped into MULTIBUS I I/O address space. These blocks are specified through an interconnect access to the "I/O 4K Segment Control" register (see Table 1). Each bit in the register represents a 4K Byte block of I/O addresses. When a bit (or bits) is set, the 4K Byte block of MULTIBUS II I/O space represented by that bit will be dedicated to MULTIBUS I I/O space.

Interrupt to Message Conversion

As the iSBC LNK/001 board receives non-bus vectored interrupts from the MULTIBUS I system, the on-board 8259A programmable interrupt controller (PIC) prioritizes the MULTIBUS I interrupts and initiates the MULTIBUS II unsolicited interrupt message generation process. Up to 8 levels of non-bus vectored interrupts are supported by the iSBC LNK/001 board.

The iSBC LNK/001 board generates the MULTIBUS II interrupt messages and is the Interrupt Source. The iSBC LNK/001 board is assigned a Source ID through interconnect space when the MULTIBUS II system is powered up or when the user programs the source ID register via interconnect space. The Interrupt Destination is the MULTIBUS II board to which the interrupt message is being sent. Each of the eight MULTIBUS I interrupt lines can be programmed to generate a unique MULTIBUS II destination address. These destination addresses are initialized through interconnect space by programming the iSBC LNK/001 Interrupt Destination Address Registers. The message source address is also configurable via interconnect space by writing to the Interrupt 0 Source Address Register with a base value. Once the base value of source Address 0 is established, Source Address 1 through 7 are set for incrementing values by the 8751A interconnect processor. The iSBC LNK/001 board recognizes MULTIBUS II Negative Acknowledge agent errors ("NACK") and performs an automatic retry algorithm.

Initialization Tests and BIST

Self test and diagnostics have been built into the MULTIBUS II system. The BIST LED is used to indicate the result of the Built-In-Self-Test and turns on when BIST starts running and turns off when it has successfully executed. BIST test failure information is recorded in the interconnect space and is accessible to software for error reporting.

PHYSICAL CHARACTERISTICS

Form Factor

The iSBC LNK/001 board is a MULTIBUS I form factor board residing in a MULTIBUS I system. Physical dimensions are identical to all standard MULTIBUS I boards.

Connection to MULTIBUS® II Bus

The iSBC LNK/001 board connects to the iSBC CSM/001 board in the MULTIBUS II system via a 60 pin conductor flat ribbon cable. The physical connection is made on the P2 connector of both the iSBC LNK/001 board and the iSBC CSM/001 board. The cable termination requirements and DC requirements for the signal drivers and receivers are detailed in the iSBC CSM/001 USERS GUIDE, Section 6.6.4. The maximum length of the cable is 3 feet. The cable and the connectors are shipped unassembled to allow user flexibility.

SOFTWARE SUPPORT

To take advantage of iSBC LNK/001 Dual Port architecture, existing software device drivers may require modification. Device driver changes depend on the specific application and vary in complexity depending upon the device driver.

SPECIFICATIONS

Word Size

16- and 24-bit Address Paths
8- and 16-bit Data Paths
Block transfers are not supported

Cable Characteristics

The cable is a 60 pin conductor flat ribbon cable with a maximum length of 3 feet. The P2 connector to the iSBC LNK/001 board is a 30/60 pin board edge connector with 0.100" pin centers, KEL-AM Part Number RF30-2853-5. The connector to the P2 DIN connector on the iSBC CSM/001 board is 3M Part Number 3338-000.

Interface Specifications

Location	Function
P1	MULTIBUS IEEE 796 System Bus
P2	Cable connection to P2 connector of iSBC CSM/001 board

PHYSICAL DIMENSIONS

The iSBC LNK/001 board meets all MULTIBUS I mechanical specifications as presented in the MULTIBUS I specification.

Depth: 17.15 cm (6.75 in.)
Height: 1.27 cm (0.50 in.)
Front Panel Width: 30.48 cm (12.00 in.)
Weight: Estimated 565 g (20 oz.)

ENVIRONMENTAL REQUIREMENTS

Temperature: Inlet air at 200 LFM airflow over boards
Non Operating: −40°C to +75°C
Operating: 0°C to +55°C

Humidity: Non Operating: 0 to 95% RH @ 55°C
Operating: 0 to 95% RH @ 55°C

POWER REQUIREMENTS

Voltage: +5V
Current: 7.14 Amps

REFERENCE MANUALS

iSBC LNK/001 Users Guide (#148756-001)

Intel MULTIBUS II Bus Architecture Specification, Rev C (#146077)

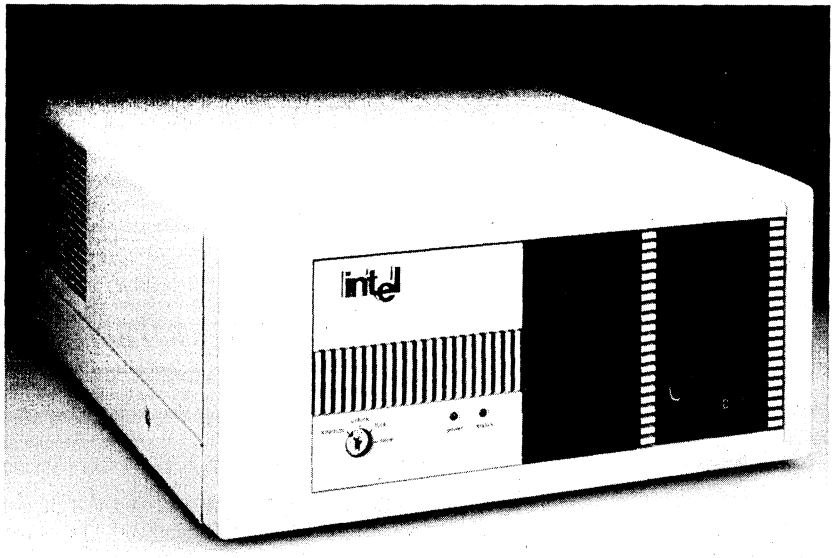
iSBC CSM/001 Users Manual (#146706-001)

Manuals may be ordered from any Sales Representative, Distributor Office, or from the Intel Literature Department, 3065 Bowers Ave., Santa Clara, CA. 95051.

ORDERING INFORMATION

Part Number	Description
iSBC LKN/001	MULTIBUS II to MULTIBUS I iSBC LNK/001 Interface Board

iRMX® MULTIBUS® II MODULES DEVELOPMENT PLATFORM



MULTIBUS® II MODULES DEVELOPMENT SUPPORT

The MULTIBUS® II Modules Development Platform (MDP) is a fully-integrated system for board designers or users to develop software for and test MULTIBUS II boards. OEM customers and MULTIBUS II board vendors can use this system to integrate off-the-shelf or custom MULTIBUS II boards, develop software drivers and applications and test the entire system. In addition, the integrated system can serve as a proof-of-concept vehicle. This makes the MDP a good system for R&D labs to evaluate unique MULTIBUS II applications. For customers using the iRMX® 286 system as their target operating system, applications developed on the MDP can be moved to the target system with little or no effort.

TWO MODELS TO FIT DEVELOPMENT TEAM SIZE

Depending on the size of the development team, two models are offered. Model I contains a single 80386-based board with 4 MB on-board RAM, an 80 MB wini; tape, floppy and an asynchronous terminal controller with 6 ports. Model II adds another 80386 CPU board, 80 MB wini and terminal controller for up to six more users.

FEATURES:

- Suitable for board developers, design labs and systems integrators
  - —Intel iRMX 286 application software and device driver development
  - —Board check-out
  - —Demo vehicle
  - —Proof-of-concept evaluation
- 80386-based with full message-passing
- Intel iRMX 286 Prototype Operating System and application tools
- Compatible with Intel's iRMX 286 Rel. 2 product
- 2 models are available with one or two 80386 CPU (4 MB RAM) boards

intel

June, 1987
Order Number: 280625-001

INDUSTRY STANDARD iRMX® 286 REL. 3 PROTOTYPE AND TOOLS

The MDP comes with Intel's iRMX 286 Rel. 3 Prototype operating system configured for MDP's specific set of boards that supports a multi-user development environment. It is based on Intel's iRMX 286 Rel. 2 product and takes advantage of the 80386 protected mode multitasking environment. The operating system also implements the systems features of the MULTIBUS II architecture: high speed message-based data transfer and interrupts, geographic addressing and high reliability physical connectors.

iRMX 286 standard software development tools are provided: ASM 286 and the 80286 Utilities (Build, Bind), PL/M 286 and the AEDIT editor. Intel's C, FORTRAN and Pascal compilers are also available and supported under the iRMX 286 operating system.

EXPANSION CAPABILITY FOR CUSTOM DESIGNS

The MDP provides both peripheral and board-level expansion capabilities. With Model I, customers have an additional full-height peripheral bay and up to 3 MULTIBUS II expansion slots with 16.7 A of +5 V. Each CPU board can also accept up to 16 MB of on-board RAM (using two 8 MB MULTIMODULES™) without any changes to the operating system.

SPECIFICATIONS

Hardware

8-slot MULTIBUS II chassis; 535 W power supply
iSBC 386/100 (16 MHz) with 4 MB on-board RAM and 80287 Math Coprocessor
iSBX 354 serial controller (console and auxiliary ports)
iSBC 186/224A peripheral controller
iSBC 186/410 async. terminal controller (6 users per board)
80 MB Winchester
320 KB floppy
60 MB streamer tape
3 terminal cables

Software

iRMX 286 Rel. 3 Prototype Operating System Documentation
iRMX 286 Release 2.0 Operating System
ASM 286 and 80286 Utilities
PL/M 286
AEDIT
DMON and iSDM Monitor PROMs

OPERATING ENVIRONMENT

Temperature:	10°C-40°C
Humidity:	85% non-condensing (operating)
	95% non-condensing (not operating)
AC power input:	88-132 VAC or 180-264 VAC; 47-63 Hz
Dimensions:	
Height:	7.75″ (19.7 cm)
Width:	17.5″ (44.5 cm)
Depth:	22.25″ (56.5 cm)
Weight:	54/64 lbs.

ORDERING INFORMATION

MBIIMDP1R	iRMX MULTIBUS II Modules Development Platform. Model I.
MBIIMDP2R	iRMX MULTIBUS II Modules Development Platform. Model II.
SBCMM01	1-, 2-, 4- and 8 MB memory
SBCMM02,	MULTIMODULE for the
SBCMM04,	iSBC 386/100 board
SBCMM08	

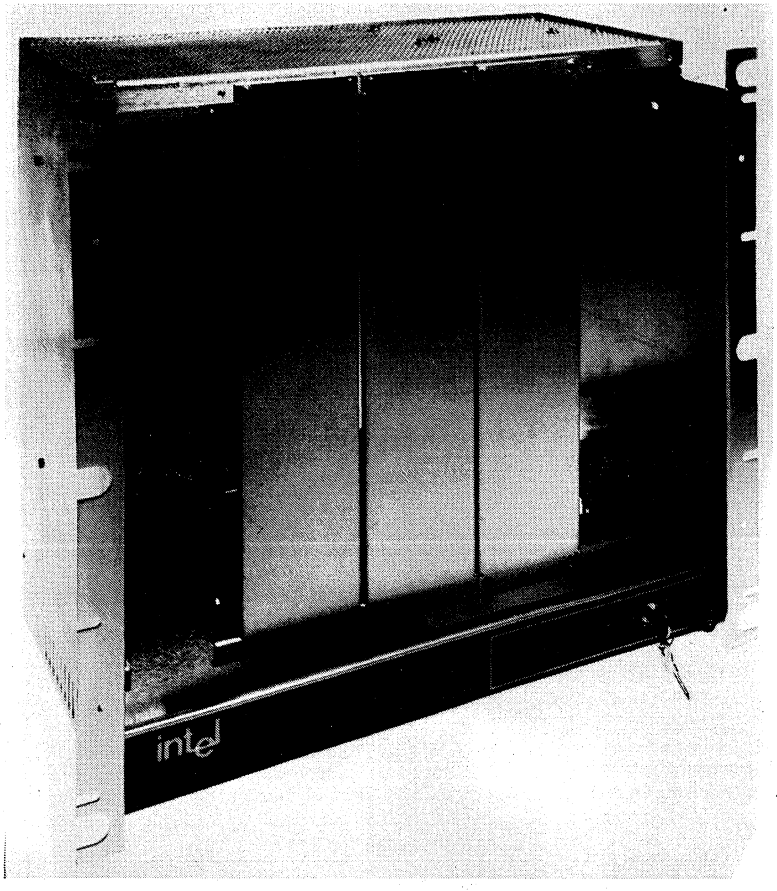
System Packaging and Power Supplies

15

iCS™ 80
INDUSTRIAL CHASSIS KIT 635, KIT 640

- **Available with iSBC® 640 Power Supply**
- **Accommodates from 1 to 3 iSBC® 604/614 Cardcage Assemblies for 4–12 MULTIBUS® Board Capacity**
- **Vertical Board Orientation and Four Fans for High Efficiency Cooling**
- **Front Access to iSBC® Boards, Power Supply, and Signal Conditioning Panels**
- **19-Inch Wide RETMA Rack Mounting or NEMA Type Backwall Mounting Brackets**
- **UL and CSA Approved**
- **Multi-Voltage Operation**
- **Lockable Service Panel**
- **Recessed Mounting Space for Signal Conditioning/Wire Termination Panels**

The iCS 80 Industrial Chassis provides industrially oriented mounting space for Intel single board computer (iSBC) products, associated iSBC power supplies, and related analog and digital conditioning/termination panels. The base unit provides a 4-slot MULTIBUS backplane (iSBC 604) with expansion space and cabling to expand to 12 MULTIBUS backplane slots by adding additional 4-slot iSBC 614s as needed (up to two). Full MULTIBUS compatability in the iCS 80 chassis allows configuration of multiple single board computers to share system tasks through communication over the bus (through multimaster bus arbitration built on the multiple iSBC processors).



280240–1

October 1986
Order Number: 280240-001

FUNCTIONAL DESCRIPTION

iCS™ 80 Kit 640

This chassis uses the higher power iSBC 640 power supply, and is designed to power higher board count systems. By installing one or two additional iSBC 614 cardcages, this chassis will accommodate up to 8 or 12 MULTIBUS boards. Signal conditioning panels may attach directly in the iCS 80.

Engineered for Industrial Applications

The MULTIBUS slots are mounted vertically to improve convection cooling and the top, bottom and sides are engineering to allow maximum air flow over the boards. Four fans are provided to increase air flow, allowing users to eliminate or minimize the need for supplementary fans or air conditioning.

Power Supply Flexibility

The power supplies are mounted on slide in/out mounting rails, and quick disconnect cabling and connectors are provided for rapid service replacement. An AC wiring barrier strip allows simple wiring connections for integration into larger systems (see Figure 4).

Industrial Rack Mounting

The chassis mounts directly into 19-inch standard width RETMA (Radio-Electronics-Television Manufacturers Association) customer provided rack. Alternately, mounting brackets and power cabling access are provided for mounting directly on a backwall, such as the backwall panel of a NEMA-type (National Electrical Manufacturers Association), front-access-only cabinet.

Front Access Serviceability

To simplify serviceability, front access is provided for all iSBC boards, the power supply, operation indicator lights, interrupt and reset buttons, and the AC power fuse.

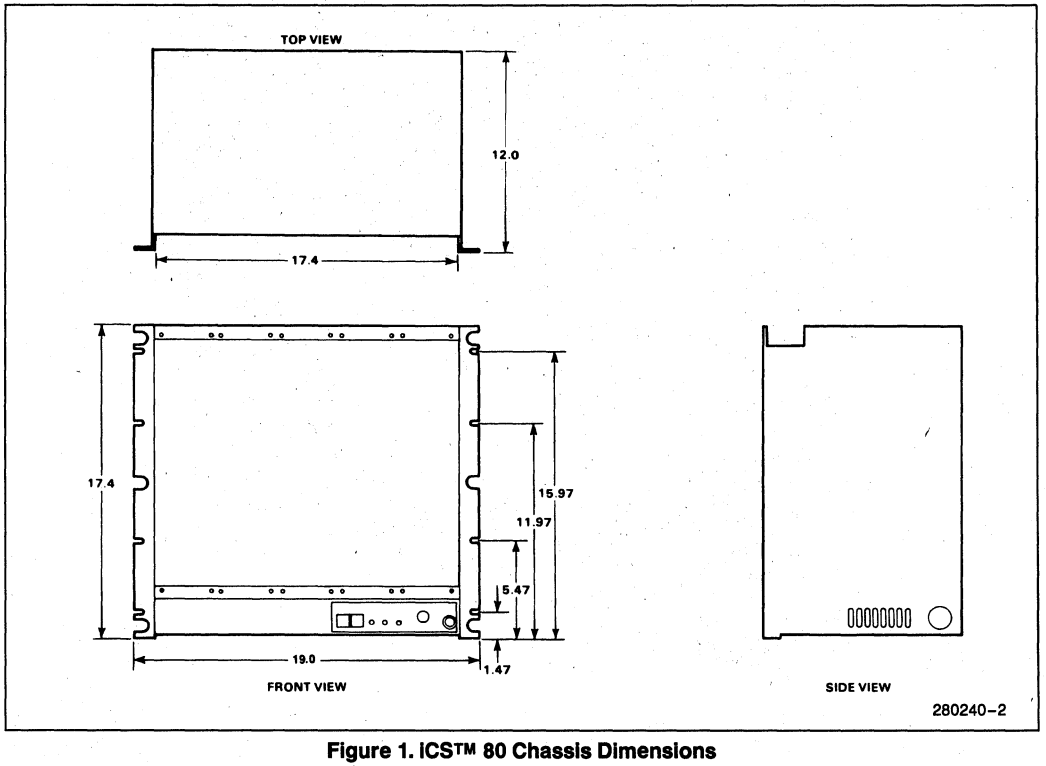


Figure 1. ICS™ 80 Chassis Dimensions

Typical Small Configuration

- iSBC 88/40A Test and Measurement Computer
- iCS 910 Analog I/O Signal Conditioning Panel
- iCS 930 AC/DC Control Interface Panel

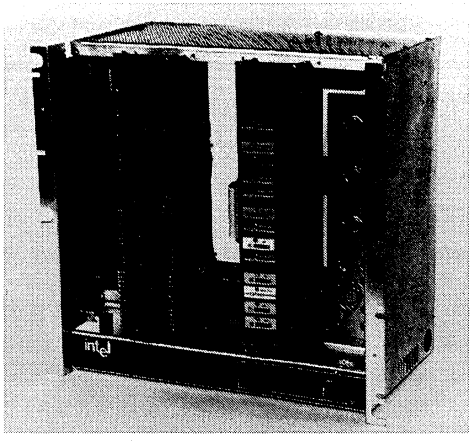


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Figure 2. Small Configuration iCS™ 80 Kit

Typical Maximum Configuration

- 16-bit 8086 processor (iSBC 86/30 w/RAM MULTIMODULE)
- 768K bytes RAM (2 - iSBC 056A)
- 128K bytes EPROM (or 16K E²PROM)
- 240 analog inputs (3 - iSBC 88/40A w/2 ea. iSBX 311)
- 24 analog voltage outputs

OR

- 24 analog current outputs (4–20 mA)
- 72 isolated digital inputs/outputs
- 144 TTL digital inputs/outputs (2 - iSBC 519s)

(All iCS 9XX Signal Conditioning/Termination Panels shown mounted to cabinet)

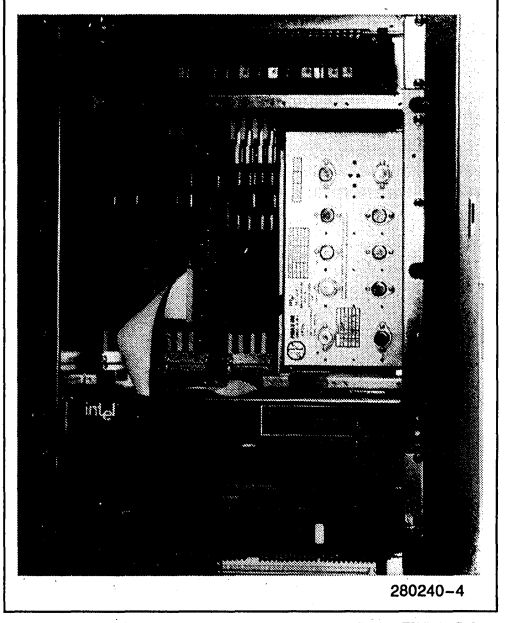

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Figure 3. iCS™ 80 Kit 640 with 12 MULTIBUS® Card Slots Mounted in NEMA Cabinet

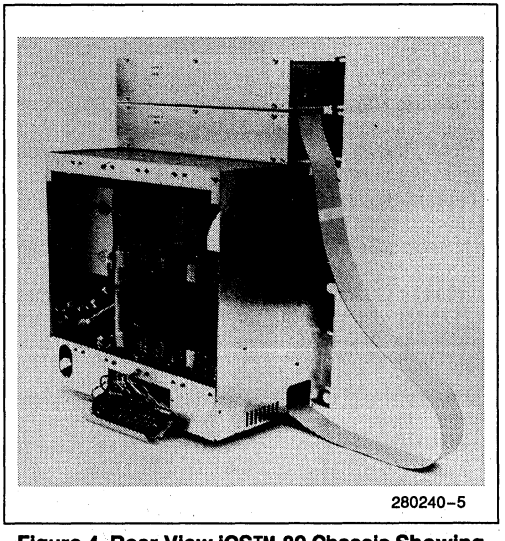

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Figure 4. Rear View iCS™ 80 Chassis Showing Power Distribution Panel (detached to show terminal block), and Cabling from iCS 80 Chassis to iCS 9XX RETMA Mounted Signal Conditioning Panels (Top of iCS 80 Chassis)

Lockable Service Panel

To assist in development, checkout and service, two pushbuttons are provided. The RESET button pulls low the initialize line (INIT) on the MULTIBUS backplane. The INTERRUPT button pulls low one interrupt line on the MULTIBUS backplane (INT1). Logic within the iCS 80 ensures that these buttons function with all versions of Intel single board computers. From the front of the iCS 80 chassis, without a CRT or other panel, an operator or service person can reset or interrupt on-going iCS 80 system operations to get attention, signal an alarm, or start a self-test operation.

A front panel key provides three positions: OFF (AC power off and key removable), ON (AC power on, pushbuttons enabled, key unremovable), and LOCK (AC power on, pushbuttons disabled, key removable).

Three indicator light emitting diodes record basic chassis status. POWER ON (GREEN); RUN (GREEN); and HALT (RED); the RESET or INTERRUPT buttons will remove the HALT state.

U.L. Approved

The iCS 80 chassis has received full Underwriters Laboratory approval (F.6 #E70842) as a U.L. listed component under the Underwriters Laboratories Safety Standard for Process Control Equipment, UL1092. When installed as described in the iCS 80 Hardware Reference Manual, the iCS 80 chassis provides adequate protection against shock, fire and casualty hazards, and should comply with most local and regional requirements for installation in ordinary locations. In addition, the iCS 80 chassis was designed to comply with the UL requirements for Data Processing Equipment, UL478. The iCS 80 has also been approved by the Canadian Standards Association under CSA category C22.2 No. 142, the Canadian Standard for Safety for Process Control Equipment and C22.2 No. 154 for Data Processing Equipment.

Mounting Space for Signal Conditioning/Wire Terminations

The cardcages and power supplies in the iCS 80 chassis are recessed behind the front edge of the rack mounting ears to provide mounting space for the iCS 9XX series signal conditioning/termination panels and field wiring. For smaller systems with only one or two iSBC 604/614 cardcages (4 to 8 slots), up to two iCS 910, iCS 920, or iCS 930 signal conditioning/termination panels can be mounted vertically over the area where the second or third cardcage would mount (see Figure 2). The benefit of this design is a completely self-contained industrial chassis with iSBC cards, power supply, signal conditioning and field wiring terminations, all in one enclosure.

SPECIFICATIONS

Capacity

Four slots for MULTIBUS compatible single computers, memory, I/O or other expansion boards

Expandable to 12 slots using two iSBC 614 cardcages (Order Separately)

Front Panel Controls

PUSHBUTTONS

RESET: Connected to Initialize/ on MULTIBUS backplane

INTERRUPT: Connected to Interrupt 1/ line on MULTIBUS backplane.

PANEL INDICATOR LIGHTS (LEDs)

POWER ON (green): +5V power exits on the MULTIBUS backplane

RUN (green): CPU is executing an instruction. Light goes out if CPU is in WAIT or HALT state

HALT (red): CPU has executed a HALT instruction

KEYLOCK

OFF: AC power off, key removable

ON: AC power on, pushbuttons enabled, key removable

LOCK: AC power on, pushbuttons disabled, key removable

Fuse: AC power (6A)

Equipment Supplied

iCS 80 industrial chassis, three fans for cardcages, one fan for power supply, 4-slot cardcage with MULTIBUS backplane, control panel with switches, indi-

cators, keylock, power distribution barrier strip, AC power fuse, line filter, 115V power cable, and logic for interrupt and reset buttons. An installation package is also provided, including a NEMA cabinet mounting kit, power supply extension cables, and RETMA cabinet mounting screws, 100/120/220/240 VAC operation.

Software

See the RMX/80 Real-time Multitasking Executive specifications for industrial related applications. In addition, system monitors for most of the Intel single board computers are available in the INSITE (Intel's Software Index and Technology Exchange) User's Program Library.

Physical Characteristics

Height: 39.3 cm (15.7 in.)

Width: 48.5 cm (19.0 in.) at front panel
43.5 cm (17.4 in.) behind front panel

Depth: 30.0 cm (12.0 in.) with all protrusions

Weight: 16.8 kg (37.0 lb) without power supplies

Environmental Characteristics

(Ambient at iCS-80 air intake, bottom of chassis)

Temperature: (Ambient)

Operating: 0°C to +50°C (32°F to 122°F)

Non-operating: −40°C to +85°C

Humidity: Up to 90% relative, noncondensing at 40°C

Electrical Characteristics

The iCS 80 chassis provides mounting space for the iSBC 640 power supply. Unless otherwise stated, electrical specifications apply to both power supplies when installed by user in iCS 80 chassis.

INPUT POWER

Frequency: 47 to 63 Hz. Voltage (Nominal)

Voltage: (Single Phase, Jumper Selectable)

iCS 80 Kit 640:100, 120, 220, 240 VAC (±10%)

	With iSBC 640	Input Voltage
Current (Including fans)	5.6A max	103 VAX
	2.8A max	206 VAX
Power, max:	580 watts	

OUTPUT POWER

Voltage	Output Current (max)	Overvoltage Protection
	iSBC 640	iSBC 640
+12V	4.5A	+14V to +16V
+5V	30.0A	+5.8V to +6.6V
−5V	1.75A	−5.8V to −6.6V
−12V	1.75A	−14V to −16V

Combined Line/Load Regulation: ±1% at ±10% static line change and ±50% static load change, measured at the output connector (±0.2% measured at the power supply under the same conditions).

Remote Sensing: Provided for +5 VDC output line regulation.

Output Ripple and Noise: 10 mV (iSBC 640 supply) peak-to-peak, max (DC to 500 kHz)

Output Transient Response: Less than 50 μsec for ±50% load change.

Maximum Watts Dissipation (load plus losses): 500W (iSBC 640 supply)

Installation

Complete instructions for installation are contained in the iCS 80 Site Planning and Installation Guide, including RETMA and NEMA cabinet mounting, and field signal, ground wiring and cooling suggestions.

Warranty

The iCS 80 Industrial Chassis is warranted to be free from defects in materials and workmanship under normal use and service for a period of 90 days from date of shipment.

Reference Manuals

9800799A: iCS 80 Industrial Chassis Hardware Reference Manual (SUPPLIED)

9800708A: iSBC 604/614 Cardcage Hardware Reference Manual (SUPPLIED)

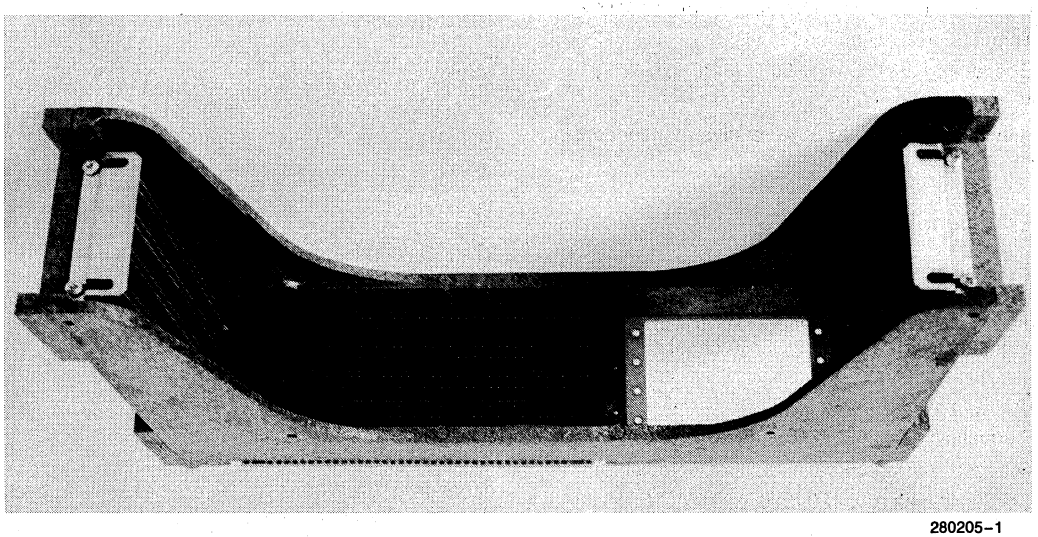
ORDERING INFORMATION

Part Number	Description
iCS 80 Kit 640	iCS 80 system consisting of: iCS 80 Industrial Chassis iSBC 640 Power Supply

iSBC® 604/614
MODULAR CARDCAGE ASSEMBLIES

- **Interconnects and Houses up to Four MULTIBUS® Boards per Cardcage**
- **Connectors Allow Interconnection of up to Four Cardcage Assemblies for 16 Board Systems**
- **Strong Cardcage Structure Helps Protect Installed Boards from Warping and Physical Damage**
- **Cardcage Mounting Holes Facilitate Interconnection of Units**
- **Compatible with 3.5-Inch RETMA Rack Mount Increments**
- **Interleaved Grounds on Backplane Minimize Noise and Crosstalk**
- **Up to 3 CPU Boards per System for Multiprocessing Applications**

The iSBC 604 and iSBC 614 Modular Cardcage Assemblies units provide low-cost, off-the-shelf housing for OEM products using two or more MULTIBUS boards. Each unit inerconnects and houses up to four boards. The base unit, the iSBC 604 Cardcage Assembly, contains a male backplane PC edge connector and bus signal termination circuits, plus power supply connectors. It is suitable for applications requiring a single unit, or may be interconnected with up to three iSBC 614 cardcage assemblies for a four cardcage (16 board) system. The iSBC 614 contains both male and female backplane connectors, and may be interconnected with iSBC 604/614 units. Both units are identical, with the exception of the bus signal terminator feature. A single unit may be packaged in a 3.5 inch RETMA rack enclosure, and two interconnected units may be packaged in a 7 inch enclosure. The units are mountable in any of three planes.



280205–1

September 1986
Order Number: 280205-001

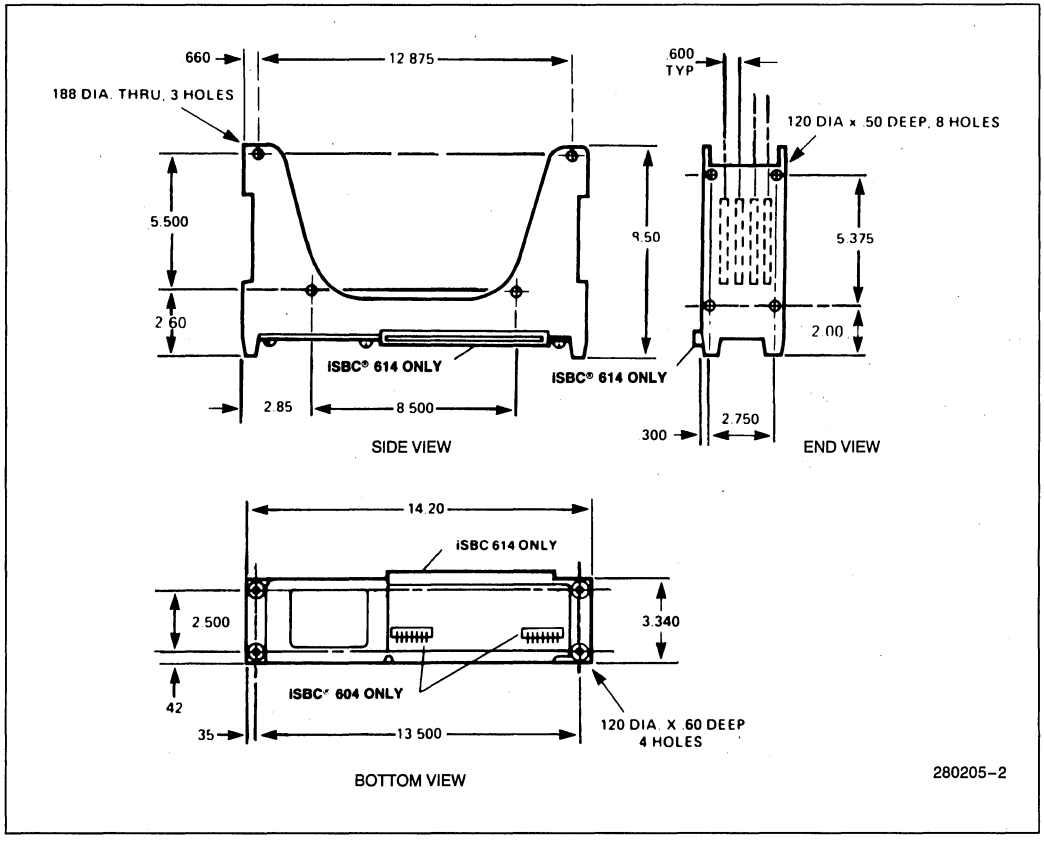


Figure 1. iSBC® 604/614 Cardcage Assembly Dimensions

SPECIFICATIONS

Backplane

Bus Lines—All MULTIBUS system bus address, data, and command bus lines are bussed to all four connectors on the printed circuit backplane

Power Connectors—G for ground, +5, −5, +12V, −12V, and −10V power supply lines

iSBC 604—Bus signal terminators, backplane male PC edge connector only, and power supply headers

iSBC 614—Backplane male and female connectors and power supply headers

Mating Power Connectors

AMP	Connector	87159-7
	Pin	87023-1
	Polarizing Key	87116-2
Molex	Connector	09-50-7071
	Pin	08-50-0106
	Polarizing Key	15-04-0219

NOTE:
1. Pins from a given vendor may only be used with connectors from the same vendor.

ORDERING INFORMATION

Part Number	Description
SBC 604	Modular Cardcage Assembly (Base Unit)

Bus Arbitration: Serial; up to 3 CPU masters

Equipment Supplied: iSBC 604 or iSBC 614 Cardcage Schematic

Physical Dimensions

Height: 8.5 in. (21.59 cm)

Width: 14.2 in. (36.07 cm)

Depth: 3.34 in. (8.48 cm)

Weight: 35 oz. (992.23 gm)

Card Slot Spacing: 0.6 in.

Environmental Characteristics

Operating Temperature: 0°C to 55°C

Reference Manual

9800708—iSBC 604/614 Cardcage Hardware Reference Manual (ORDER SEPARATELY)

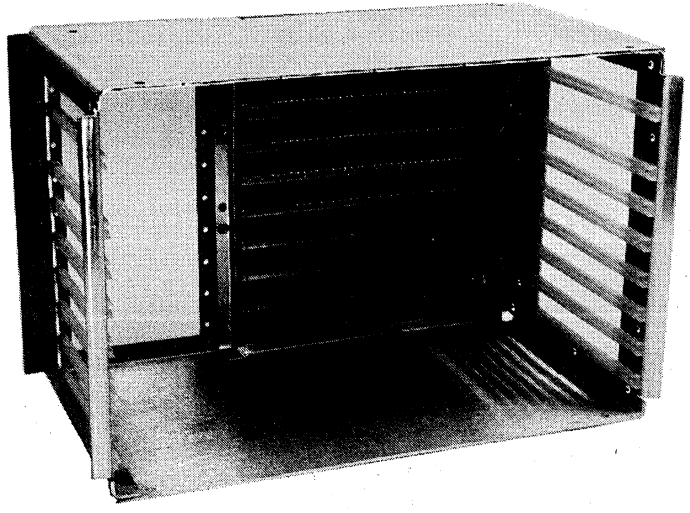
Part Number	Description
SBC 614	Modular Cardcage Assembly (Expansion Unit)

iSBC® 608/618 CARDCAGES

- **Houses Eight MULTIBUS® iSBC® Boards in an Aluminum Package**
- **Board-to-Board Clearance for iSBC® MULTIMODULE™ Boards on All Slots**
- **Board-to-Board Clearance for iSBX™ MULTIMODULE™ Boards on Two Slots**
- **Parallel Priority Circuitry for up to Eight Multimaster iSBC® Boards**
- **Enhanced Bus Noise Immunity for High Speed Systems**
- **Plug on iSBC 618 Unit for up to Sixteen Board Systems**
- **NEMA-Type Backwall or 19-Inch Rack Mount Hardware Included**
- **Signal Line Termination Circuitry on iSBC® 608 Cardcage**

Intel's iSBC 608/618 Cardcages are matched to the latest generation of iSBC/iSBX boards which mount in the MULTIBUS system bus. These products provide several features which make them the industry's leading price/performance cardcage product. MULTIMODULE board clearance, parallel priority circuitry, enhanced backplane noise immunity, and precision fit card guides are a few of the distinctions which make this the industry's better product.

The iSBC 608 Cardcage is the base unit, housing up to eight iSBC boards and their MULTIMODULE boards. Additionally, this base unit includes mounting hardware and fan mounting bracketry. The iSBC 618 is the expansion unit, providing eight additional iSBC board slots to the iSBC 608 Cardcage for a total of sixteen board slots which can be NEMA-type backwall or 19-inch rack mounted. This is accomplished with the mounting hardware of the iSBC 608 Cardcage. The iSBC 618 expansion unit also includes fan mounting bracketry.



210373-1

November 1986
Order Number: 210373-001

FUNCTIONAL DESCRIPTION

Mechanical Aspects

The iSBC 608/618 Cardcages provide housing and a MULTIBUS system bus for up to sixteen single board computers and their MULTIMODULE boards. The iSBC 608 unit and iSBC 618 unit offer board-to-board clearance (0.8 inches or greater) on all eight slots for iSBC MULTIMODULE boards. Two slots provide clearance (1.2 inches or greater) for iSBX MULTIMODULE boards as shown in Figure 1. Each cardcage includes precision fitted nylon cardguides for secure board fit and accurate MULTIBUS board pin alignment. Fan mounting bracketry is also included with each cardcage. This bracketry allows the mounting of several industry standard fans. The iSBC 608 Cardcage base unit includes aluminum mounting hardware for NEMA-type backwall mounting, or anchoring a sixteen slot iSBC 608/618 combination in a standard 19-inch rack.

Electrical Aspects

The iSBC 608/618 Cardcages implement a parallel priority resolution scheme by using plug-in jumper connections. There are six different priority schemes allowed, each requiring a different jumper configuration. In systems where an iSBC 618 Cardcage is attached to the base unit, the base unit will have lower priority overall. That is, master boards in the iSBC 608 base unit bay gain control of the MULTIBUS lines only when no boards in the iSBC 618 expansion unit are asserting the bus request (BREQ/) signal.

Noise-minimizing ground traces are strategically interleaved between signal and address lines on these backplanes. This provides the enhanced noise immunity and minimized signal-to-signal coupling which is important in high speed, high board count microcomputer systems.

The iSBC 608/618 Cardcages provide power connector lug bolts for +5 VDC and ground. The lug bolts, compared to other power connection methods, help transfer higher amounts of current. Other voltages (±12 VDC, −5 VDC) are connected via a mating power connector plug as shown in Figure 2.

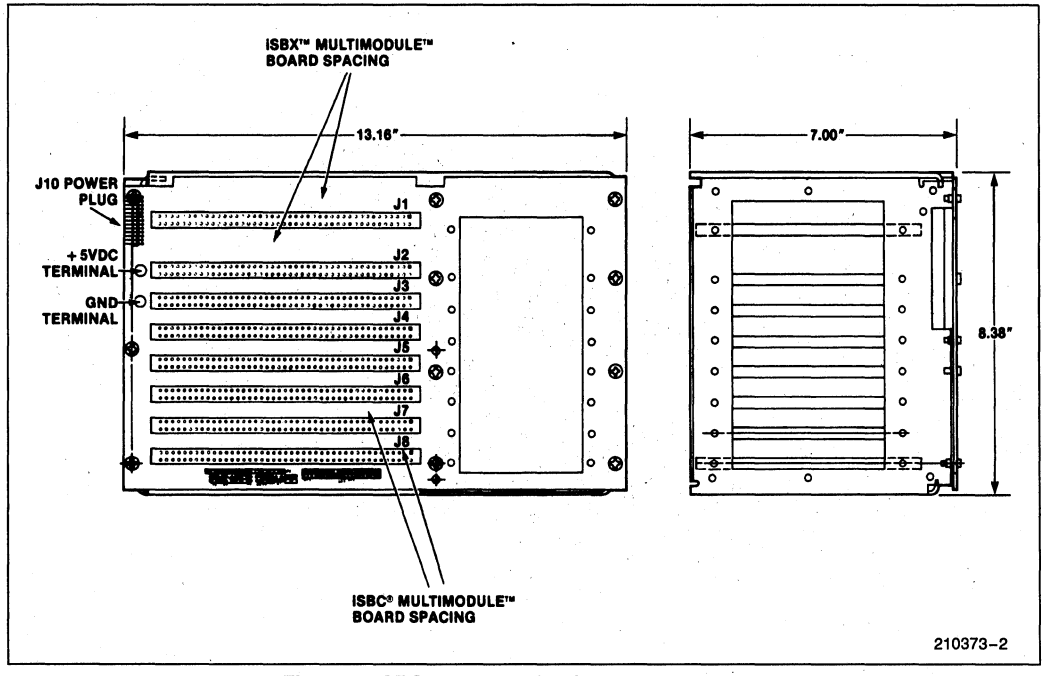


Figure 1. iSBC® 608/618 Cardcages Dimensions

SPECIFICATIONS

Bus Lines

All MULTIBUS (IEEE 796) system bus address and command lines are bussed to each of the eight MULTIBUS connectors on the backplane. Ground traces are interleaved among these signal lines and bussed to the backplane edge connector for interconnection of the iSBC 608 and iSBC 618 backplane.

Power Connectors

Ground (0V), +5V, −5V, +12V, −12V power supply header stakes and power lug bolts are provided on the iSBC 608/618 Cardcages as shown in Figure 2.

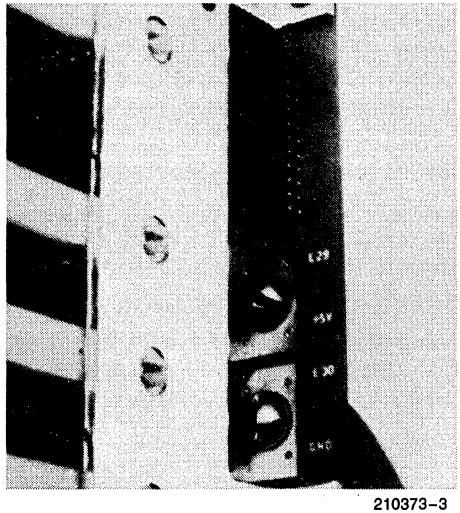


Figure 2. Power Header Stakes and Lugs

Environmental Characteristics

Operating Temperature:	0°C to 55°C
Storage Temperature:	−40°C to +85°C
Humidity:	50% to 95% non-condensing at 25°C to 40°C.
Vibration and Shock:	2G max. through 50 Hz

Physical Characteristics

SLOT-TO-SLOT DIMENSIONS (See Figure 1)

Top-J1:	1.200 in. (to center)
J1-J2:	1.300 in. (center to center)
J8-Bottom:	0.700 in. (to center)
All Others:	0.800 (center to center)

Physical Dimensions

Height:	8.38 in. (21.29 cm)
Length:	13.16 in. (33.43 cm)
Width:	7.50 in. (19.05 cm)
Weight:	3.50 lbs (1.59 kg)
Shipping Weight:	5.75 lbs (2.61 kg)

Equipment Supplied

iSBC® 608 BASE UNIT

Eight Slots:	Two at greater than 1.2 inches; six at 0.8 inches
Male Backplane Connector:	For expansion with iSBC 618 cardcage
Parallel Priority Circuitry:	Eight slots are configurable via the use of jumper stakes. Six priority schemes allowed
Construction Materials:	Aluminum card housing
	Nylon card guides
	Power connector header stakes and lug bolts

Accessories

iSBC® 618 EXPANSION UNIT

Eight-Slots:	Two at greater than 1.2 inches; six at 0.8 inches
Female Backplane Connector:	For expansion to iSBC 608 base unit
Parallel Priority Circuitry:	Eight slots are configurable via the use of jumper stakes. Six priority schemes allowed.
Construction Materials:	Aluminum card housing
	Nylon card guides
	Power connector header stakes and lug bolts
	Fan Mounting Hardware
	Schematic

User-Supplied Equipment

MATING POWER CONNECTORS

Vendor	Part Number
3M	3399-6026
Ansley	609-2600M
Berg	65485-009

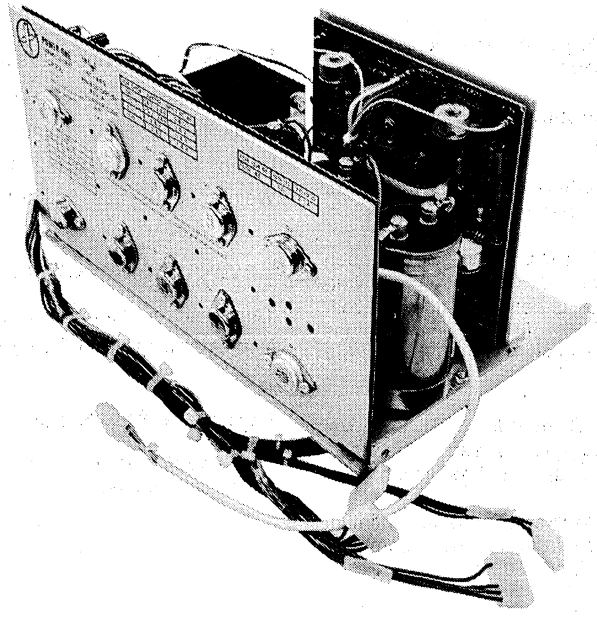
MOUNTABLE FANS

Vendor	Part Number
Rotron	SU2A1-028267
Torin	TA300-A30473-10
Pamotor	8506D

iSBC® 640 POWER SUPPLY

- ±5V and ±12V Output Voltage
- Sufficient Power for 8–12 MULTIBUS® Computer, Memory, and Peripheral Boards
- Current Limiting and Overvoltage Protection on All Outputs
- UL Listed and CSA Certified
- "AC Low" Power Failure TTL Logic Level Output Provided for System Power-Down Control
- DC Power Cables and Connectors Mate Directly to iSBC 604/614 and iSBC 608/618 Modular Cardcage/ Backplane Assemblies
- 100, 120, 220, and 240V AC Operation
- 50 Hz or 60 Hz Input

The iSBC 640 Power Supply provides low cost, off-the-shelf, single chassis power generation for OEM and industrial system products using Intel single board computers. The iSBC 640 supply provides regulated DC output power at +12V, +5V, and −5V and −12V levels. The current capabilities of each of these output levels has been chosen to provide power over a 0°C to +55°C temperature range for one fully loaded Intel single board computer, plus residual capability for most combinations of up to eleven iSBC memory, I/O, or combination expansion boards. Current limiting and over-voltage protection is provided on all outputs. Access for AC input is provided via a standard 4-pin keyed connector. DC output power levels are provided on cables with keyed connectors directly compatible with the iSBC 604/614 and iSBC 608/618 Modular Backplane/ Cardcage assemblies. The iSBC 640 supply includes logic whose purpose is to sense system AC power failure and generate a TTL signal for clean system power-down control.



280212–1

October 1986
Order Number: 280212-001

SPECIFICATIONS

Electrical Characteristics

Input Power

Frequency: 50 Hz ±5%, 60 Hz ±5%

Voltage: 100/120/220/240 VAC ±10%

Via user configured wiring options

Output Power

Nominal Voltage	Current (Amps) (Max)	Current Limit Range (Amps)	Short Circuit (Amps) (Max)	Over-voltage Protection
+12V	4.5A	4.7–6.8	2.3	15V ± 1V
+5V	30A	31.5–45.0	15.0	6.2V ± 0.4V
−5V	1.75A	1.8–3.2	0.9	−6.2V ± 0.4V
−12V	1.75A	1.8–3.2	0.9	−15V ± 1V

Combined Line/Load Regulation—±1% at ±10% static line change and ±50% static load change, measured at the output connector (±0.2% measured at the power supply under the same conditions).

Remote Sensing—Provided for +5 VDC output line regulation.

Output Ripple and Noise—10 mV peak-to-peak maximum (DC to 500 KHz)

Output Transient Response—Less than 50 μsec for ±50% load change.

Output Transient Deviation—Less than ±10% of initial voltage for ±50% load change.

Power Failure Indication (AC Low)—A TTL open collector high signal is provided when the input voltage drops below 90% of its nominal value. DC voltages will remain within 5% of their nominal values for 3.0 milliseconds (minimum, 7.5 ms typical) after AC Low goes true.

The "AC Low" signal will reset to a TTL low level when the AC input voltage is restored and after all output voltages are within specified regulation.

The "AC Low" threshold is adjustable for optimum powerdown performance at other input combinations (i.e. 100 VAC, 220 VAC, 50 Hz).

Mating Connectors(1)

AC Input

Housing	Molex	03–09–2042 or Equivalent
Pin	Molex	02-09-2118 or Equivalent (18 to 22 Gauge Wire)

DC Output2

Housing	Molex	26-03-3071
	Amp	3-87025-3
Pins	Molex	08-50-0187 or 08-50-0189
	Amp	87023-1
Key	Molex	15-04-9209
	Amp	87116-2

Compatible with Molex 09-66-1071 Header

NOTES

1. Pins from given vendor may only be used with connectors from the same vendor.
2. iSBC 640 DC output connectors are directly compatible with input power connectors on iSBC 604/614 and iSBC 608/618 Modular Cardcage/Backplane assemblies. Four connectors are provided.

Physical Characteristics

Height: 6.66 in. max. (16.92 cm)

Width: 8.19 in. max. (20.80 cm)

Depth: 12.65 in. max. (32.12 cm)

Weight: 30 lbs. max (13.63 kg)

Environmental Characteristics

Temperature: 0°C to 55°C with 55 CFM moving air

Non-Operating: −40°C to +85°C

Equipment Supplied

iSBC 640 Power Supply with AC and DC cables with keyed connectors.

Reference Manuals

9800803— iSBC 640 Power Supply Hardware Reference Manual (order separately)

9800798— iCS 80 Systems Site Planning and Installation Manual (for installation of iSBC 640 supply into iCS 80 Industrial Chassis) (Order Separately)

Manuals may be ordered from any Intel sales representative, distributor office or from Intel Literature Department, 3065 Bowers Avenue, Santa Clara, California 95051.

ORDERING INFORMATION

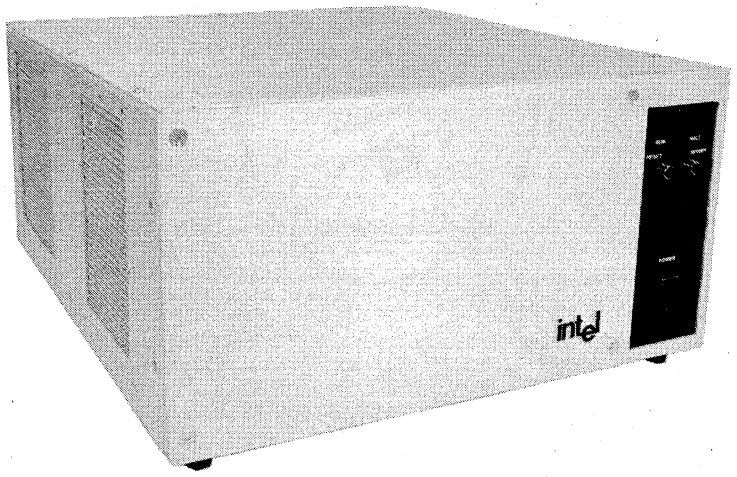
Part Number	Description
SBC 640	Power Supply

iSBC® 661
SYSTEM CHASSIS

- **Eight-Slot MULTIBUS® Chassis with Parallel Priority Circuitry**
- **UL, FCC and CSA Approved for Data Processing Equipment**
- **230 Watt Power Supply with Power Fail Warning**
- **Designed for Slide Rack Mounting or Table-Top Use**
- **Extra-Wide Cardcage Slot Spacing for iSBX™ MULTIMODULE™ Board Clearance**
- **Configurable for Front or Rear Access to MULTIBUS® Circuit Boards**
- **Five Connector Ports for I/O Cabling**
- **Operational from 47 Hz to 63 Hz, 100/120/220/240 VAC ± 10%**

The iSBC 661 System Chassis is an advanced MULTIBUS (IEEE) 796 chassis which incorporates unique usability and service features not found on competitive products. This chassis is designed or rack-mount or table-top applications and reliably operates up to an ambient temperature of 50°C. Additionally, this sytem chassis is certified by UL, CSA and FCC for data processing equipment.

An application requiring multiprocessing will find this eight-slot MULTIBUS chassis particularly well suited to its needs. Parallel priority bus arbitration circuiry has been integrated into the backplane. This permits a bus master to reside in each slot. Extra-wide inter-slot spacing on the cardcage allows the use of plug-on MULTIMODULE boards without blocking adjacent slots. For this reason, the iSBC 661 System Chassis provides the slot-functionality of most 16-slot chassis. Standard logic recognizes a system AC power failure and generates a TTL signal for use in powerdown control. Additionally, current limiting and over-voltage protection are provided at all outputs.



210866-1

October 1986
Order Number: 210866-002

FUNCTIONAL DESCRIPTION

Mechanical Features

The iSBC 661 System Chassis houses, cools, powers, and interconnects up to eight iSBC single board computers and their MULTIMODULE boards for the MULTIBUS System Bus. Based on Intel's iSBC 608 Cardcage, the chassis provides 0.8 inches of board center-to-center clearance on six slots, and 1.2 inches or more of center-to-center clearance on two slots. This permits the users of standard MULTIMODULE boards and custom wire-wrap boards to plug into the MULTIBUS System Bus without blocking adjacent slots. All slots provide enough clearance for iSBC MULTIMODULE boards, and two slots can accommodate iSBX MULTIMODULE boards.

High-technology MULTIBUS applications requiring rack-mount, or laboratory table-top use will find the iSBC 661 System Chassis ideal. Standard 19″ slide-rack mounting is possible with user-provided slides attached to the side panels. Slide mounting holes are provided in the chassis for the slide-rails listed under User Supplied Options. Rubber feet are included on the chassis for convenient table-top use.

The chassis is constructed of burnished aluminum which has been coated with corrosion-resistant chromate. It contains a system control module which presents the front panel control switches to the user, and holds the I/O cabling bulkhead to the rear. The chassis has the unique feature of being configurable for either front or rear access to MULTIBUS circuit boards.

This is accomplished by a simple procedure involving removal of the system control module, reversing it end-for-end, and re-securing it to the chassis. The system chassis is shipped in a configuration such that the MULTIBUS boards are installed from the front.

Electrical Features

The iSBC 661 System Chassis is powered by the iSBC 640 power supply. This is a standard Intel power supply which has been adopted by several MULTIBUS vendors throughout the industry. It sup-

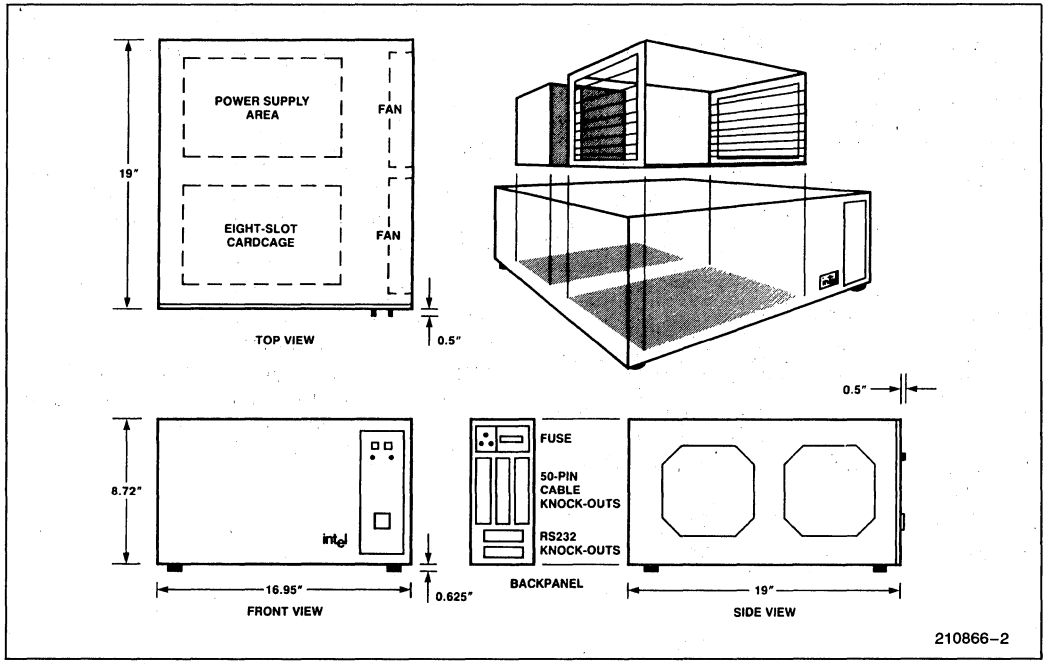


Figure 1. iSBC® 661 System Chassis Dimensions

plies 230 watts of power, power fail warning, and remote sensing of +5 volts. Its electrical and operational parameters are listed under Specifications.

The cardcage of the iSBC 661 System Chassis implements a user-changeable parallel priority bus arbitration scheme by using plug-in jumper connections. Six different priority schemes are allowed, each scheme fixing the priority to the eight MULTIBUS board slots. Bus contention among eight busmasters in a multiprocessing environment can be managed using this approach.

Noise minimizing ground traces are strategically interleaved between signal and address lines on the system bus. This provides the enhanced noise immunity and minimized signal-to-signal coupling which is particularly important in high speed, high board count microcomputer systems.

SPECIFICATIONS

Electrical Parameters

OUTPUT POWER

Table 1. Output Power Levels iSBC® 661-1

Voltage	Output Current (max.)	Current Limits (amps)	Over-Voltage Protection
+12V	4.5A	4.7–6.8	15V ±1V
+5V	30.0A	31.5–45.0	6.2V ±0.4V
−5V	1.75A	1.8–3.2	−6.2V ±0.4V
−12V	1.75A	1.8–3.2	−15V ±1V

Operational Parameters

Input AC Voltage—100/120/220/240 VAC ±10% (User selects via external switch), 47–63 Hz

Power-Fail Indication and Hold-Up Time (triggered at 90% of VAC in)—TTL O.C. High 3 msec. (min.)

Output Ripple and Noise—1% Peak-to-Peak output nominal (DC to 0.5 MHz)

Operational Temperature—0°C to 50°C

Storage Temperature—−40°C to 70°C

Operational Humidity—10% to 85% relative, noncondensing

Remote Sensing—Provided for +5 VCD

Output Transient Response—50 μs or less for ±50% load change

Physical Characteristics

Width: 16.95 inches (43.05 cm)

Height: 8.72 inches (22.2 cm)

Depth: 19.00 inches (48.3 cm)

Weight: 41 pounds (21 kg)

Shipping Weight (approx.): 50 pounds (25 Kg)

Equipment Supplied

iSBC® 661-1—Eight-slot MULTIBUS system chassis with parallel priority arbitration circuitry and 230 watt linear power supply

Reference Manual

(Not included: order separately)

145340-001—iSBC 661 System Chassis Hardware Reference Manual

User Supplied Options

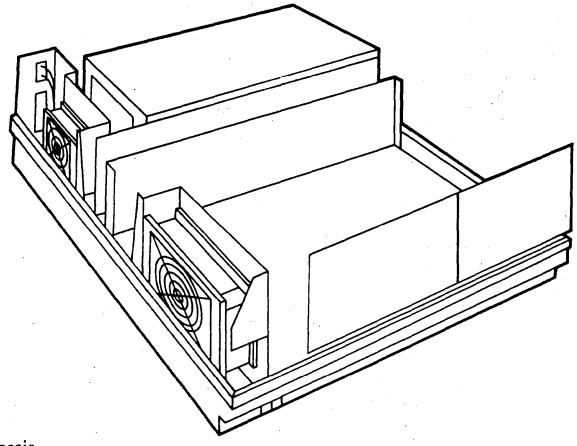
Compatible Rack-Mount Slides—Chassis Trak, Inc., P. O. Box 39100, Indianapolis, IN 46239; Part No. C300 S 122

ORDERING INFORMATION

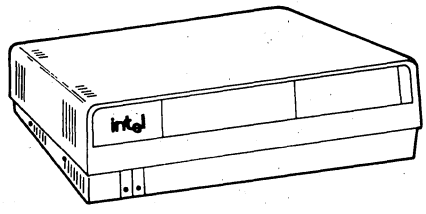
Part Number	Description
SBC 6611	Eight-slot MULTIBUS system chassis with parallel priority arbitration circuitry and 230 watt Linear Power Supply

OEM CHASSIS
MODEL 93
MODEL 94

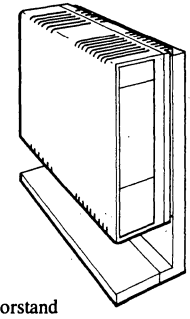
- A chassis for user installed 5¼" peripherals and MULTIBUS® single board computers
- Model 93 — Four MULTIBUS slots, three iLBX™ slots
- Model 94 — Five MULTIBUS slots, two iLBX slots
- Extra wide cardcage slot spacing for iSBX or MULTIMODULE™ clearance for two of seven slots
- 360 watt power supply
- Designed to meet UL, CSA, FCC Class A, IEC 435 and VDE Class A requirements for data processing equipment



The Open Chassis



Standard Package



312 Floorstand

AUGUST 1986
ORDER NUMBER 280395-001

Cardcage/Backplane

The cardcage accepts up to seven MULTIBUS (IEEE 796) single board computers and supports parallel priority resolution for multiprocessing applications. Two of the seven slots have extra wide spacing to accommodate iSBX MULTIMODULE boards.

The Model 93 incorporates three iLBX bus slots on the P2 connector. The Model 94 incorporates two iLBX bus slots on the P2 connector.

There is room in the chassis for one non-standard printed circuit board. This space would typically house a data separator or tap formatter board.

Peripheral Mounting

The chassis contains space for two full height or four half height 5¼" peripheral devices. The dimensions are:

Width: 30.0 cm (11 3/4")
Height: 8.5 cm (3 1/8")
Depth: 22.0 cm (8 3/4")

This chassis provides standard mounting holes for 5¼" devices. Filler panels are shipped with the system to cover any space not occupied by mass storage devices.

Cooling

Two fans force air across the chassis from left to right (looking at the front of a horizontally oriented chassis).

Package Construction

The chassis consists of a plastic base, a plastic top cover, a metal I/O panel and two front filler panels. The MULTIBUS cards are oriented horizontally when the system is oriented horizontally.

User Controls

The front of the chassis contains a reset button, an interrupt button, a power on light, and a run light. user installation of appropriate wiring (not included) is required to operate these controls.

Mounting Options

The chassis can be mounted hrizontally on a table top or in a 19" NEMA rack. The chassis can be mounted vertically in an optional floorstand.

Rack mounting holes are molded into the chassis base and are designed for use with rack mount slide available from Chassis Trak.

Vertical mounting requires the purchase of an optional floorstand (order code SYP312). Use of the floorstand does not change the environmental specifications.

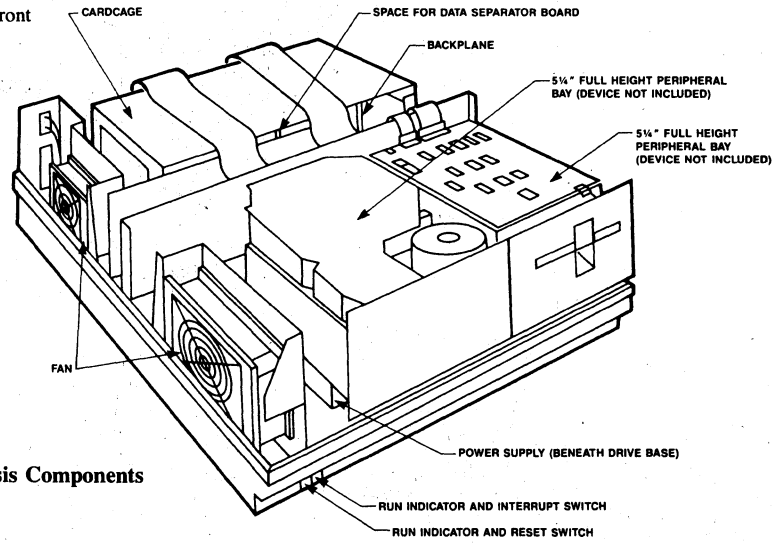
Rear Panel

The rear panel of the chassis contains a metal Input/Output panel as well as the on/off switch, the AC power receptacle, a fuse, a filter, and a voltage selector. The metal Input/Output panel contains knockouts which can support the following connector types:

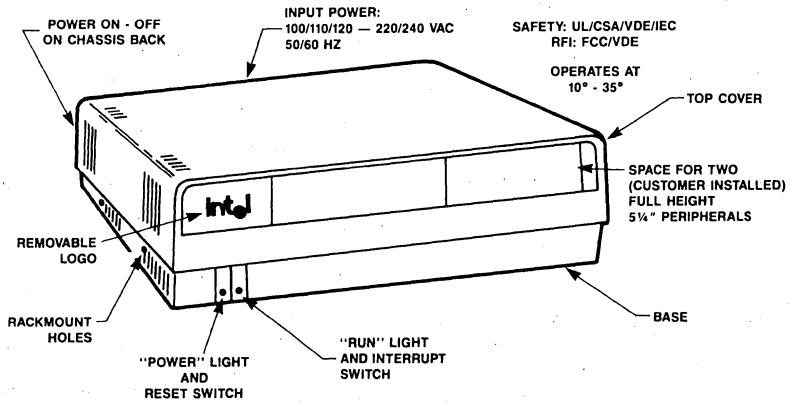
Connector Type	Quantity
15 pin D sub	2
25 pin D sub	21
37/50 pin D sub	3
75Ω BNC	5
36 pin D	1
26 GPIB	1

Power Supply

The chassis contains a 360 watt power supply which is user selectable for 110/220 VAC 47-63 Hertz. The wiring harness shipped with the chassis supplies power to the MULTIBUS backplane, the fans, two industry standard 5¼" or four half high industry standard 5¼" peripherals.

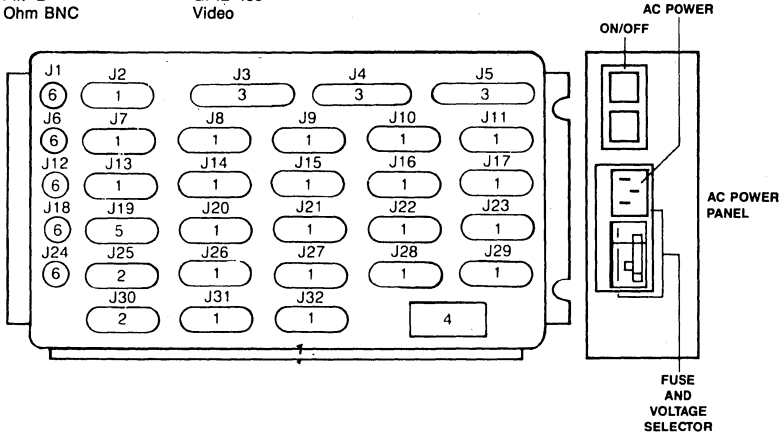


Major Chassis Components



Chassis Front View
Desk Top or Rack Mount or Floor Standing (W/Optional Stand)

PORT TYPE	SIZE	TYPICAL USE
TYPE 1	25-Pin 'D' subminiature	RS232C
TYPE 2	15-Pin 'D' subminiature	Networks
TYPE 3	37-Pin 'D' subminiature	Miscellaneous
TYPE 4	35-Pin 'D'	Parallel Printer
TYPE 5	26-Pin 'D'	GPIB 488
TYPE 6	75 Ohm BNC	Video



Chassis Back View

SPECIFICATIONS

Dimensions

HORIZONTAL ORIENTATION

Height: 165 mm (6.5″)
Width: 432 mm (17.0″)
Depth: 508 mm (20.0″)
Approximate Weight: 18.1 Kg (42 lb)

VERTICAL ORIENTATION

Height: 620 mm (24.4″)
Width: 216 mm (8.5″)
Depth: 584 mm (23.0″)
Approximate Weight: 25.5 Kg (55 lb)

Safety Requirements EMI Limits

The chassis is designed to meet:
Safety: UL 114, CSA 22.2, IEC 435
RFI/EMI: FCC Docket 20780 Class A
VDE0871 Class A

Actual compliance will depend on the single board computers, peripherals, and the cable connectors which the user installs in the chassis.

Input Power

Voltage and Maximum Current:
88 to 132 VAC, 6 amps or
176 to 264 VAC, 4 amps

Frequency: 47 to 63 Hertz

Maximum power consumption: 600 watts

The chassis is shipped configured for 120 VAC operation. The user can easily change this setting for use with 220 VAC.

Output Power

Voltage and maximum current:

+5VDC	4.75 to 5.25VDC	45 amps
+12VDC	11.40 to 12.60VDC	8 amps
−12VDC	−11.4 to −12.6VDC	2.5 amps

Maximum total output power: 360 watts

Environmentals

The following numbers are the limits for this chassis regardless of customer configuration

Operating: 10°C to 35°C
26°C maximum Wet Bulb temperature 20% to 80% Relative Humidity, non-condensing

Altitude: Sea Level to 2,400 meters (8,000 ft)

Shock: 30 G Non-operating

Vibration:
5 Hz to 1 KHz Random
0.001 Ga/Hz (1 G rms) Operating

The chassis is not intended for use in mobile or high vibration environments

ORDERING INFORMATION

Chassis: SYS310AP93
Chassis: SYS310AP94
Floorstand: SYP312

Chassis Trak 300S non-pivoting rack slide or equivalent are available from Chassis Trak, Inc., P.O. Box 39100, Indianapolis, Indiana 46239.

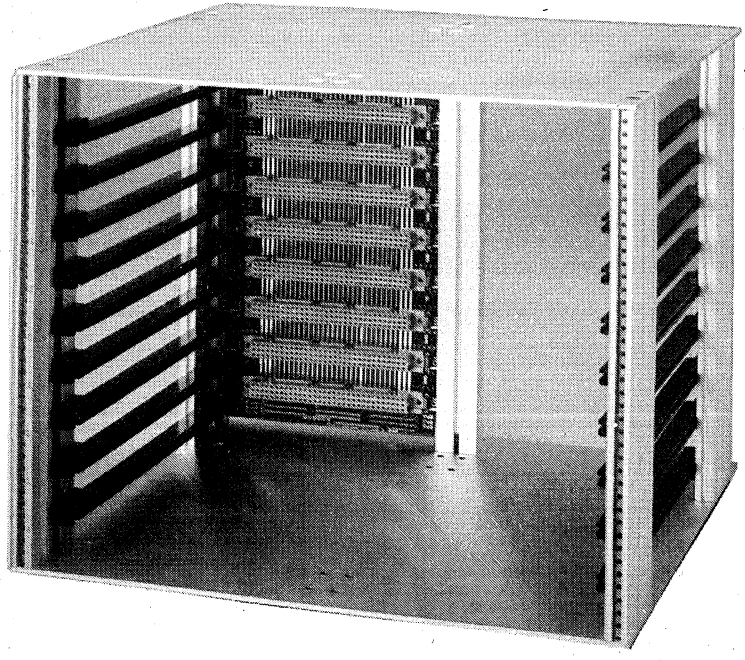
MULTIBUS® II System Packaging and Power Supplies

16

iSBC® PKG/606
iSBC PKG/609
MULTIBUS® II CARDCAGE ASSEMBLIES

- **Available in Two Sizes to Hold Up to 6 or 9 MULTIBUS® II Boards**
- **Designed to Mount Inside a Chassis or Other Enclosure**
- **Accommodates Intel iSBC® PKG/902 and iSBC® PKG/903 2 and 3 Slot iLBX™ II Backplanes**
- **All Lines Fully Terminated per the iPSB MULTIBUS II Specification**
- **Assembly Uses Aluminum Extrusion Construction for Strength and Rigidity**
- **Uses a 6 Layer Parallel System Bus (iPSB) Backplane**

The iSBC PKG/606/609 series of cardcages are designed to mount and interconnect up to 6 or 9 MULTIBUS II boards for small to medium size advanced MULTIBUS II microcomputer systems. The cardcages are compact in size and easily mount in standard or custom enclosures. Extra-wide support extrusions and heavy duty endplates help make the iSBC PKG/606/609 cardcage assemblies especially suited for installation in systems located in high vibration or high shock environments. Installed in the cardcage assembly is a 6 layer iPSB backplane that utilizes separate power and ground planes and fully terminates all signal lines. This layout minimizes system noise and ensures reliable operation even in a fully loaded, multiprocessor-based system.



280075-1

September 1986
Order Number: 280075-002

FUNCTIONAL DESCRIPTION

Mechanical Features

The cardcages accommodate up to 6 (iSBC PKG/606) or 9 (iSBC PKG/609) MULTIBUS II boards spaced at 0.8 inch centers. The assemblies are designed to hold "double high" (6U) Euro form-factor boards (233.4 mm high x 220 mm deep) or a mixture of "single high" (3U) and "double high" boards using additional hardware (not supplied). Each installed board is held in place by two screws supplied as part of the board retainer hardware.

The cardcage frame is built using five support extrusions and two aluminum end plates as shown in figure 1. Both cardcages are 10.5″ wide and 10.1″ deep and vary in height according to model (see specifications section).

The cardcages are designed to mount inside chassis or other enclosures and may be installed so that the MULTIBUS II boards load either horizontally or vertically in the unit. All assembly hardware is countersunk allowing the cardcages to be mounted flush against any internal chassis surface.

A Parallel System Bus (iPSB) backplane is mounted to the P1 side of the assembly, and one or more iLBX™ II backplanes (not supplied) can be mounted to the P2 side.

Electrical Features

The iPSB backplane uses a 6 layer design with separate power and ground layers and a signal routing scheme which minimizes ringing, crosstalk, and capacitive loading on the bus. Mounted on the backplane are 6 or 9, 96-pin, female DIN connectors (depending on model), bus termination resistors, decoupling capacitors, and power terminals. Press-fit technology is used throughout. The PC board is UL recognized for flammability. The card cages themselves are UL recognized components.

Single In-line Package (SIP) style resistors are used to terminate all address, clock, data, and control lines. Each termination consists of two resistors which connects the line to +VCC and ground. Different size resistors are used according to the type of driver connected to the line in an operating system.

The DIN type connectors are female, 96 pins, fully gold plated, and meet IEC standard 603-2-IEC-C096F. The connectors are mounted on 0.8″ centers to match Intel's iPSB (Parallel System Bus) MULTIBUS II backplanes and are keyed to ensure proper mating to the MULTIBUS II board. The connector can provide up to 9 amps of current at +5V to each MULTIBUS II board in addition to the current available over the iLBX II backplane.

Screw terminals on the backplane are provided for connection to +5V, ±12V power and ground. In addition, an extra +5V terminal is provided for connection to a backup battery for memory protection during power fail conditions. These terminals, each of which can handle up to 25 amps of current at 55°C, provide a simple and highly reliable connection method to the system power supply.

The first slot position is designed to accept the Central Services Module (CSM) MULTIBUS II board. All other slots can accept any combination of MULTIBUS II boards.

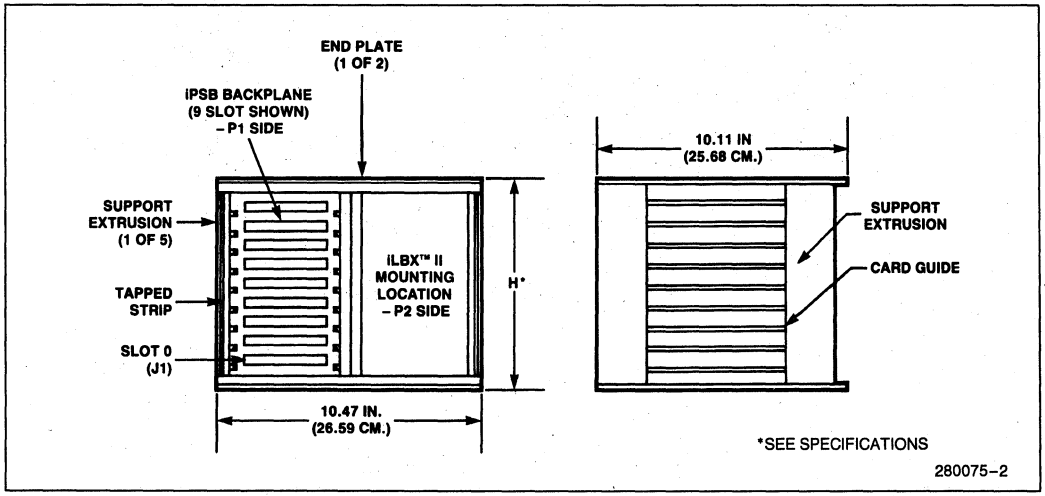


Figure 1. Cardcage Assembly Dimensions (iSBC® PKG/609 shown)

SPECIFICATIONS

Mechanical

Specification	iSBC® PKG/606 Cardcage	iSBC® PKG/609 Cardcage
Board Capacity	6	9
Dimensions Height	15.20 cm (5.98 in.)	21.20 cm (8.38 in.)
Width	26.59 cm (10.47 in.)	26.59 cm (10.47 in.)
Depth	25.93 cm (10.21 in.)	25.93 cm (10.21 in.)
Weight	4 lbs. (1.8 kg)	5 lbs. (2.3 kg)
Board Spacing	0.8 in. (20.3 cm)	
Mounting Hole Locations	See Figure 2	
Construction Materials, Cardcage Frame	Aluminum extrusions and end plates, nylon card guides	
Construction Method iPSB Backplane	Six layer backplane with separate VCC and ground layers; all connectors, power terminals, and resistor/capacitor sockets are press-fit into the backplane	
Connector Type	96 pin "DIN" female, gold plated, meets IEC standard 603-2-IEC-C096-F	

Electrical

iPSB Backplane— Meets Intel MULTIBUS II specification No. 146077 for board dimensions, layout, signal line termination, and transmission characteristics

Power Connections— Type: Screw terminal block, AMP P/N 55181-1, Winchester P/N 121-25698-2, or equivalent

Quantity of Power Terminals and Current Rating:

Voltage	iSBC® PKG/606 Cardcage		iSBC® PKG/609 Cardcage	
	Quantity	Current (amps)	Quantity	Current (amps)
+5	3	54	4	81
+12	1	12	1	18
−12	1	12	1	18
+5BB	1	12	1	18
GND	4	78	5	135

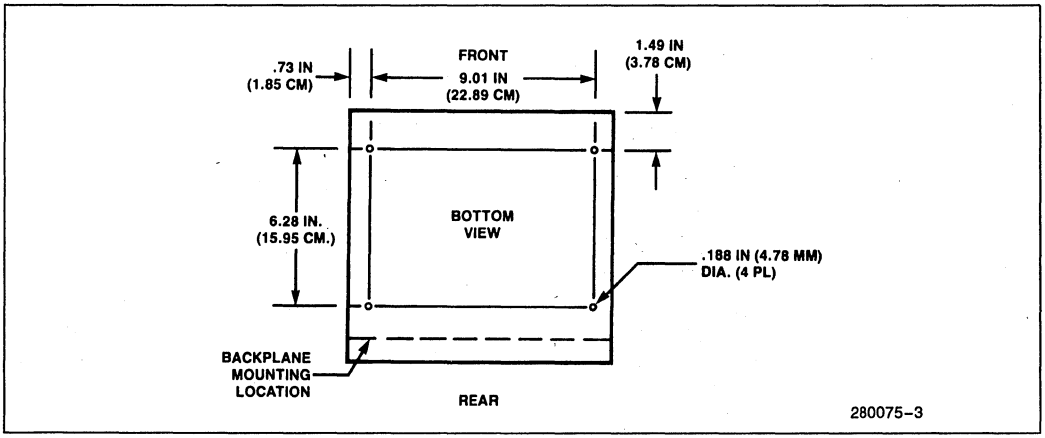


Figure 2. Mounting Hole Locations

Mating Connection: No. 6 locking spade or ring tongue lug

Maximum current available per slot:

Voltage	Current
+ 5V	9A
+12V	2A
−12V	2A
+5BB	2A

Operating Environment:
0–55°C (at 25 amps per power terminal);
0–70°C (at ≤ 18 amps per power terminal);
0% to 95% relative humidity, non-condensing;
0–10,000 ft. altitude.

Reference Manual— MULTIBUS II Cardcage Assembly and iLBX II Backplane User's Guide, P/N 146709-001 (supplied).

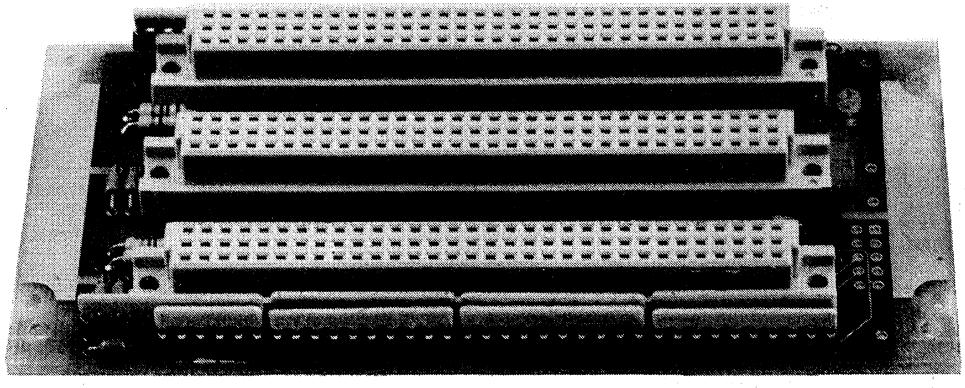
ORDERING INFORMATION

Part Number	Description
iSBC PKG/606	6 slot MULTIBUS II Cardcage Assembly
iSBC PKG/609	9 slot MULTIBUS II Cardcage Assembly

iSBC® PKG/902
iSBC® PKG/903
MULTIBUS® II iLBX™ II BACKPLANES

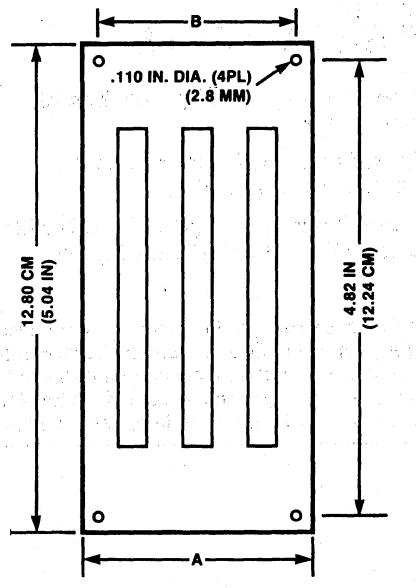
- **Provides iLBX™ II Interconnect for Fastest CPU/Memory Data Transfers**
- **Designed to Mount in MULTIBUS® II Cardcage Assemblies**
- **Meets All Electrical and Mechanical Requirements of the MULTIBUS® II Specifications**
- **Uses a 6 Layer, Fully Terminated Backplane**
- **Includes a 10 Pin Connector for BITBUS™ Applications**
- **Available in 2 Slot (iSBC® PKG/902) and 3 Slot (iSBC® PKG/903) Sizes**

The iSBC PKG/902 and iSBC PKG/903 series of iLBX II backplanes are designed to mount on the P2 side of Intel's MULTIBUS II cardcage assembly or other double Euro (6U) cardcage. One or more backplanes may be installed in a system to allow high speed data transfers between the CPU and memory boards installed in the system. The iLBX II backplane uses a 6 layer PCB with separate power and ground planes and full termination on all signal lines. This design minimizes system noise and ensures reliable operation in all applications.



280074-1

October 1986
Order Number: 280074-002



Dimensions		A	B
iSBC PKG/902	IN	1.55	.80
	CM	3.94	2.03
iSBC PKG/903	IN	2.35	1.60
	CM	5.97	4.06

Figure 1. iLBX™ II Board Dimensions (iSBC® PKG/903 Shown)

FEATURES

Mechanical and Electrical

The iSBC PKG/902 and iSBC PKG/903 iLBX II backplanes use a 6 layer printed circuit board (PCB) with separate power and ground layers and a signal lead routing scheme which minimizes ringing, crosstalk, and capacitive loading on the bus. Mounted on the PCB are two (iSBC PKG/902) or three (iSBC PKG/903) 96 pin DIN connectors, one 10-pin BITBUS connector, terminating resistors, decoupling capacitors, and power terminals. The resistors and capacitors are mounted into sockets, and all parts are press-fit into the backplane. The PCB is UL recognized for flammability.

Single In-line Package (SIP) style resistors are used to terminate all address, clock, data, and control lines. Each termination consists of two resistors which connects the line to +VCC and ground. Different size resistors are used according to the type of driver connected to the line in an operating system. The SIP style resistors help make the board compact in size and allows the designer to mount several backplanes directly adjacent to one another in a system without having to skip slots.

Mounted on the rear of the backplane is a 10-pin BITBUS connector. This connector serves as the serial communication interface for any iSBX 344 BITBUS controller boards installed in the system.

The DIN type connectors are female, 96 pins, fully gold plated, and meet IEC standard 603-2-IEC-C096F. The connectors are mounted on 0.8″ centers to match Intel's iPSB (Parallel System Bus) MULTIBUS II backplanes and are keyed to ensure proper mating to the MULTIBUS II board. The connector can provide up to 6 amps of current at +5V to each MULTIBUS II board in addition to the current available over the Parallel System Bus backplane.

Screw terminals on the backplane are provided for connection to +5V power and ground. These terminals, each of which can handle up to 25 amps of current, provide a simple and highly reliable connection method to the power supply.

SPECIFICATIONS

Mechanical and Environmental

Connector Spacing: 20.3 cm (0.8 in)

Number of Slots: iSBC PKG/902: 2 slots
iSBC PKG/903: 3 slots

Board Dimensions: See Figure 1

Weight: iSBC PKG/902—0.2 kg (8 oz)
iSBC PKG/903—0.3 kg (12 oz)

Connectors:

DIN: 96-pin female, gold plated, meets IEC standard 603-2-IEC-C096-F

BITBUS: 10-pin male, gold plated, T&B Ansley 609-1012M, or equivalent

Constructed Method: Six layer backplane with separate VCC and Ground layers
All connectors, power terminals, and resistor/capacitor sockets are press-fit into the backplane

Mounting Hole Location: See Figure 1

Operating Environment: 0°C–70°C ambient temperature; 0% to 90% relative humidity, non-condensing; 0 ft.–10,000 ft. altitude

Electrical

Backplane Electrical Characteristics and Line Terminations:	Per Intel MULTIBUS II specification 146077, Sec. II, iLBX II

Power Connections

Type: Screw terminal block: AMP P/N 55181-1; Winchester P/N 121-25698-2; or equivalent

Mating Connection: No. 6 locking spade or ring tongue lug

Quantity: 2(VCC, Ground)

Current Rating: iSBC PKG/902: 12 amps; iSBC PKG/903: 18 amps (Power and Ground)

Maximum Current Available Per Slot: 6 amps (over the iLBX II backplane)

REFERENCE MANUAL

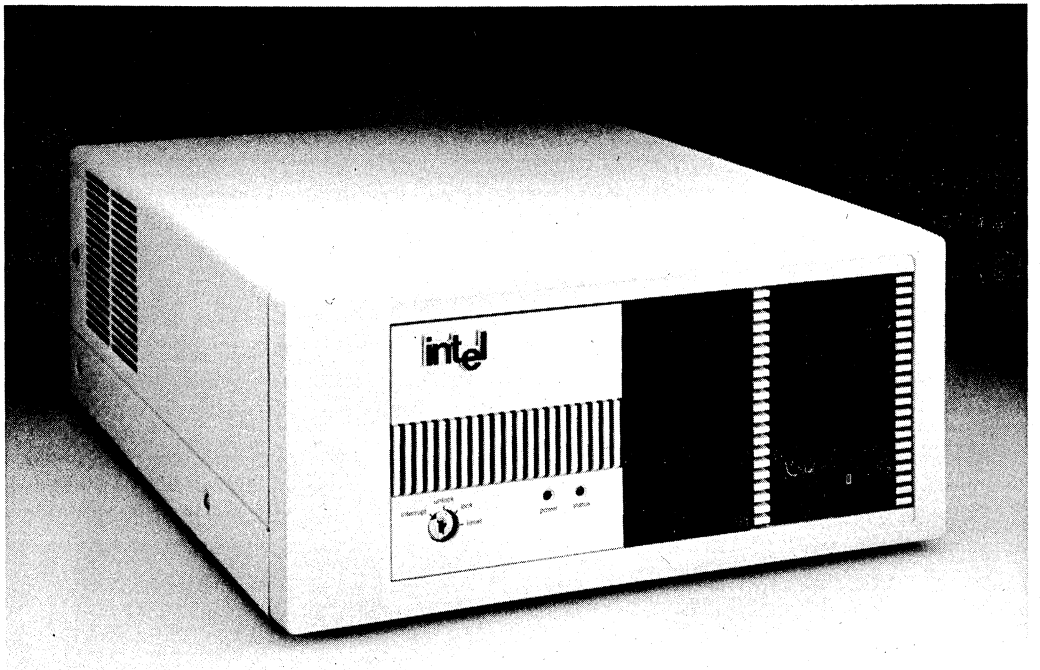
MULTIBUS II Cardcage Assembly and iLBX Backplane User's Guide, P/N 146709-001 (not supplied)

ORDERING INFORMATION

Part Number	Description
iSBC PKG/902	2 slot iLBX II Backplane
iSBC PKG/903	3 slot iLBX II Backplane

SYP 500 MULTIBUS® II SYSTEM CHASSIS

- Full enclosure MULTIBUS® II design development tool or OEM chassis
- Office and industrial applications
- 3 full height/6 half height peripheral bays
- 8 slot MULTIBUS® II cardcage assembly
- 3 slot iLBX™ II backplane
- 535 Watt power supply
- Fully tested: low-noise, shock/vibration and electrostatic resistant



DECEMBER 1986
ORDER NUMBER: 280153-002

The SYP 500 System Chassis is a MULTIBUS II design tool enabling product designers to begin work immediately on MULTIBUS II development projects. It is also ideal for OEM applications. Two front mounted LEDs indicate "Power On" and "Status" (PSB busy) while a keyswitch provides external "reset" capabilities for the chassis. The voltage selector, power-on switch and cardcage opening are located in the rear of the chassis. Three peripheral bays, two of which are accessible from the front of the chassis, support up to three industry standard 5.25" full-height or six half-height peripherals. An eight slot cardcage, Parallel System Bus and iLBX II backplane assembly are integrated with a 535 Watt power supply.

FUNCTIONAL DESCRIPTION

Mechanical Features

Intel's SYP 500 MULTIBUS II Chassis is a full enclosure, off-the-shelf design development tool and OEM chassis. Designers and systems integrators can integrate their MULTIBUS II board set with tape, Wini or floppy peripherals into a complete system. The SYP 500 has three full-height 5.25" peripheral bays. Peripheral power cables, office and industrial environment cooling, and peripheral mounting brackets for industry standard full- or half-height peripherals are provided with the chassis. Access via the front panel allows two of the bays to be configured with removable media peripherals e.g. tape and floppy drives.

This chassis includes an eight-slot MULTIBUS II cardcage assembly with 0.8" centers (slot width). The cardcage is made with heavy duty endplates and extra-wide support extrusions to ensure adequate support for most applications. For industrial applications, this chassis is mountable into any 19" vertical rack.

Two backplanes are installed in the cardcage assembly: the system backplane and the auxiliary backplane. The system backplane is the Parallel System Bus (iPSB) for communications between up to eight MULTIBUS II boards. This backplane utilizes separate power and ground planes and fully terminates all signal lines. The auxiliary backplane, on the other hand, provides direct high speed interconnection between a processor board and memory boards. It contains three iLBX slots. One of these slots has a 10-pin BITBUS connector that serves as a serial interface for any iSBX 344 BITBUS controller board installed in the system. This cardcage conforms to the published MULTIBUS II specification.

Electrical Features

The SYP 500 chassis has a 535 Watt switching power supply with selectable AC power input of 115 V or 220 V at 47-63Hz. The AC input power is externally selectable with a slide switch mounted on the rear of the chassis. A power distribution board is installed in the chassis to allow easy connection to all peripheral bays through six plugs mounted on the power distribution board.

The chassis has been fully tested to ensure low-audible noise emission, resistance to electrostatic discharge and resistance to appropriate levels of vibration and shock in both office and industrial environments.

SPECIFICATIONS:

Electrical Parameters

Maximum Amperage:

Voltage	Current
+ 5V	75A
+12V	10A
−12V	2.5A

Designed to meet: UL 478
CSA C22.2 No. 154
FCC Class B
VDE Level B
IEC 435

Operational Parameters

AC Power Input: 90-132 VAC or
180-264 VAC at 47-63 Hz
Operating Temperature Range: 10°C to 55°C
Storage Temperature: −40°C to 60°C
Operational Humidity: 10% to 85% relative, non-condensing

Physical Parameters

Height: 7.75" (19.7 cm)
Width: 17.5" (44.5 cm)
Depth: 22.25" (56.5 cm)
Weight: 33 lbs. (15 kg.)

Bay Dimensions

3.5" wide × 6" high × 8.5" deep

Acoustical Noise

Less than 50 dbA in office environment (30°C)

Electrostatic Discharge

No hard errors to 12.5 kV

Contents

- 8-slot MULTIBUS II Chassis
- Power cord
- User's guide
- Two keys
- Peripheral mounting brackets & power cables

Ordering Information

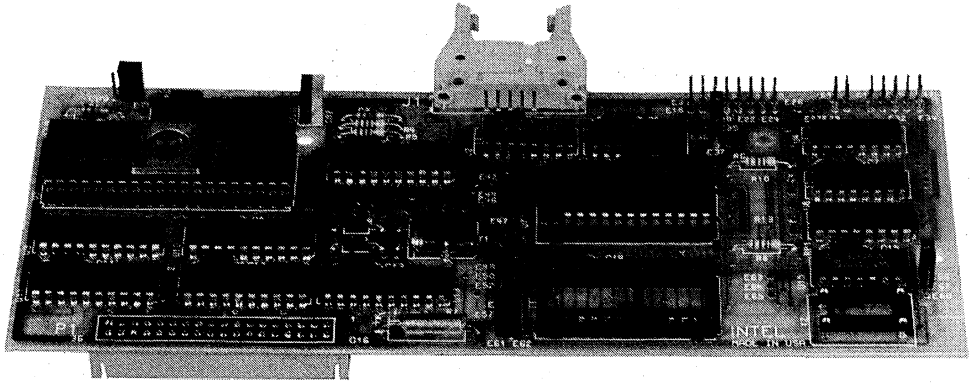
SYP 500

Distributed Control Modules 17

iSBX™ 344A
BITBUS™ INTELLIGENT MULTIMODULE™ BOARD

- **High Performance 12 MHz 8044 Controller**
- **Integral Firmware Including the iDCX 51 Executive Optimized for Real-Time Control Applications**
- **Full BITBUS™ Support**
- **2 28-Pin JEDEC Memory Sites for User's Control Functions**
- **Low Cost, Double-Wide iSBX™ BITBUS Expansion MULTIMODULE™ Board**
- **Power Up Diagnostics**

The iSBX 344A BITBUS Intelligent MULTIMODULE board is the BITBUS gateway to all Intel products that support the iSBX I/O Expansion Interface. Based on the highly integrated 8044 component (an 8-bit 8051 microcontroller and an SDLC-based controller on one chip) the iSBX 344A MULTIMODULE board extends the capability of other microprocessors via the BITBUS interconnect. With the other members of Intel's Distributed Control Modules (iDCM) family, the iSBX 344A MULTIMODULE board expands Intel's OEM microcomputer system capabilities to include distributed real-time control. Like all members of the iDCM family, the iSBX 344A MULTIMODULE board includes many features that make it well suited for industrial control applications such as: data acquisition and monitoring, process control, robotics, and machine control.



280247-1

October 1987
Order Number: 280247-002

OPERATING ENVIRONMENT

Intel's Distributed Control Modules (iDCM) product family contains the building blocks to implement real-time distributed control applications. The iDCM family incorporates the BITBUS interconnect to provide standard high speed serial communication between microcontrollers. The iDCM hardware products: including the iSBX 344A MULTIMODULE board, iPCX 344A board and all iRCB BITBUS Remote Controller Boards communicate in an iDCM system via the BITBUS interconnect as shown in Figure 1.

As a member of the iDCM product line the iSBX 344A MULTIMODULE board fully supports the BITBUS microcontroller interconnect. Typically, the iSBX 344A MULTIMODULE board would be part of a node (master or slave) on the BITBUS interconnect in an iDCM system. As shown in Figure 2 the iSBX 344A MULTIMODULE board plugs into any iSBC® board with an iSBX connector.

The iSBX 344A MULTIMODULE board is the hardware interface between Intel's MULTIBUS® and the BITBUS environment. With this interface the user can harness the capabilities of other Intel microprocessors e.g. 80386, 80286, 80186, 8086, 80188, 8088 in a iDCM system or extend an existing MULTIBUS system with the iDCM family.

MULTIBUS® Expansion

Typically, MULTIBUS iSBC boards have a maximum of two iSBX I/O expansion connectors. These connectors facilitate addition of one or two iSBX I/O MULTIMODULE boards with varying numbers of I/O lines. The iSBX 344A MULTIMODULE board increases the number of I/O lines that can be accommodated by a MULTIBUS system by at least an order of magnitude.

Extending BITBUS™/iDCM System Processing Capability

The iSBX 344A MULTIMODULE board allows utilization of other processors in a iDCM system to accommodate particular application requirements. The MULTIMODULE board is compatible with any iSBX connector so that any board having a compatible connector can potentially enhance system performance. Intel's DCS100 BITBUS Toolbox Software provides easy to use high performance software interfaces for iSBC boards. The iSBC 86/35, 286/12, and 188/48 boards are a few examples. Custom configurations are also possible with user customized software.

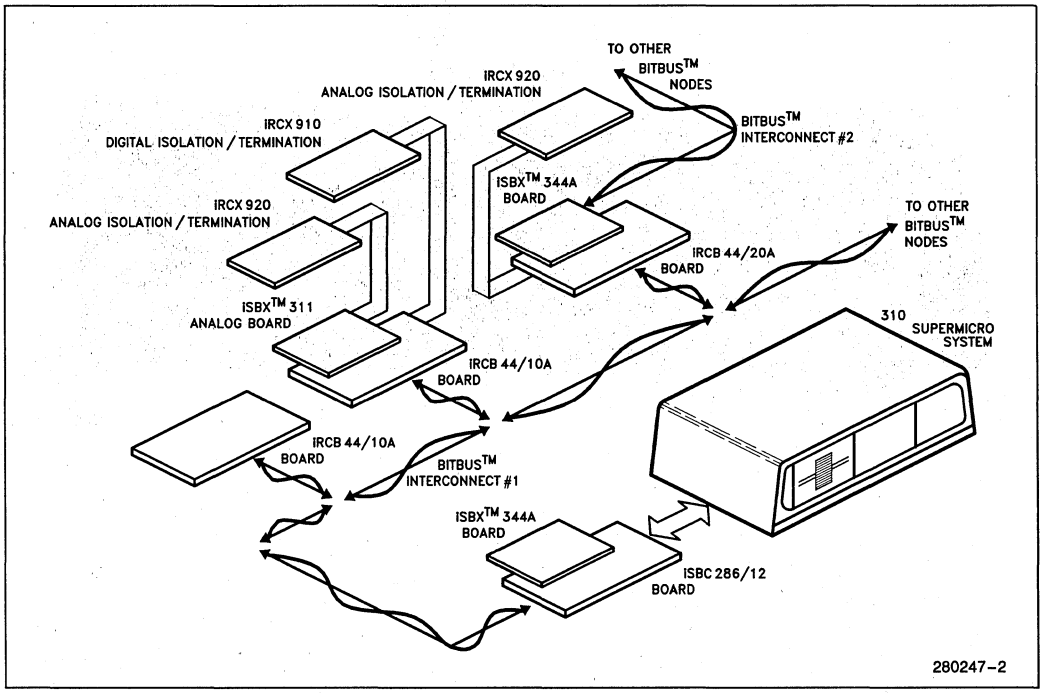


Figure 1. iDCM Operating Environment

ARCHITECTURE

Figure 3 illustrates the major functional blocks of the iSBX 344A board: 8044 BITBUS Enhanced Microcontroller (BEM), memory, BITBUS microcontroller interconnect, Byte FIFO interface, initialization and diagnostic logic.

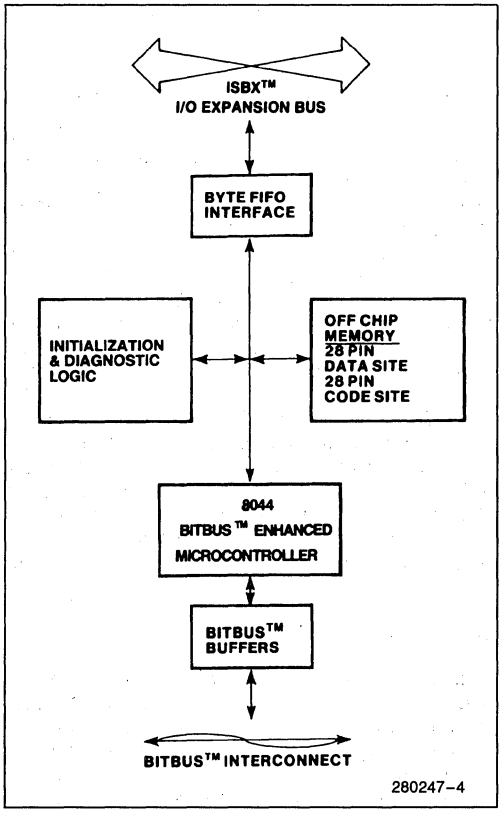


Figure 3. iSBX™ 344A Block Diagram

iDCM Controller

The heart of the iSBX 344A MULTIMODULE board's controlling and communication capability is the highly integrated 12 MHz 8044 microcontroller. The 8044 consists of the advanced 8-bit, 8051 microcontroller and a SDLC-based controller called the Serial Interface Unit (SIU). This dual processor architecture allows complex control and high speed communication to be realized cost effectively.

The 8044 BEM microcontroller also includes built-in firmware known as DCM44. This firmware includes a set of functions called Remote Access and Control (RAC), a preconfigured version of the DCX51 Executive, communications software, and a power-up test procedure.

Memory

The iSBX 344A MULTIMODULE board memory consists of two internal and external memory. Internal memory is located in the on-chip memory of the iDCM controller. The iDCX 51 Executive and the remaining 8044 BEM firmware ration this resource. However, eight bytes of bit addressable internal memory are reserved for the user. Ample space is reserved for user programs and data in the iSBX 344A MULTIMODULE board external memory.

Two 28-pin JEDEC sites comprise the iSBX 344A MULTIMODULE board external memory. One site has been dedicated for data; the other for code. Table 1 lists the supported memory devices for each site. Intel's 2764 and 27128 are examples. The user may choose one of two memory configurations and specify different memory sizes by placing the proper jumpers at system initialization. The most flexible configuration option provides the user with access to the code site for program download or upload. This feature ensures expansion of an existing system is easily accommodated. For example, the addition of another conveyor to a material handling system would require adding another controller or controllers and changes to existing applications code and addition of new code.

Table 1. Supported Memory Devices

Device	Data Site	Code Site
4K x 8–64K x 8 EPROM/ROM	No	Yes
2K x 8–32K x 8 SRAM	Yes	Yes
2K x 8–16K x 8 NVRAM and E2PROM	No	Yes

BITBUS™ Microcontroller Interconnect

The iSBX 344A MULTIMODULE board fully supports the BITBUS microcontroller interconnect. The BITBUS interconnect is a serial bus optimized for control applications. The interconnect supports both synchronous and self-clocked modes of operation. These modes of operation are selectable dependent on application requirements as are the transmission rates. Table 2 shows different combinations of modes of operations, transmission rates, and distances. The SDLC-based protocol, BITBUS message format, and compatibility with Intel's other software and hardware products comprise the remainder of this established architecture. These features contribute to BITBUS reliability and usefulness as a microcontroller interconnect.

The BITBUS connection consists of one or two differential pair(s) of wires. The BITBUS interface of the iSBX 344A MULTIMODULE board consists of a half-duplex RS 485 transceiver and an optional clock source for the synchronous mode of operation.

Byte FIFO Interface

The Byte FIFO Interface on the iSBX 344A MULTIMODULE board implements the required hardware buffering between the 8044 BEM and an extension. An extension is defined as a device attached to the iSBX I/O expansion interface on the iSBX 344A MULTIMODULE board. In an iDCM system, an example of an extension is an iSBC 286/12 board which may be considered the host board in a MULTIBUS system. When used with the software handlers in the BITBUS Toolbox, implementation of this interface is complete.

For particular applications, the user may wish to develop a custom software interface to the extension or host board. On the iSBX 344A MULTIMODULE board side of the interface the iDCM firmware automatically accepts messages for the FIFO. No user code is required, increasing the time available for application system development.

The Byte FIFO supports both byte and message transfer protocol in hardware via three register ports: data, command, and status. The extension side supports polled, interrupt, and limited DMA modes of operation (e.g. 80186 type DMA controllers).

Initialization and Diagnostic Logic

Like the other members of Intel's Distributed Control Modules (iDCM) product line, the iSBX 344A MULTIMODULE board includes many features which make it well suited for industrial control applications. Power up diagnostics is just one of these features. Diagnostics simplify system startup considerably, by immediately indicating an 8044 BEM or external bus failure. The LEDs used for power up diagnostics are available for user diagnostics after power up as well as to further contribute to reliable operation of the system.

Initial iSBX 344A MULTIMODULE board parameters are set by positioning jumpers. The jumpers determine the BITBUS mode of operation: synchronous, self-clocked, transmission rate, and address of the iSBX module in the BITBUS system. This minimizes the number of spare boards to be stocked for multiple nodes, decreasing stocking inventory and cost.

INTEGRAL FIRMWARE

Resident firmware located in the 8044 BEM includes: a pre-configured iDCX 51 Executive for user program development; a Remote Access and Control (RAC) function that enables user communication and control of different microcontrollers and I/O points; a communications gateway to connect the BITBUS interconnect, iSBX bus, and iDCX 51 Executive tasks; and power up diagnostics.

Table 2. BITBUS™ Microcontroller Interconnect Modes of Operation

	Speed Kb/s	Maximum Distance Between Repeaters M/ft	Maximum # Nodes Per Segment	Maximum # Repeaters Between a Master and Any Slave
Synchronous	500–2400	30/100	28	0
Self Clocked	375	300/1000	28	2
	62.5	1200/4000	28	10

Segment: Distance between master and repeater or a repeater and a repeater.
Synchronous mode requires user supplied crystal.

The iDCX 51 Executive is an event-driven software manager that can respond to the needs of multiple tasks. This real-time multitasking executive provides: task management, timing, interrupt handling, and message passing services. Table 3 shows the iDCX 51 calls. Both the executive and the communications gateway allow for the addition of up to seven user tasks at each node while making BITBUS operations transparent.

The Remote Access and Control Function is a special purpose task that allows the user to transfer commands and program variables to remote BITBUS controllers, obtain the status of a remote I/O line(s), or reverse the state of a remote I/O line. Table 4 provides a complete listing of the RAC services. No user code need be written to use this function.

The services provided by the iSBX 344A MULTIMODULE board integral firmware simplify the development and implementation of complex real-time control application systems. All iDCM hardware products contain integral firmware thus supplying the user with a total system solution.

DEVELOPMENT ENVIRONMENT

Intel provides a complete development environment for the iSBX 344A MULTIMODULE board. Software development support consists of: the 8051 Software Development Package, the DCS100 BITBUS Toolbox Host Software Utilities, the DSC110 Bitware for ICE™ Support, and the DCS120 Programmer's Support Package. The 8051 Software Development Package provides the RL 51 Linker and Relocator Program, and ASM 51. PL/M 51 is also available. Hardware tools consist of the In-Circuit Emulator (ICE 5100/044).

Table 3. iDCX 51 Calls

Call Name	Description
TASK MANAGEMENT CALLS	
RQ$CREATE$TASK	Create and schedule a new task.
RQ$DELETE$TASK	Delete specified task from system.
RQGETFUNCTION$IDS	Obtain the function IDs of tasks currently in the system.
INTERTASK COMMUNICATION CALLS	
RQ$ALLOCATE	Obtain a message buffer from the system buffer pool.
RQ$DEALLOCATE	Return a message buffer to the system buffer pool.
RQ$SEND$MESSAGE	Send a message to specified task.
RQ$WAIT	Wait for a message event.
MEMORY MANAGEMENT CALLS	
RQGETMEM	Get available SMP memory.
RQ$RELEASE$MEM	Release SMP memory.
INTERRUPT MANAGEMENT CALLS	
RQ$DISABLE$INTERRUPT	Temporarily disable an interrupt.
RQ$ENABLE$INTERRUPT	Re-enable an interrupt.
RQ$WAIT	Wait for an interrupt event.
TIMER MANAGEMENT CALLS	
RQSETINTERVAL	Establish a time interval.
RQ$WAIT	Wait for an interval event.

Table 4. RAC Services

RAC Service	Action Taken by Task 0
RESET_STATION	Perform a software reset.
CREATE_TASK	Perform an RQ$CREATE$TASK system call.
DELETE_TASK	Perform an RQ$DELETE$TASK system call.
GET_FUNCTION_ID	Perform an RQGETFUNCTION$IDS call.
RAC_PROJECT	Suspend or resume RAC services.
READ_I/O	Return values from specified I/O ports.
WRITE_I/O	Write to the specified I/O ports.
UPDATE_I/O	Update the specified I/O ports.
UPLOAD_MEMORY	Return the values in specified memory area.
DOWNLOAD_MEMORY	Write values to specified memory area.
OR_I/O	OR values into specified I/O ports.
AND_I/O	AND values into specified I/O ports.
XOR_I/O	XOR values into specified I/O ports.
READ_INTERNAL	Read values at specified internal RAM areas.
WRITE_INTERNAL	Write values to specified internal RAM areas.
NODE_INFO	Return device related information.
OFFLINE	Set node offline.
UPLOAD_CODE	Read values from code memory space.
DOWNLOAD_CODE	Write values to specified EEPROM memory.

NOTE:
Internal memory locations are included in the 192 bytes of data RAM provided in the microcontroller. External memory refers to memory outside the microcontroller — the 28-pin sockets of the iSBX 344A module and the iRCB 44/10A board. Each RAC Access Function may refer to multiple I/O or memory locations in a single command.

SPECIFICATIONS

CPU

8044 BITBUS Enhanced Microcontroller (BEM)

Word Size

Instruction: 8 bits

Data: 8 bits

Processor Clock 12 MHz

Instruction Execution Times

1 μs 60% instructions

2 μs 40% instructions

4 μs Multiply & Divide

Memory Capacity/Addressing

iDCM Controller: Up to 64 Kbytes code

Address Range

	Option A	Option B
External Data Memory	0000H–7FFFH	0000H–7FFFH
External Code Memory	1000H–0FFFFH	8000H–0FEFFH
Internal Code Memory	0000H–0FFFH	0000H–0FFFH

Option A: Supports maximum amount of external EPROM code memory.
Option B: Supports downloading code into external RAM or EEPROM memory.

Terminations

Sockets provided on board for ¼ Watt 5% Carbon type resistors. Resistor value to match characteristic impedance of cable as closely as possible—120Ω or greater.

Message Size

54 bytes max

8044 BITBUS™ Enhanced Microcontroller (8044 + Firmware) I/O Addressing as Viewed from the 8044

Function	Address	Read	Write	Bit	Comments
Data	FF00H	✓	✓		
Command	FF01H	✓	✓		Write sets command to extension — Read clears command from extension
Status					
-RFNF*	B3H	✓		✓	Also INT1 Input
-TFNE*	B2H	✓		✓	Also INT0 Input
-TCMD*	92H	✓		✓	
LED #1	90H	✓	✓	✓	
LED #2	91H	✓	✓	✓	
RDY/NE*	B4H	✓	✓	✓	
Node Address	FFFFH	✓			
Configuration	FFFEH	✓			

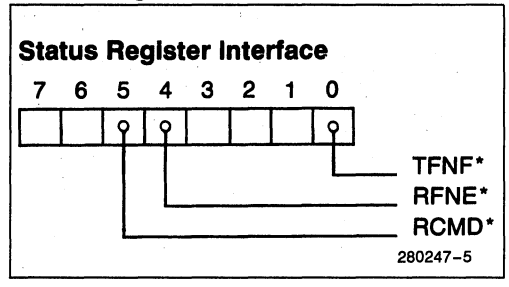
iSBX™ 344A MULTIMODULE™ Board I/O Addressing as Viewed from the iSBX™ 344A MULTIMODULE™ Board

Register Function	Address	Comments
Data	Base'	Read/Write
Command	Base' + 1	Write sets command from extension Read clears command to extension
Status	Base' + 2	Read Only

Interrupt/DMA Lines

Signal	Location	Interface Option
RINT	MDRQ/MINT0	INT
TINT	MINT1	INT
RCMI	OPT0	INT or DMA
RDRQ	MDRQ/MINT0	DMA
TDRQ	MINT1	DMA

Status Register Interface



Connector Options

10 Pin Plug

Flat Cable: 3M 3473-6010, TB Ansley 609-1001M, or equal

Discrete Wire: BERG 65846-007, ITT Cannon 121-7326-105, or equal

Pinout

Pin	Signal
1	+12V
2	+12V
3	GND
4	GND
5	DATA*
6	DATA
7	DCLK*/RTS*
8	DCLK/RTS
9	RGND
10	RGND

Electrical Characteristics

Interfaces

iSBX™ I/O Expansion Bus: supports the standard I/O Expansion Bus Specification with compliance level IEEE 959.

Memory Sites: Both code and data sites support the standard 28-pin JEDEC site.

BITBUS™ Interconnect: Fully supported synchronous mode at 2.4 Mbits/sec and self clocked mode for 375 kbits/sec and 62.5 kbits/sec

The iSBX 344A MULTIMODULE board presents one standard load to the BITBUS bus

Power Requirements

0.9A at +5V ±5% (does not include power to the memory devices)

Physical Characteristics

Double-wide iSBX™ MULTIMODULE™ Form Factor

Dimensions

Height: 10.16 mm (0.4 in) maximum component height

Width: 63.5 mm (2.50 in)

Length: 190.5 mm (7.50 in)

Weight: 113 gm (4 ounces)

Environmental Characteristics

Operating Temperature: 0°C to 55°C at 200 Linear Feet/Minute Air Velocity

Humidity: 90% non-condensing

Reference Manual (NOT Supplied)

148099— iSBX 344A Intelligent BITBUS Interface Board User's Guide

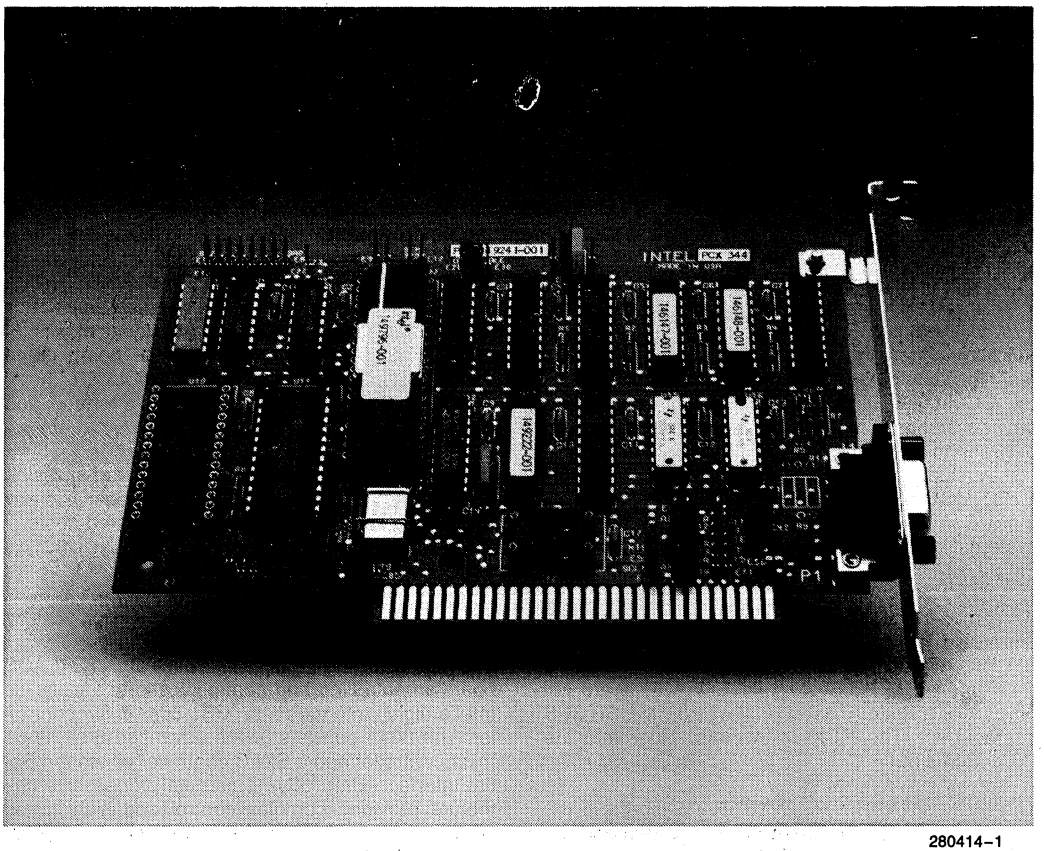
Ordering Information

Part Number	Description
iSBX 344A	BITBUS Intelligent MULTIMODULE board

iPCX 344A
BITBUS™ IBM* PC INTERFACE BOARD

- **High Performance 12 MHz 8044 Single-Chip Microcontroller**
- **Integral Firmware Optimized for Real-Time Control Applications Using the BITBUS™ Interconnect**
- **Fully Supports Intel's Complete Remote Control Board Product Line (iRCB)**
- **Compatible with Intel's DOS-Based Development Tools**
- **External Memory Sites for User's Control Programs**
- **IBM PC System Form Factor Board**
- **Power Up Diagnostics**

The iPCX 344A BITBUS IBM PC INTERFACE board provides the BITBUS gateway to IBM's family of Personal and Industrial Computers. Based on Intel's highly integrated 8044 (an 8051 microcontroller and an SDLC controller on one chip) the iPCX 344A IBM PC INTERFACE board extends the real-time control capability of the IBM PC via the BITBUS interconnect. The PC system performs the human interface functions for the BITBUS interconnect. Like all members of Intel's Distributed Control Modules (iDCM) family, the iPCX 344A IBM PC INTERFACE board includes features that make it well suited for Industrial Control applications such as: data acquisition and monitoring, process control, machine control, and statistical process control (SPC).



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*IBM is a trademark of International Business Machines.

October 1987
Order Number: 280414-002

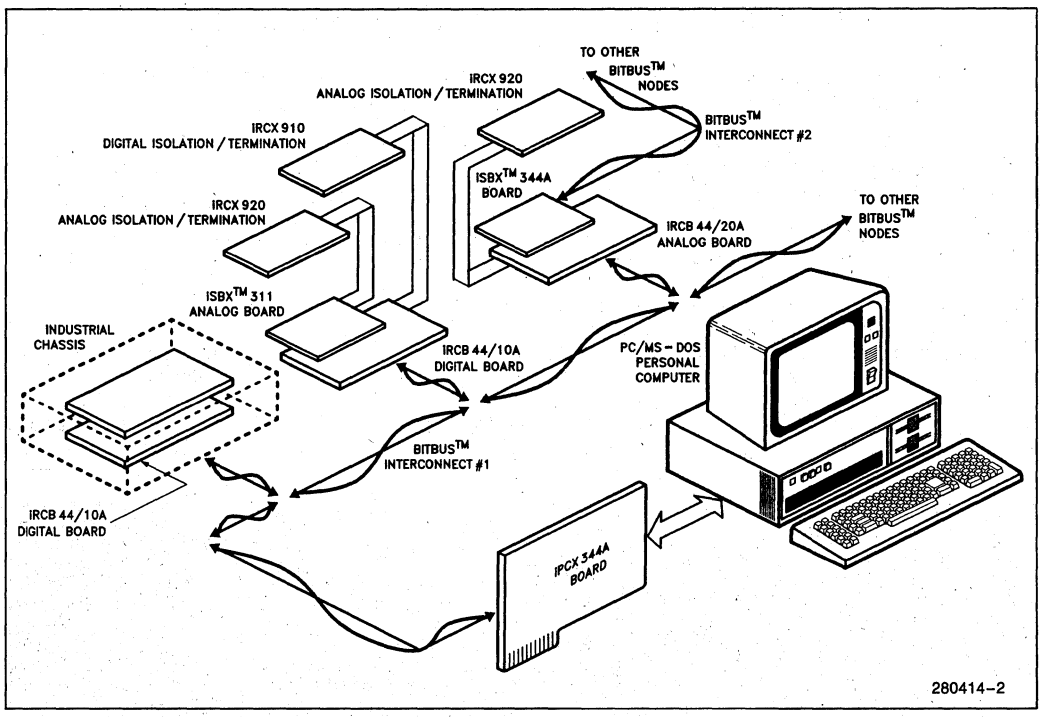


Figure 1. iDCM Operating Environment

OPERATING ENVIRONMENT

Intel's Distributed Control Modules (iDCM) product family provides the building blocks to implement real-time distributed I/O control applications. All of the iDCM family utilizes the BITBUS interconnect to provide standard high speed serial communication between microcontrollers. The iDCM hardware products: including the iPCX 344A board, iSBX™ 344A MULTIMODULE™ board and all iRCB BITBUS Remote Controller Boards communicate in an iDCM system via the BITBUS interconnect as shown in Figure 1.

As a member of the iDCM Product line, the iPCX 344A IBM PC INTERFACE board fully supports the BITBUS microcontroller interconnect. Typically, the iPCX 344A IBM PC System INTERFACE board will be part of a node (master or slave) on the BITBUS interconnect. The iPCX 344A board plugs into the PC add-in slot.

The iPCX 344A IBM PC INTERFACE board is the hardware interface between the PC system and the BITBUS environment. With this interface the user can utilize the human interface and application software of the PC and extend the I/O range of the PC to include real-time distributed control.

ARCHITECTURE

Figure 2 illustrates the major functional blocks of the iPCX 344A IBM PC INTERFACE board: 8044 BITBUS ENHANCED MICROCONTROLLER, memory, BITBUS interconnect, PC System Interface, and initialization/diagnostic logic.

Memory, mode of operation, and bus transmission rate options are easily selected by the user, thereby decreasing inventory levels and associated costs.

8044 BITBUS™ Enhanced Microcontroller (BEM)

The source of the iPCX 344A IBM PC INTERFACE board's controlling and communication capability is Intel's highly integrated 12 MHz 8044 microcontroller. The 8044 consists of the advanced 8-bit, 8051 microcontroller and a SDLC controller called the Serial Interface Unit (SIU). This dual processor architecture provides complex control and high speed communications in a cost-effective, single chip implementation.

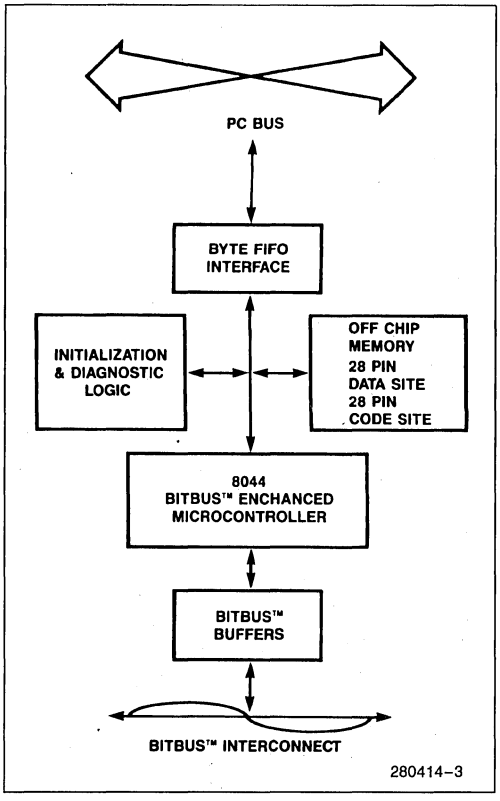


Figure 2. iPCX 344A Block Diagram

Another essential part of the 8044 controller is the integral firmware residing on-chip to implement the BITBUS interface. In the operating environment of the iPCX 344A board, the 8044's SIU acts as an SDLC controller offloading the on-chip 8051 microcontroller of communication tasks; freeing the 8051 to concentrate on real-time control.

The 8044 BEM (8044 microcontroller and on-chip firmware) provides in one package a simple user interface, and high performance communications and control capabilities to efficiently and economically build a complex control system.

Memory

The iPCX 344A IBM PC System INTERFACE board contains both internal and external memory. Internal memory is located in the on-chip memory of the 8044 BEM. The BITBUS firmware includes Intel's powerful iDCX 51, real-time, multitasking, executive. Eight bytes of bit-addressable internal memory are reserved for the user. Additional space is reserved for user programs and data in the board's external memory.

Two 28-pin JEDEC sites comprise the iPCX 344A board's external memory. One site is dedicated to data; the other to code. Table 1 lists the supported memory devices for each site. Intel's 2764 and 27128 are examples. The user can choose one of two memory configurations and specify different memory sizes by configuring the correct jumpers. This configurability provides the user with access to the code site for program download or upload and ensures that an existing system is easily expanded.

Table 1. Supported Memory Devices

Device	Data Site	Code Site
4K x 8–64K x 8 EPROM/ROM	No	Yes
2K x 8–32K x 8 SRAM	Yes	Yes
2K x 8–16K x 8 NVRAM and E^2PROM	No	Yes

BITBUS™ Microcontroller Interconnect

The iPCX 344A IBM PC INTERFACE board fully supports the BITBUS microcontroller interconnect. The BITBUS interconnect is a serial bus optimized for control applications and supports both synchronous and self-clocked modes of operation. Each mode of operation and the different transmission rates are jumper selectable dependent on application requirements.

Table 2 shows different combinations of mode of operation, transmission rate, and distance. The SDLC protocol, BITBUS message format, and compatibility with Intel's other software and hardware products comprise the remainder of this established architecture. These features contribute to BITBUS reliability and usefulness as a microcontroller interconnect.

The BITBUS connection consists of one or two differential user selected pair(s) of wires. The BITBUS interface on the iPCX 344A board consists of a half-duplex RS485 transceiver and an optional clock source for the synchronous mode of operation.

PC System Interface

The iPCX 344A board will operate in any IBM PC XT, PC AT, or compatible system that meets the following requirements:

— An IBM PC, PC XT with an oscillator running at 4.77 MHz (processor running at 4.77 MHz also)

— An IBM PC AT with an oscillator running at 12 or 16 MHz (processor running at 6 or 8 MHz)

— An available I/O channel with addresses that are *not* used by any other boards in the system in the range of 200H to 3FFH on even addresses

— At least one available system interrupt (required ONLY if running the iPCX 344A board in interrupt mode; user selectable from PC Interrupts 2, 3, 4, 5, 6, or 7)

All IBM guidelines have been followed to ensure complete IBM PC system compatibility.

Initialization and Diagnostic Logic

Like the other members of Intel's Distributed Control Modules (iDCM) product line, the iPCX 344A BITBUS IBM PC INTERFACE board includes many features making it well suited for industrial control applications. Power on diagnostics simplify system startup considerably by immediately indicating an 8044 BEM or external bus failure.

INTEGRAL FIRMWARE

The iPCX 344A BITBUS PC-BUS INTERFACE board contains resident firmware located in the 8044 BITBUS ENHANCED MICROCONTROLLER. This on-chip firmware consists of: a pre-configured iDCX 51 Executive for real-time, multitasking control; DCM 44, a Remote Access and Control (RAC) program that enables BITBUS communication and control of I/O points on the BITBUS interconnect; and power up diagnostics.

The iDCX 51 Executive is an event-driven software manager that can respond to the needs of multiple tasks. This real-time multitasking executive provides: task management, timing, interrupt handling, and message passing services. Table 3 shows the iDCX 51 operating system calls. The executive supports up to seven user tasks at each node while making BITBUS operations transparent.

Remote Access and Control (RAC) is a special purpose task that allows the user to transfer commands and program variables to and from BITBUS controllers to obtain the status of I/O or data line(s), or reverse the state of an I/O line or read and write memory, etc. No user code need be written to use this function. See Table 4 for a complete listing of RAC services.

The services provided by the iPCX 344A board's integral firmware simplify the development and implementation of complex real-time control systems.

DEVELOPMENT ENVIRONMENT

Intel provides a variety of development environments for BITBUS applications. Intel's Development Systems and OEM Systems Handbooks provide details on the following development tools.

— BITBUS TOOLBOX—BITBUS Monitor and Interface Handlers

— ASM/PLM 51—Low and High level languages for application code generation on 8044

Table 2. BITBUS™ Microcontroller Interconnect Modes of Operation

	Speed Kb/s	Maximum Distance Between Repeaters M/ft	Maximum # Nodes Per Segment*	Maximum # Repeaters Between a Master and Any Slave
Synchronous	500–2400	30/100	28	0
Self Clocked	375 62.5	300/1000 1200/4000	28 28	2 10

*Segment: Distance between master and repeater or repeater and repeater.
Synchronous mode requires user supplied crystal.

Table 3. iDCX 51 Systems Calls

Call Name	Description
TASK MANAGEMENT CALLS	
RQ$CREATE$TASK	Create and schedule a new task.
RQ$DELETE$TASK	Delete specified task from system.
RQGETFUNCTION IDS	Obtain the function IDs of tasks currently in the system.
INTERTASK COMMUNICATION CALLS	
RQ$ALLOCATE	Obtain a message buffer from the system buffer pool.
RQ$DEALLOCATE	Return a message buffer to the system buffer pool.
RQ$SEND$MESSAGE	Send a message to specified task.
RQ$WAIT	Wait for a message event.

Table 3. iDCX 51 Systems Calls (Continued)

Call Name	Description
MEMORY MANAGEMENT CALLS	
RQGETMEM	Get available SMP memory.
RQ$RELEASE$MEM	Release SMP memory.
INTERRUPT MANAGEMENT CALLS	
RQ$DISABLE$INTERRUPT	Temporarily disable an interrupt.
RE$ENABLE$INTERRUPT	Re-enable an interrupt.
RQ$WAIT	Wait for an interrupt event.
TIMER MANAGEMENT CALLS	
RQSETINTERVAL	Establish a time interval.
RQ$WAIT	Wait for an interval event.

Table 4. RAC Services

RAC Service	Action Taken by Task 0
RESET_STATION	Perform a software reset.
CREATE_TASK	Perform an RQ$CREATE$TASK system call.
DELETE_TASK	Perform an RQ$DELETE$TASK system call.
GET_FUNCTION_ID	Perform an RQGETFUNCTION$IDS call.
RAC_PROJECT	Suspend or resume RAC services.
READ_I/O	Return values from specified I/O ports.
WRITE_I/O	Write to the specified I/O ports.
UPDATE_I/O	Update the specified I/O ports.
UPLOAD_MEMORY	Return the values in specified memory area.
DOWNLOAD_MEMORY	Write values to specified memory area.
OR_I/O	OR values into specified I/O ports.
AND_I/O	AND values into specified I/O ports.
XOR_I/O	XOR values into specified I/O ports.
READ_INTERNAL	Read values at specified internal RAM areas.
WRITE_INTERNAL	Write values to specified internal RAM areas.
NODE_INFO	Return device related information.
OFFLINE	Set node offline.
UPLOAD_CODE	Read values from code memory space.
DOWNLOAD_CODE	Write values to specified EEPROM memory.

SPECIFICATIONS

CPU

8044 BITBUS Enhanced Microcontroller (BEM)

Word Size

Instruction—8 bits
Data—8 bits

Processor Clock

12.0 MHz

Instruction Execution Time

1 μs 60% instructions
2 μs 40% instructions
4 μs Multiply and Divide

Memory Capacity Addressing

iDCM Controller: Up to 64 Kbytes code.

Device	Data	Code
EPROM/ROM		
4K x 8—64K x 8	No	Yes
SRAM		
2K x 8—32K x 8	Yes	Yes
NVRAM and E2PROM		
2K x 8—16K x 8	No	Yes

External I/O Space

0FF00H–0FFFFH (mapped into data memory space)

Termination

Minimum 120Ω each end of BITBUS interconnect with user supplied resistors

Address Ranges

	Option A	Option B
External Data Memory Site	0000H–7FFFH	0000H–7FFFH
External Code Memory Site	1000H–0FFFFH (0000H–0FFFFH If EA Active)	8000H–0FEFFH
Internal Code Memory	0000H–0FFFH	0000H–0FFFH

Option A: Supports maximum amount of external EPROM code memory.
Option B: Supports downloading code into external RAM or EEPROM memory.

Message Size:

Up to 54 bytes

Connectors

Standard 9-pin—D Subminiature socket

Physical Characteristics

IBM PC ADD-ON FORMAT
Height: 3.98 in.
Depth: 6 in.

Interfaces

BITBUS Interconnect: Fully supports synchronous mode at 500 Kbps to 2.4 Mbs and self-clocked modes at 375 Kbs or 62.5 Kbs

Note: On-board ALE clock supports 1 Mbps synchronous operation. All other synchronous mode speeds require user-supplied 2.0 MHz–9.6 MHz crystal.

PC System: Two unidirectional, one-byte-deep, nine-bit FIFO buffers (ninth bit distinguishes between data and command)

Power Requirements

0.9A at +5V ±5% (memory not included)

Environmental Requirements

Operating Temperature: 16°C to 32°C at no air flow
0°C to 55°C at 200 Linear Feet/Minute air velocity
Operating Humidity: 90% Noncondensing
Storage Temperature: −40°C to +70°C
Storage Humidity: 95% Noncondensing

REFERENCE MANUAL

149235-001— iPCX 344A BITBUS IBM PC System Interface Board User's Guide

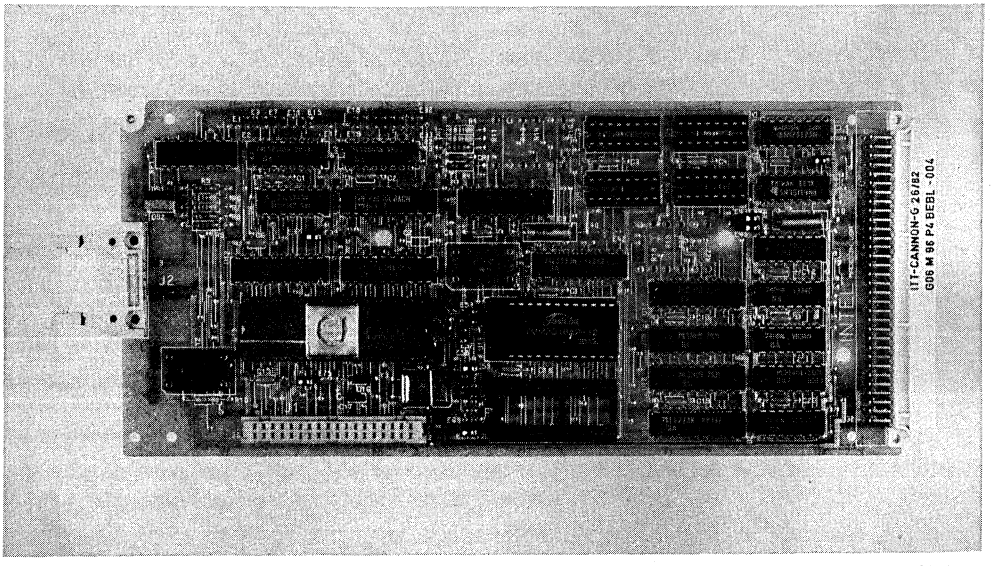
ORDERING INFORMATION

Part Number	Description
iPCX 344A	BITBUS IBM PC System INTERFACE Board

iRCB 44/10A
BITBUS™ DIGITAL I/O REMOTE CONTROLLER BOARD

- **High Performance 12 MHz 8044 Controller**
- **Integral Firmware: iDCX Executive, Optimized for Real-Time Control**
- **Full BITBUS™ Support**
- **Standard Industrial Packaging: Eurocard, DIN Connector**
- **2 28-Pin JEDEC Memory Sites for User's Control Functions**
- **I/O Expansion with 8-Bit iSBX™ Connector**
- **Programmable Control/Monitoring Using 24 Digital I/O Lines**
- **Power Up Diagnostics**
- **Compatible with iRCX 910 Digital Signal Isolation and Termination Module**

The iRCB 44/10A BITBUS™ Digital I/O Remote Controller Board is an intelligent real-time controller and a remote I/O expansion device. Based on the highly integrated 8044 component (an 8 bit 8051 microcontroller and an intelligent SDLC-based controller on one chip) the iRCB 44/10A board provides high performance control capability at low cost. The iRCB 44/10A board can expand Intel's OEM microcomputer system capabilities to include distributed real-time control. Like all members of the iDCM family, the iRCB 44/10A board is well suited for industrial control applications such as data acquisition and monitoring, process control, robotics, and machine control.



280213-1

October 1987
Order Number: 280213-003

OPERATING ENVIRONMENT

Intel's Distributed Control Modules (iDCM) product family contains the building blocks to implement real-time distributed control applications. The iDCM family incorporates the BITBUS interconnect to provide standard high speed serial communication between microcontrollers. The iDCM hardware products, which include the iPCX 344A board, iSBX 344A MULTIMODULE™ board and the iRCB 44/10A BITBUS Remote Controller Board (and other iRCB boards), communicate in an iDCM system via the BITBUS interconnect as shown in Figure 1.

The iRCB 44/10A board can be used as an intelligent remote controller or an I/O expansion device. When performing as an intelligent controller the iRCB 44/10A board not only monitors the status of multiple process points, but it can execute varied user supplied control algorithms. When functioning as an I/O expansion device, the iRCB 44/10A board simply collects data from multiple I/O ports and transmits this information via the BITBUS or iSBX bus interface to the system controller for analysis or updating purposes.

As a member of the iDCM product line, the iRCB 44/10A board fully supports the BITBUS microcontroller interconnect. Typically, the iRCB 44/10A board would be a node in a BITBUS system. The iRCB 44/10A board could be a master or slave node. (The BITBUS system supports a multidrop configuration: one master, many slaves.)

ARCHITECTURE

Figure 2 illustrates the major functional blocks of the iRCB 44/10A board: 8044 BITBUS Enhanced Microcontroller, memory, BITBUS microcontroller interconnect, parallel I/O, iSBX expansion, initialization and diagnostic logic.

8044 BITBUS™ Enhanced Microcontroller

The heart of the iRCB 44/10A board's controlling and communication capability is the highly integrated 12 MHz 8044 microcontroller. The 8044 consists of the advanced 8-bit 8051 microcontroller and a SDLC controller called the Serial Interface Unit (SIU). This dual processor architecture allows complex control and high speed communication functions to be realized cost effectively. The 8044's SIU acts as a SDLC-based controller which offloads the on-chip 8051 microcontroller of communication tasks; freeing the 8051 to concentrate on real-time control.

The 8044 BEM microcontroller also includes, in firmware, a set of procedures known as Remote Access and Control (RAC), a preconfigured version of the DCX 51 Executive, communications software, and power-up diagnostics.

The BEM (8044 microcontroller and on-chip firmware) provides, in one package, a simple user interface, and high performance communications and control capabilities to efficiently and economically build a complex control system.

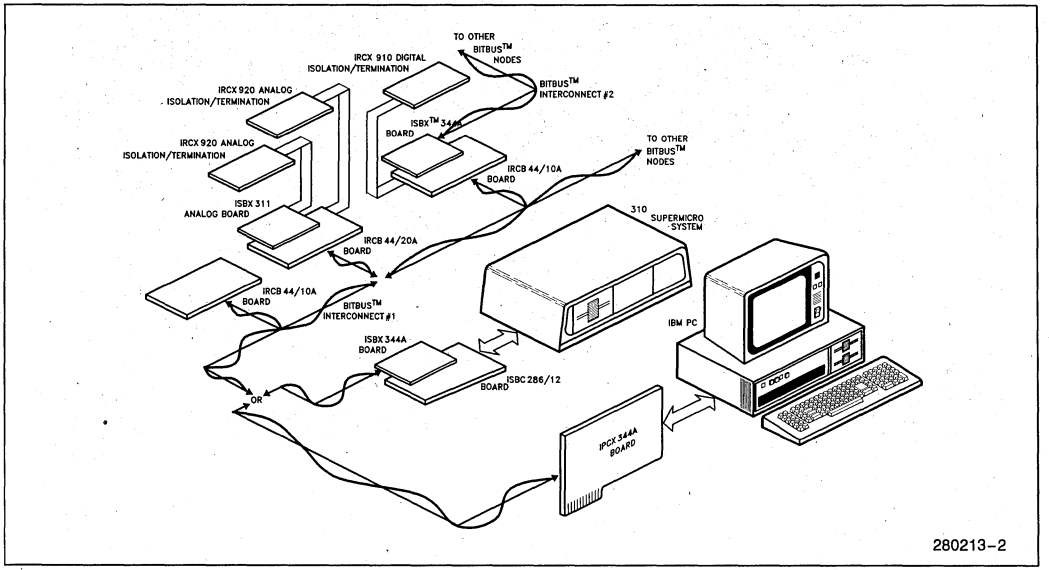


Figure 1. iDCM Operating Environment

Memory

The iRCB 44/10A board memory consists of two sections: internal and external. Internal memory is located in the on-chip memory of the BEM. The iDCX51 Executive and the remaining BEM firmware ration this resource. However, eight bytes of bit addressable internal memory are reserved for the user. Ample space is reserved for user programs and data in the iRCB 44/10A board external memory.

Two 28 pin JEDEC sites comprise the iRCB 44/10A board external memory. One site has been dedicated for data, the other for code. Table 1 lists the supported memory devices for each site. Intel's 2764, and 27128 are examples. The user may choose one of two memory configurations and specify different memory sizes by placing the proper jumpers at system initialization. The most flexible configuration option provides the user with access to the code site for program download or upload. This feature ensures expansion of an existing system is easily accommodated.

Table 1. Supported Memory Devices

Device	Data Site	Code Site
4K × 8-64K × 8 EPROM/ROM	NO	YES
2K × 8-32K × 8 SRAM.	YES	YES
2K × 8-16K × 8 NVRAM and E2PROM	NO	YES

BITBUS™ Microcontroller Interconnect

The iRCB 44/10A board serial interface fully supports the BITBUS microcontroller interconnect. The BITBUS interconnect is a serial bus optimized for

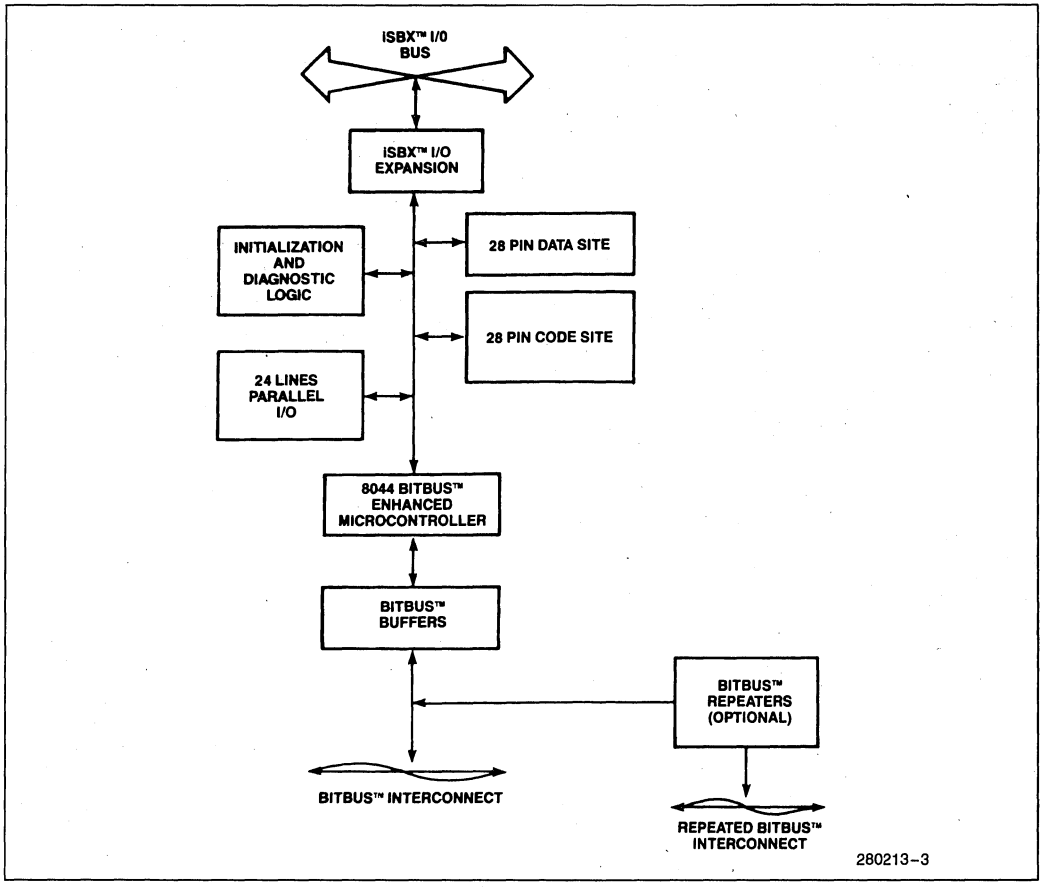


Figure 2. iRCB™ 44/10A Block Diagram

control applications. The bus supports both synchronous and self-clocked modes of operation. These modes of operation are selectable dependent on application requirements as are the transmission speeds. Table 2 shows the different combinations of modes of operation, transmission speeds, and distances. The SDLC-based protocol, BITBUS message format, and compatibility with Intel's other software and hardware products comprise the remainder of the BITBUS architecture. These features contribute to BITBUS system reliability and usefulness as a microcontroller interconnect.

The BITBUS connection consists of one or two differential pair(s) of wires. The serial (BITBUS) interface of the iRCB 44/10A board consists of: a half-duplex RS 485 transceiver, an optional BITBUS repeater and an optional clock source for the synchronous mode of operation.

Digital Parallel I/O

In order to provide an optimal parallel I/O interface for control applications, the iRCB 44/10A board supports 24 software programmable parallel I/O lines. This feature supplies the flexibility and simplicity required for control and data acquisition systems. Sixteen of these lines are fully programmable as inputs or outputs, with loopback, on a bit by bit basis so that bit set, reset, and toggle operations are streamlined. The remaining eight lines are dedicated as inputs. Figure 3 depicts the general I/O port structure.

The parallel I/O lines can be manipulated by using the Remote Access and Control (RAC) function (in BEM firmware) from a supervisory node or locally by a user program. The user program can also access the RAC function or directly operate the I/O lines. Input, output, mixed— input and output, and bit operations are possible simply by reading or writing a particular port.

iSBX™ Expansion

One iSBX I/O expansion connector is provided on the iRCB 44/10A board. This connector can be used to extend the I/O capability of the board. In addition to specialized and custom designed iSBX boards, a full line of compatible high speed, 8-bit expansion MULTIMODULE boards, both single and double wide, are available from Intel. The only incompatible modules are those that require the MWAIT* signal or DMA operation. A few of Intel's iRCB 44/10A board compatible iSBX MULTIMODULE boards include: parallel I/O, serial I/O, BITBUS expansion, IEEE 488 GPIB, analog input and analog output.

With the iSBX 344A BITBUS Controller MULTIMODULE board and user supplied software, the iRCB 44/10A board can act as an intelligent BITBUS repeater facilitating the transition between two BITBUS segments operating at different speeds.

Initialization and Diagnostic Logic

Like the other members of Intel's Distributed Control Modules (iDCM) product line, the iRCB 44/10A board includes many features which make it well suited for industrial control applications. Power up diagnostics is just one of these features. Diagnostics simplify system startup considerably, by immediately indicating an iDCM controller or external bus failure. The LEDs used for power up diagnostics are

Table 2. BITBUS™ Microcontroller Interconnect Modes of Operation

	Speed Kb/s	Maximum Distance Between Repeaters M/ft	Maximum #Nodes Per Segment*	Maximum # Repeaters Between A Master And Any Slave
Synchronous	500–2400	30/100	28	0
Self Clocked	375 62.5	300/1000 1200/4000	28 28	2 10

*Segment: Distance between master and repeater or repeater and repeater. Synchronous mode requires user supplied crystal.

available for user diagnostics after power up as well to further contribute to reliable operation of the system.

Initial iRCB 44/10A board parameters are set by positioning jumpers. The jumpers determine the BITBUS mode of operation: synchronous, self clocked, transmission speed, and address of the iRCB 44/10A board in the BITBUS system. This minimizes the number of spare boards to be stocked for multiple nodes, decreasing stocking inventory and cost.

INTEGRAL FIRMWARE

The iRCB 44/10A board contains resident firmware located in the 8044 BEM. The on-chip firmware consists of: a pre-configured iDCX 51 Executive for user program development; a Remote Access and Controller (RAC) function that enables user communication and control of different microcontrollers and I/O points; a communications gateway to connect the BITBUS interconnect, iSBX bus, iPCX bus and iDCX 51 tasks; and power up diagnostics.

Table 3. iDCX 51 Executive Calls

Call Name	Description
TASK MANAGEMENT CALLS	
RQ$CREATE$TASK	Create and schedule a new task.
RQ$DELETE$TASK	Delete specified task from system.
RQGETFUNCTION$IDS	Obtain the function IDs of tasks currently in the system.
INTERTASK COMMUNICATION CALLS	
RQ$ALLOCATE	Obtain a message buffer from the system buffer pool.
RQ$DEALLOCATE	Return a message buffer to the system buffer pool.
RQ$SEND$MESSAGE	Send a message to specified task.
RQ$WAIT	Wait for a message event.
MEMORY MANAGEMENT CALLS	
RQGETMEM	Get available SMP memory.
RQ$RELEASE$MEM	Release SMP memory.
INTERRUPT MANAGEMENT CALLS	
RQ$DISABLE$INTERRUPT	Temporarily disable an interrupt.
RQ$ENABLE$INTERRUPT	Re-enable an interrupt.
RQ$WAIT	Wait for an interrupt event.
TIMER MANAGEMENT CALLS	
RQSETINTERVAL	Establish a time interval.
RQ$WAIT	Wait for an interval event.

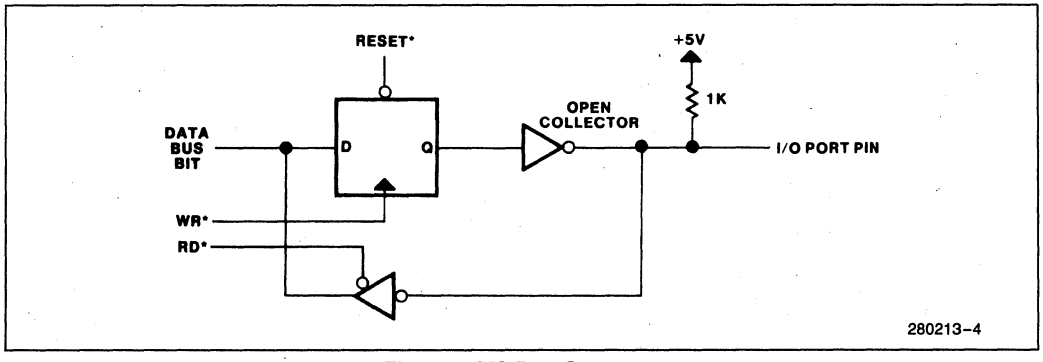


Figure 3. I/O Port Structure

The iDCX 51 Executive is an event-driven software manager that can respond to the needs of multiple tasks. This real-time multitasking executive provides: task management, timing, interrupt handling, and message passing services. Table 3 shows the iDCX 51 calls. Both the Executive and the communications gateway allow for the addition of up to seven user tasks at each node while making BITBUS operation transparent.

The Remote Access and Control Function is a special purpose task that allows the user to transfer commands and program variables to remote BITBUS controllers, obtain the status of a remote I/O line(s), or reverse the state of a remote I/O line. Table 4 provides a complete listing of the RAC services. No user code need be written to use this function. Power up tests provide a quick diagnostic service.

The services provided by the iRCB 44/10A board integral firmware simplify the development and implementation of complex real-time control application systems. All iDCM hardware products contain integral firmware thus supplying the user with a total system solution.

Table 4. RAC Services

RAC Service	Action Taken by Task 0
RESET_STATION	Perform a software reset.
CREATE_TASK	Perform an RQ$CREATE$TASK system call.
DELETE_TASK	Perform an RQ$DELETE$TASK system call.
GET_FUNCTION_ID	Perform an RQGETFUNCTION$IDS call.
RAC_PROTECT	Suspend or resume RAC services.
READ_IO	Return values from specified I/O ports.
WRITE_IO	Write to the specified I/O ports.
UPDATE_IO	Update the specified I/O ports.
UPLOAD_MEMORY	Return the values in specified memory area.
DOWNLOAD_MEMORY	Write values to specified memory area.
OR_I/O	OR values into specified I/O ports.
AND_I/O	AND values into specified I/O ports.
XOR_I/O	XOR values into specified I/O ports.
READ_INTERNAL	Read values at specified internal RAM areas.
WRITE_INTERNAL	Write values at specified internal RAM areas.
NODE_INFO	Return device related information.
OFFLINE	Set node offline.
UPLOAD_CODE	Read values from code memory space.
DOWNLOAD_CODE	Write values to specified EEPROM memory.

INDUSTRIAL PACKAGING

The iRCB 44/10A form factor is a single high, 220 mm deep Eurocard and supports most standard industrial packaging schemes as well as Intel's RCX 910 Digital Signal Conditioning, Isolation and Termination Module (see below). The Eurocard form factor specifies reliable DIN connectors. A standard 64 pin connector is included on the iRCB 44/10A board.

Physical Characteristics

Single high, 220 mm deep Eurocard Form Factor

Dimensions

Width: 13.77 mm (0.542 in) maximum component height

Height: 100 mm (3.93 in.)

Depth: 220 mm (8.65 in.)

Weight: 169 gm (6 ounces)

DIGITAL SIGNAL CONDITIONING, ISOLATION, AND TERMINATION

The RCB 44/10A is fully compatible with the RCX 910 Digital Signal Conditioning, Isolation and Termination Panel. The RCX 910 panel provides integral mounting for one RCB 44/10A, with connectors for power, the BITBUS interconnect signals, and 24 Industry Standard I/O isolation and signal conditioning modules. These modules, available from a number of vendors worldwide, typically provide greater than 1500V isolation and support signal conditioning in a number of voltages including 5–60 VDC, 120 and 240 VAC.

SPECIFICATIONS

Word Size

Instruction: 8 bits

Data: 8 bits

Processor Clock 12 MHz

Instruction Execution Times

1 μsec 60% instructions
2 μsec 40% instructions
4 μsec Multiply & Divide

Memory Capacity/Addressing

iDCM Controller: Up to 64 Kbytes code

DEVELOPMENT ENVIRONMENT

Intel provides a complete development environment for the iRCB 44/10A board.

BITBUS™ Development Environments

	BITBUS™ TOOLS								NODE CODE			ICE™	EPROM PROG.	
	DCS 100 TOOLBOX													
	BBM	UBI	BIH	PC Bridge	OBJHEX	UDI2DOS	DCS 110	DCS 120	ASM 51	PL/M 51	RL 51, LIB 51	ICE 5100/044	iUP200A/201A with iUPF87/44A module and iPPS sw	iPDS with iUPF87/44A module and iPPS sw
Series II									C	C	C		X	
III			X				X	X	X	X	X	X	X	
IV							X	X	X	X	X	X	X	
iPDS	A	A	A				X	X	C	C	C			X
iRMX 5¼"	X	X	X	X	X		X	X	D	D	D			
8"	X	X	X	X	X		X	X	D	D	D			
XENIX 5¼"	X	X		B	X									
8"	X	X		B	X									
DOS	X	X	X	X	X	X	X	X	X	X	X	X	X	

NOTES:
A. iPDS uses Release 1 Toolbox.
B. Supports operation with XENIX. XENIX disks not required.
C. Down-revision version.
D. Available for iRMX® 86.

Address Ranges

Memory	Option A	Option B
External —Data	0000H-7FFFH	0000H-7FFFH
—Code	1000H-0FFFFH	8000H-0FEFFH
Internal	0000H-0FFFH	0000H-0FFFH

NOTES:
Option A: Supports maximum amount of external EPROM code memory.
Option B: Supports downloading code into RAM or EEPROM memory.

Interrupt Sources

Two external: iSBX I/O Expansion bus sources or other sources.
BITBUS Microcontroller Interconnect.

8044 BITBUS™ Enhanced Microcontroller I/O Addressing

Function	Address	Read	Write	Bit
PORT A	FFCOH	✓	✓	
PORT B	FFC1H	✓		
PORT C	FFC2H	✓	✓	
MCSO	FF80H-FF87H FF00, FF01	✓	✓	
MSC1	FF88H-FF8F	✓	✓	
LED #1	90H	✓	✓	✓
LED #2	91H	✓	✓	✓
RDY/NE*	B4H	✓	✓	✓
NODE ADDRESS	FFFFH	✓		
CONFIGURATION	FFFEH	✓		
OPT0	92H	✓	✓	✓
OPT1	93H	✓	✓	✓
INT0	B2H	✓		✓
INT1	B3H	✓		✓

PARALLEL I/O

Number: 2 8-Bit Bi-directional Ports
1 8-Bit Input Port

Table 5. Parallel I/O Electrical Specification

Parameter	Condition	Min	Max	Units
V_{OL}	$I_{OL}=16$ mA		0.5	V
V_{OH}	$I_{OH}=-2$ mA	2.4		V
V_{IH}		2.0	7.0	V
V_{IL}		−1.0	0.8	V
I_{IL}	$V_{IL}=0.5V$		6.0	mA
I_{IH}	V_{IH} = logic high		0.0	mA
I_I	$V_{IH}=7V$		−2.2	mA

Terminations

Sockets provided on board for 1/4 Watt 5% Carbon type resistors. Resistor value to match characteristic impedance of cable as closely as possible—120Ω or greater.

Repeaters

Sockets provided on board: Devices 75174 and 75175

Connector Options

10 PIN PLUG

Flat Cable: 3M 3473-6010, TB Ansley 609-1001M, or equal

Discrete Wire: BERG 65846-007, ITT Cannon 121-7326-105, or equal

DIN CONNECTOR PLUG

Flat Cable: GW Elco 00-8259-096-84-124, Robinson Nugent RNE-IDC64C-TG30, or equal

Discrete Wire: ITT Cannon G06 M96 P3 BDBL-004 GW Elco 60 8257 3017, or equal

10 Pin Repeater Connector Pin Out

Pin	Signal
1	+12V
2	+12V
3	GND
4	GND
5	DATA*
6	DATA
7	DCLK*/RTS*
8	DCLK/RTS
9	RGND
10	RGND

Electrical Characteristics

Interfaces

iSBX I/O expansion bus: supports the standard I/O Expansion Bus Specification with compliance level D8/8F

Memory Sites: Both code and data sites support the electrical Universal Memory Site specification

BITBUS™ Interconnect: The iRCB 44/10A Remote Controller Board supports the BITBUS Specification as follows:

Fully supported synchronous mode at 2.4 Mbits/second and self clocked mode for 375 kbits/second and 62.5 kbits/second

The iRCB 44/10A Remote Controller Board presents one standard load to the BITBUS without repeaters, with repeaters two standard loads

Message length up to 54 bytes supported

RAC Function support as shown in Table 4

Parallel I/O: See the Table 5 for Electrical Specifications of the interface.

Power Requirements

0.9A at +5V ±5% iRCB 44/10 board only (power to memory, repeater, or iSBX board NOT included)

Environmental Characteristics

Operating Temperature: 0°C to 55°C at 200 Linear Feet/Minute Air Velocity

Humidity: 90% non-condensing

Reference Manual (NOT Supplied)

iRCB 44/10 Digital I/O Remote 148100-001 Controller Board User's Guide

Ordering Information

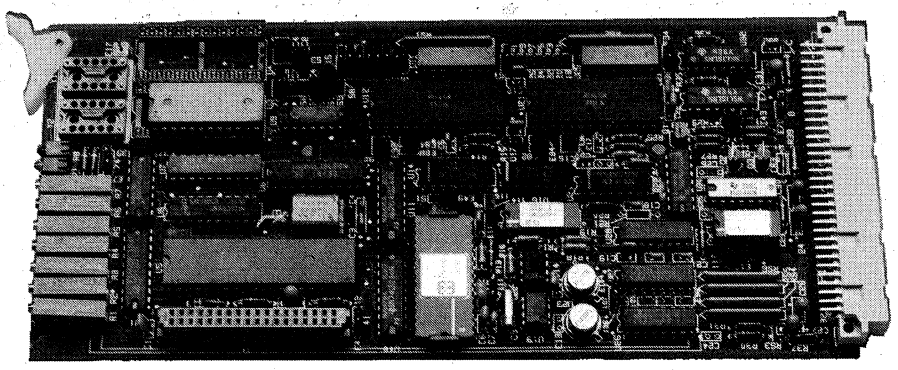
Part Number	Description
iRCB 44/10A	BITBUS Digital I/O Remote Controller Board

iRCB 44/20A
ANALOG I/O CONTROLLER

- **Distributed Intelligence via BITUS™ Serial Bus**
- **8044 8-bit Microcontroller at 12 MHz**
- **12-bit Analog Resolution**
- **Up To 20 KHz Aquisition Rate (50 ms)**
- **Software Programmable Gain: 1, 10, 100, 500**
- **Two 28-pin JEDEC Memory Sites**
- **16 Single-ended or 8 Differential Input Channels**
- **2 Outputs Channels**
- **±10V Range or 4–20 mA Current Loop**
- **I/O Expandable via iSBX™ Connector**
- **Compact Single-Eurocard Packaging**
- **Low Power Consumption**
- **Compatible with iRCX 920 Analog Signal Conditioning, Isolation and Termination Panel**

The iRCB 44/20A is a fully programmable analog I/O subsystem on a single-Eurocard form-factor board. The resident 8044 microcontroller operating at 12 MHz provides a means of executing data aquisition and control routines remote from the host computer. Real-time capability is made possible by the iDCX 51 Distributed Control Executive, resident in the 8044 microcontroller. Distribution of real-time control is implemented by the BITBUS Serial Bus protocol, which is also managed integrally by the 8044.

Offering high performance, low-cost, and improved system bandwidth via distributed intelligence, the iRCB 44/20A Analog I/O Controller is ideal for data acquisition and control in both laboratory and industrial environments.



280721-1

MULTIMODULE™ is a trademark of Intel Corporation.

IBM® PC is a registered trademark of International Business Machine Corporation.

October 1987
Order Number: 280721-002

APPLICATION ENVIRONMENT

Intel's Distributed Control Modules (iDCM) product family contains the building blocks to implement real-time distributed control applications. The iDCM family incorporates the BITBUS interconnect to provide standard high-speed serial communication between microcontrollers. The iRCB 44/20A may communicate with other nodes in a distributed system via the BITBUS interconnect as shown in Figure 1. Other nodes in the system may be the iSBX 344A BITBUS Controller MULTIMODULE™, the iPCX 344A BITBUS IBM® PC Interface, the iRCB 44/10A BITBUS Digital I/O Controller Board, or other BITBUS compatible products.

The iRCB 44/20A board, can be used as an intelligent remote controller or an I/O expansion device. When performing as an intelligent controller the iRCB 44/20A board not only monitors the status of multiple sensors, it can also locally execute user developed control algorithms. When functioning as an I/O expansion device the iRCB 44/20A board manages the multiple I/O ports, transmitting this information via the BITBUS bus or iSBX interface to the system controller for analysis or data logging purposes.

Typically, the iRCB 44/20A board will operate as a node in a BITBUS system. BITBUS communication supports a multidrop configuration with one master, and multiple subordinate nodes. The iRCB 44/20A board may be either a master or slave node to manage a wide variety of analog input or output tasks.

FUNCTIONAL DESCRIPTION

The major functional blocks of the iRCB 44/20A board, shown in Figure 2, include the 8044 microcontroller and BITBUS interconnect, local memory, Analog I/O, and iSBX expansion.

Distributed Intelligence

The heart of the iRCB 44/20A board's controlling and communication capability is the highly integrated 8044 microcontroller which operates at 12 MHz. The 8044 contains the advanced 8-bit, 8051 microcontroller and a complimentary SDLC controller, called the Serial Interface Unit (SIU). This dual processor architecture provides complex control and high speed communication functions at a low cost.

Another essential part of the 8044 controller is the on-chip firmware that exercises the BITBUS interface. The 8044's SIU acts as an SDLC controller, off loading the on-chip microcontroller of communication tasks so it may concentrate on real-time control.

The 8044 microcontroller simplifies the user interface, and offers high performance communications and control capabilities in a single component package. Many interconnected Distributed Control Modules can form a powerful platform to efficiently and economically administer a complete control system.

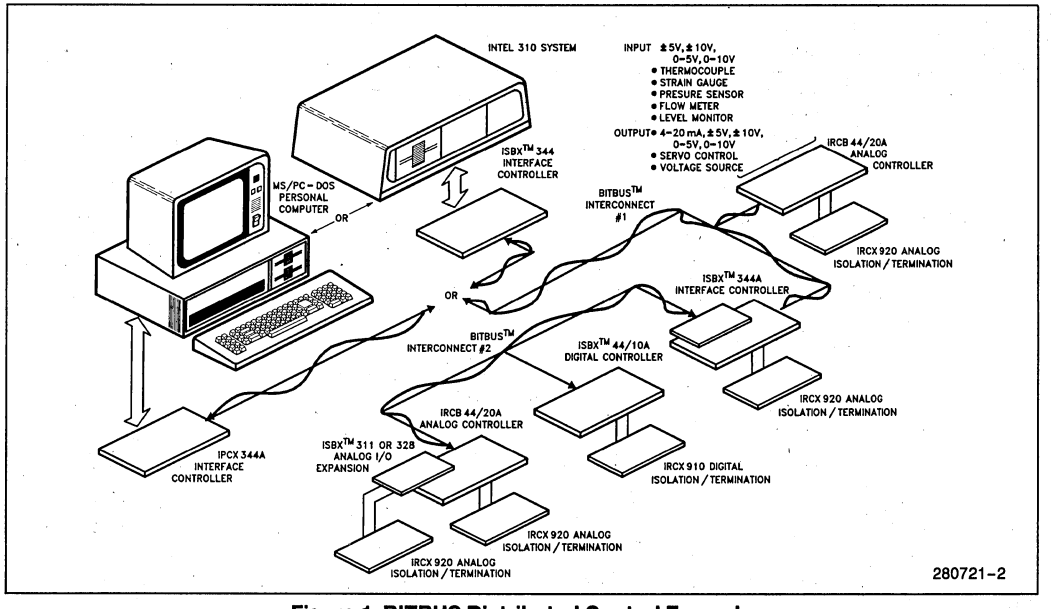


Figure 1. BITBUS Distributed Control Example

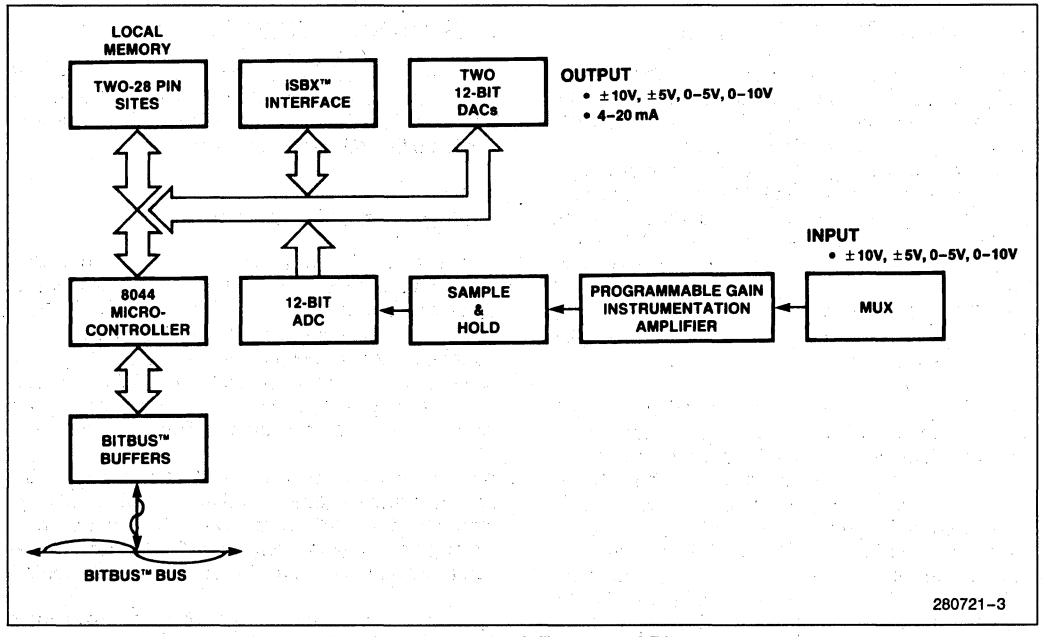


Figure 2. iRCB 44/20A Functional Diagram

BITBUS™ Microcontroller Interconnect

The iRCB 44/20A board fully supports the BITBUS microcontroller interconnect. BITBUS is a serial bus optimized for control applications. Both synchronous and self-clocked modes of operation are supported as well as multiple transmission rates. Table 1 shows the different combinations of modes of operation, transmission speeds, and distances. The SDLC protocol and BITBUS message format comprise the data-link level of the BITBUS architecture. Use of these standards maximizes system reliability and flexibility.

The physical connection to BITBUS uses either one or two pairs of wires across which differential signals travel. The iRCB 44/20A board contains a half-duplex RS 485 tranceiver and an optional clock source for the synchronous mode of operation.

Local Memory

The iRCB 44/20A board contains both internal and external local memory. Internal memory is located within the 8044 controller and is used by the iDCX 51 Executive and the SIU. Eight bytes of bit-addressable internal memory have been reserved for the user.

Two 28-pin JEDEC sites provide the iRCB 44/20A board with memory that is external to the 8044. One site has been dedicated for data, the other for application code. Table 2 lists the supported memory devices for each site. The user may select one of two memory configurations using jumpers. One option provides the user with access to the application code site for uploading or downloading programs, which allows expansion or modification of an existing system from a remote site.

Table 1. BITBUS™ Microcontroller Interconnect Modes Of Operation

	Speed Kb/S	Maximum Distance Between Repeaters M/ft	Maximum # Nodes Per Segment*	Maximum # Repeaters Between A Master And Any Slave
Synchronous	500–2400	30/100	28	0
Self Clocked	375	300/1000	28	2
	62.5	1200/4000	28	10

* Segment: Distance between master and repeater or repeater and repeater. Synchronous Mode requires user supplied crystal.

Table 2. Supported Memory Devices

Device	Data Site	Code Site
4K x 8–64K x 8 EPROM/ROM	NO	YES
2K x 8–32K x 8 SRAM	YES	YES
2K x 8–16K x 8 NVRAM and E2PROM	NO	YES

Analog I/O

The iRCB 44/20A has been designed to manage a wide variety of analog functions. The jumper-selectable voltage or current ranges plus software programmable gain allows the iRCB 44/20A to acquire data from a combination of up to 16 thermocouples, strain gauges, pressure transducers, flow meters, level sensors, or any devices that operate on a 4–20 mA current loop. Two analog output channels provide the capability to adjust system parameters locally through servo control, voltage-driven devices, or other actuators that respond to 4–20 mA signals.

The 8044 microcontroller on the iRCB 44/20A allows Proportional Integral/Derivative (PID) algorithms, event timing, or averaging tasks to operate independent of the host computer or programmable controller. By off-loading the host in this manner, the overall system performance can be improved significantly.

The analog I/O lines can be manipulated from a remote supervisor by communicating with the Remote Access and Control (RAC) functions, which are included in the 8044 controller firmware. The local application program running on the iRCB 44/20A can also access the RAC functions or directly operate the I/O lines.

iSBX™ Expansion

One 8-bit iSBX I/O expansion connector is provided to expand the functionality of the iRCB 44/20A board. A full line of compatible expansion MULTIMODULE boards are available from Intel; both single- and double-wide versions are supported by the iRCB 44/20A. Parallel I/O, serial I/O, IEEE 488, magnetic-bubble memory, or additional analog I/O may be added in this manner.

Also, the iSBX 344A BITBUS Controller MULTIMODULE can be used to implement another BITBUS hierarchy with the iRCB 44/20A functioning as the master. With user supplied software, this product combination can operate as an intelligent BITBUS repeater, facilitating the transmission between two BITBUS segments operating at different speeds.

Initialization and Diagnostic Logic

Like the other members of the Intel's Distributed Control Modules (iDCM) product line, the iRCB 44/20A board includes many features which make it well suited for industrial control applications. Power-up diagnostics simplify system initialization by immediately indicating a failure in either the 8044 microcontroller or external bus. On-board LEDs indicate diagnostic status and are available after power-up for user developed diagnostic routines.

Initial iRCB 44/20A board parameters are manually set with jumpers. These jumpers specify the mode of operation (synchronous or self clocked), and transmission speed. The address of the iRCB 44/20A board within the BITBUS system is also declared in this manner. Therefore, spare board inventory is reduced, since the iRCB 44/20A may be positioned at any node address.

INTEGRAL iDCX 51 FIRMWARE

The iRCB 44/20A board contains resident firmware located within the 8044 controller. This on-chip firmware, known as DCM 44, consists of a pre-configured iDCX 51 Distributed Control Executive for user program development and execution, a library of Remote Access and Control (RAC) functions for internode communications and I/O control, plus an iSBX communications gateway, and power-up diagnostics.

The iDCX 51 Executive is an event-driven software manager that can respond to the needs of multiple tasks. This real-time multitasking executive provides task management and timing, interrupt handling, and message passing services. Table 3 shows the iDCX 51 user command library. Both the executive and the communications gateway allow for the addition of seven user tasks at each node that are independent of BITBUS bus management operations.

Remote Access and Control (RAC) functions are special purpose tasks that allow the host system to transfer commands and program variables to remote BITBUS controllers and read/write to the remote I/O lines. Table 4 provides a complete listing of the RAC commands. No user code need be written to use this function. Power-up tests provide a quick diagnostic service.

The DCM 44 firmware, integral to the iRCB 44/20A board, simplifies the development and implementation of complex real-time control applications. All iDCM hardware products contain this integral firmware, providing the user with application code portability.

Table 3. iDCX 51 Executive Calls

Call Name	Description
TASK MANAGEMENT CALLS	
RQ$CREATE$TASK	Create and schedule a new task.
RQ$DELETE$TASK	Delete specified task from system.
RQGETFUNCTION$IDS	Obtain the function IDs of tasks currently in the system.
INTERTASK COMMUNICATION CALLS	
RQ$ALLOCATE	Obtain a message buffer from the system buffer pool.
RQ$DEALLOCATE	Return a message buffer to the system buffer pool.
RQ$SEND$MESSAGE	Send a message to specified task.
RQ$WAIT	Wait for a message event.
MEMORY MANAGEMENT CALLS	
RQGETMEM	Get available SMP memory.
RQ$RELEASE$MEM	Release SMP memory.
INTERRUPT MANAGEMENT CALLS	
RQ$DISABLE$INTERRUPT	Temporarily disable an interrupt.
RQ$ENABLE$INTERRUPT	Re-enable an interrupt.
RQ$WAIT	Wait for an interrupt event.
TIMER MANAGEMENT CALLS	
RQSETINTERVAL	Establish a time interval.
RQ$WAIT	Wait for an interval event.

Table 4. RAC Services

RAC Service	Action Taken by Task 0
RESET_STATION	Perform a software reset.
CREATE_TASK	Perform an RQ$CREATE$TASK system call.
DELETE_TASK	Perform an RQ$DELETE$TASK system call.
GET_FUNCTION_ID	Perform an RQGETFUNCTION$IDS call.
RAC_PROTECT	Suspend or resume RAC services.
READ_IO	Return values from specified I/O ports.
WRITE_IO	Write to the specified I/O ports.
UPDATE_IO	Update the specified I/O ports.
UPLOAD_MEMORY	Return the values in specified memory area.
DOWNLOAD_MEMORY	Write values to specified memory area.
OR_I/O	OR values into specified I/O ports.
AND_I/O	AND values into specified I/O ports.
XOR_I/O	XOR values into specified I/O ports.
READ_INTERNAL	Read values at specified internal RAM areas.
WRITE_INTERNAL	Write values to specified internal RAM areas.
NODE_INFO	Return device related information.
OFFLINE	Set node offline.
UPLOAD_CODE	Read values from code memory space.
DOWNLOAD_CODE	Write values to specified EEPROM memory.

NOTES:
Internal memory locations are included in the 192 bytes of data RAM provided in the microcontroller. External memory refers memory outside the microcontroller—the 28-pin sockets of iRCB 44/20A board. Each RAC Access Function may refer to 1, 2, 3, 4, 5 or 6 individual I/O or memory locations in a single command.

INDUSTRIAL PACKAGING

The iRCB 44/20A board conforms to a single-wide (3V), 220 mm deep Eurocard form-factor. This allows the iRCB 44/20A to fit within standard industrial racks or chassis as well as Intel's RCX 920 Analog Signal Conditioning, Isolation & Termination Panel (see below). The Eurocard specification references DIN 41612 connectors, which are used on the iRCB 44/20A board.

ANALOG SIGNAL CONDITIONING, ISOLATION AND TERMINATION

The RCB 44/20A is fully compatible with the RCX 920 Analog Signal Conditioning, Isolation and Termination Panel. The RCX 920 panel provides integral mounting for one RCB 44/20A, with connectors for power, the BITBUS interconnect signals, and 18 Analog Devices 5B Series Signal Conditioning and Isolation Modules. These modules provide 240V RMS field wiring protection, and 1500V RMS common mode voltage isolation and support signal conditioning in a wide range of analog voltages and currents including thermocouple and RTD sensors, millivolt and volt inputs and 4–20 mA and 0–20 mA outputs.

SPECIFICATIONS

CPU

8044 BITBUS Enhanced Microcontroller (BEM)

Word Size

Instruction—8 bits
Data—8 bits

Processor Clock

12 MHz

Instruction Execution Times

1 μsec 60% instructions
2 μsec 40% instructions
4 μsec Multiply & Divide

Memory Addressing

iDCM Controller
Up to 64K bytes code

Address Ranges

	Option A	Option B
External Data Memory Site	0000H–7FFFH	0000H–7FFFH
External Code Memory Site	1000H–0FFFFH (0000H–0FFFFH if EA Active)	8000H–0FFEFH
Internal Code Memory	0000H–0FFFH	0000H–0FFFH

NOTES:
Option A: Supports maximum amount of external EPROM code memory
Option B: Supports downloading code into external RAM or EEPROM memory

BITBUS™ Development Environments

HOST SYSTEM	BITBUS™ TOOLS								NODE CODE			ICE™	EPROM PROG.	
	DCS 100 TOOLBOX													
	BBM	UBI	BIH	PC Bridge	OBJHEX	UDI2DOS	DCS 110	DCS 120	ASM 51	PL/M 51	RL 51, LIB 51	ICE 5100/044	iUP200A/201A with iUPF87/44A module and iPPS sw	iPDS with iUPF87/44A module and iPPS sw
Series II									C	C	C		X	
III			X				X	X	X	X	X	X	X	
IV							X	X	X	X	X	X	X	
iPDS™	A	A	A				X	X	C	C	C			X
iRMX® 5¼″	X	X	X	X	X		X	X	D	D	D			
8″	X	X	X	X	X		X	X	D	D	D			
XENIX 5¼″	X	X		B	X									
8″	X	X		B	X									
DOS	X	X	X	X	X	X	X	X	X	X	X	X	X	

NOTES:
A. iPDS™ uses Release 1 Toolbox.
B. Supports operation with XENIX. XENIX disks not required.
C. Down-revision version.
D. Available for iRMX® 86.

I/O Capability

Analog—16 single-ended or 8 differential channels and 2 outputs channels

Expansion—one single-or double-wide iSBX MULTIMODULE (MWAIT * or DMA not supported by iRCB 44/20)

Interrupt Sources

Two external: iSBX I/O Bus or BITBUS Interconnect sources

Bus Termination

Jumper selectable resistors provide termination capability for cable with an impedance of 120Ω or greater.

Analog Input Specifications

Number of channels—16 single-ended or 8 differential
Input ranges—0 to 5V, 0 to 10V (unipolar) ±5V, ±10V (bipolar)
Gain ranges—1, 10, 100, 500, (software programmable)
Input impedance—100MΩ
Input bias current—±50 nA
Overvoltage protection—±32V power on
±20V power off

Accuracy

Resolution—12 bits
Linearity and Noise—±¾ LSB (trimmable)
System Accuracy
Gain = 1—±0.035% full-scale range (trimmable)
Gain = 500—±0.15% full-scale range (trimmable)

Stability

Gain tempco—32 ppm/°C (gain = 11)
75 ppm/°C (gain = 500)
Offset tempco—100 microvolts/°C max.

Dynamic Performance

Aggregate throughout—20 KHz (gain = 1, 10)
7.5 KHz (gain = 100, 500)
Common mode rejection—70 dB (gain = 1)
100 dB (gain = 500)
A/D conversion time—30 microseconds

Analog Output Specifications

Number of channels—2
Output ranges—0 to 5V, 0 to 10V (unipolar) ±5V, ±10V (bipolar)
Current-loop range—4 to 20 mA (unipolar mode only)
Output impedance—0.2Ω min. (voltage)
5 MΩ max. (current)
Output current—±5 mA (short-circuit protected)

Accuracy

Resolution—12 bits
Linearity and Noise—±¾ SB (trimmable)
System Accuracy—
Gain = 1—−0.35% full-scale range (trimmable)
Gain = 500—±0.15% full-scale range (trimmable)

Stability

Full-scale temperature coefficient
150 microvolts/°C (unipolar)
300 microvolts/°C (bipolar)
0.6 microamps/°C (current-loop)

Offset temperature coefficient
30 microvolts/°C (unipolar)
180 microvolts/°C (bipolar)
0.3 microamps/°C (current-loop)

Mating Connectors

Function	# of Pins	Type	Vendor	Part Number
BITBUS Connector	64	Flat Cable	GW Elco Robinson Nugent	00-8259-096-84-124 RNE-IDC-64C-TG30
iSBX Connector	36	Wire Wrap	ITT Cannon GW Elco	G06 M96 P3 BDBL-004 60 8257 3017
		Solder	Viking	000292-0001

Dynamic Performance

Aggregate throughput—20 KHz (gain = 1, 10)
7.5 KHz (gain = 100, 500)
Settling Time—15 microseconds to ±½ LSB

Electrical Characteristics

Interface Compliance

iSBX BUS (through level D8/8F):
Memory sites—code and data sites are JEDEC compatible

BITBUS:

— Synchronous and self-clocked mode support for 500 Kbps to 2.4 Mbps, 375K and 62.5K bits/sec

NOTE:
On-board ALE clock supports 1 Mbps synchronous operation. All other synchronous mode speeds require user-supplied 2.0–9.6 MHz crystal.

— Equivalent to 1.1 standard (RS 485) loads

— Message length up to 54 bytes maximum

Power Requirement (exclusive of optional memory or iSBX MULTIMODULE)

Voltage	Current (amps)	Max, Power (watts)
+5V ±5% +12V ±5% −12V ±5%	0.9 max. 0.7 typ 100 mA max. 100 mA max.	4.5

NOTE:
+15V and −15V required for 0 to 10V and ±10V ranges; for ±15V operation, the iRCB 44/20A cannot be used with iSBX MULTIMODULES that use ±12V power sources.

Physical Characteristics

Width: 3.77 mm (0.542 in) maximum component height
Height: 100 mm (3.93 in)
Depth: 220 mm (8.65 in)
Weight: 169 gm (6 ounces)

Environmental Characteristics

Operating Temperature: 0°C to +60°C at 0.8 CFM air volume
Relative Humidity: 90% non-condensing

Reference Manual (Not Supplied)

148816— iRCB 44/20A Hardware Reference Manual

ORDERING INFORMATION

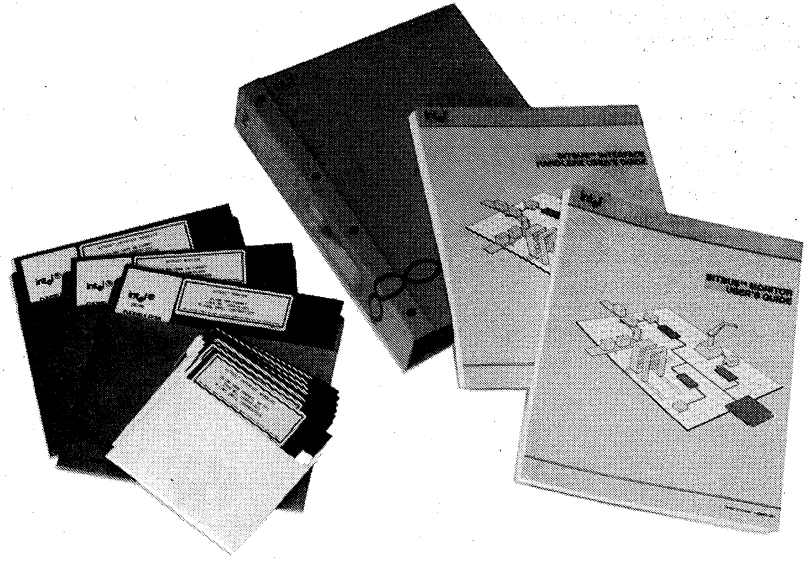
Part Number	Description
iRCB 44/20A	BITBUS Analog I/O Controller Board

DCS100 BITBUS™ TOOLBOX HOST SOFTWARE UTILITIES

- **Six Utilities Simplify Development of Host Software for Controlling BITBUS™-Based Systems**
- **Includes the BITBUS™ Monitor Which Provides On-Line Monitoring and Control of a BITBUS™ System**
- **Reliable and Easy to Use**
- **Universal BITBUS™ Interface and BITBUS™ Interface Handler Libraries Provide 32 System Management/ Control Procedure**
- **Compatible with Intel's C, PL/M and ASM Languages**
- **For DOS, iRMX® 86/286, XENIX*, and iPDS™ Host Systems**

The BITBUS Toolbox provides a set of utilities designed to simplify development of host system software for controlling a BITBUS network. The Toolbox includes: two libraries of procedures that can be called from the host code; an on-line program called the BITBUS Monitor which is invaluable for troubleshooting, monitoring, and manually controlling a system; and code conversion/communication software to support applications software development on a PC.

The procedure libraries contain common procedures used by the host to read or write data to remote node I/O ports, download or upload programs and data, start and stop tasks (program modules) running on the nodes, send and receive messages, and perform a variety of system status and control functions. By using these libraries, the programmer's task of generating BITBUS host code is substantially reduced.



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*XENIX is a trademark of Microsoft Corporation.

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Order Number: 280732-001

THE BITBUS™ TOOLBOX—PRODUCT DESCRIPTION

The BITBUS Toolbox is used to develop host code for controlling a BITBUS network, and is an essential tool for both centralized and distributed control applications.

With centralized control, the host code sends commands to a node to read and update the I/O. All the decisions are made at the host. Normally, this kind of system would require extensive host code. However, the Toolbox includes the UBI and BIH procedure libraries that can be called to perform simple or complex control procedures.

In addition to the Toolbox, all BITBUS boards include, in firmware, a set of procedures known as Remote Access and Control (RAC). By sending simple messages to these procedures, basic I/O functions can be performed. The RAC procedures are listed in Table 1.

With distributed control systems, programs run on the remote BITBUS boards (nodes) and offload the host system of most decision making responsibilities. Using UBI calls or the BITBUS Monitor, commands can be sent to the nodes to control tasks or to periodically upload data for further analysis or storage. The software tools in the BITBUS Toolbox reduce the time and effort necessary to develop host code for these applications.

In addition to the DCS100 BITBUS Toolbox, other host code tools include a full set of host software compilers, libraries, debuggers, and in-circuit emulators. The BITBUS Toolbox is described in detail in the sections that follow.

Table 1. Remote Access and Control Procedures

Name	Function
RESET_STATION	Perform a software reset.
CREATE_TASK	Perform an RQ$CREATE$TASK system call.
DELETE_TASK	Perform an RQ$DELETE$TASK system call.
GET_FUNCTION_ID	Perform an RQGETFUNCTION$IDS call.
RAC_PROTECT	Suspend or resume RAC services.
READ_I/O	Return values from specified I/O ports.
WRITE_I/O	Write to the specified I/O ports.
UPDATE_I/O	Update the specified I/O ports.
UPLOAD_MEMORY	Return the values in specified memory area.
DOWNLOAD_MEMORY	Write values to specified memory area.
OR_IO	OR values into specified I/O ports.
AND_IO	AND values into specified I/O ports.
XOR_IO	XOR values into specified I/O ports.
READ_INTERNAL	Read values at specified internal RAM areas.
WRITE_INTERNAL	Write values to specified internal RAM areas.
NODE_INFO	Return device related information.
OFFLINE	Set node offline.
UPLOAD_CODE	Read values from code memory space.
DOWNLOAD_CODE	Write values to specified EEPROM memory.

BITBUS™ TOOLBOX UTILITIES

The DCS100 BITBUS Toolbox includes six host software utilities. They include:

- Universal BITBUS Interface (UBI)—a set of 28 procedures for implementing remote I/O and controlling a BITBUS network.
- BITBUS Interface Handlers (BIH)—four basic procedures for sending/receiving messages over a BITBUS network.
- BITBUS Monitor (BBM)—An on-line program with 36 commands that enable a user to configure, troubleshoot, monitor, and manually control a BITBUS network.
- PC Bridge—Communications program for the PC to support software development on a PC and download into an iRMX or XENIX-hosted BITBUS network.
- OBJHEX Conversion Utility—Converts an object file to hex format for downloading code.
- UDI2DOS—Converts Intel object code programs to .exe format for execution on the PC.

Universal BITBUS™ Interface

UBI is a library of 28 procedures called by the host program to manage the I/O, download or upload code and data, manage tasks on a node, send and receive messages, and perform an assortment of miscellaneous functions. These procedures are listed in Table 2, below.

Table 2. UBI Procedure Calls

I/O	
BQANDI/O	AND I/O
BQORI/O	OR I/O
BQXORI/O	Excl. OR I/O
BQ$WRITE$I/O	Write I/O
BQ$READ$I/O	Read I/O
BQ$UPDATE$I/O	Write I/O and read back
MEMORY MANAGEMENT	
BQABSLOAD	Download program to code memory
BQ$WRITE$CODE$MEM	Write to code memory
BQ$READ$CODE$MEM	Read code memory
BQ$WRITE$INT$MEM	Write to internal data memory
BQ$READ$INT$MEM	Read internal data memory
BQ$WRITE$EXT$MEM	Write to external data memory
BQ$READ$EXT$MEM	Read external data memory
TASK MANAGEMENT	
BQ$CREATE$TASK	Create task
BQ$DELETE$TASK	Delete task
BQGETFUNCTION$IDS	Read task function IDs
MESSAGE MANAGEMENT	
BQ$FLUSH	Clear an iSBX/iPCX interface
BQ$RECEIVE$MESSAGE	Receive a message
BQ$SEND$MESSAGE	Send a message

Table 2. UBI Procedure Calls (Continued)

MISCELLANEOUS CALLS	
BQ$DELAY	Perform a time delay
BQ$NODE$INFO	Return node information
BQ$PROBE$SBX	Check for BITBUS iSBX board
BQ$PROTECT$RAC	Lockout (protect) a node
BQ$RESET$DEVICE	Initiate a software reset
BQ$RESYNC$NODE	Set a node offline, prep. to resync
BQSETPORT	Set port I/O address
BQSETSBX	Set port I/O address
BQ$SHELL	Shell escape and then return

The UBI utility includes libraries interfacing with PL/M and C host code running within DOS, iRMX, and XENIX environments. Also included are declaration files for the procedures.

To use these procedures, the UBI calls are incorporated into the source code modules together with parameters needed by the procedures (e.g. node address, port address, memory location, task number, and data). The source module and UBI declaration files are then compiled and linked with the UBI library.

When the call executes, the called procedure will be performed, data will be returned (in the case of READ or UPLOAD procedures) together with an error code. These error codes can help the host system take corrective action.

BITBUS™ Interface Handlers (BIH)

BIH is a library of four basic procedures for sending and receiving messages between the host and network nodes. These procedures, listed in Table 3, are most useful when generating custom UBI-like procedures. The BIH utility includes procedure libraries and declaration files for DOS, iRMX 86/88/286, and ISIS-PDS (iPDS)-based systems.

Table 3. BIH Procedure Calls

Call Name	Description
CQDCMINIT	Performs any initialization required by the BITBUS Interface Handlers.
CQDCMRECEIVE	Receives one message from any BITBUS node.
CQDCMSTATUS$CHECK	Determines whether a BITBUS message is available to receive.
CQDCMTRANSMIT	Transmits one message to any BITBUS node.

To use these libraries, the appropriate declaration file is included with the host source code. The modules are then compiled and the resultant object module is linked to the BIH library.

BITBUS™ Monitor

The BITBUS Monitor (BBM) is an on-line program that is invaluable for troubleshooting and testing a BITBUS system and can also be used to manually control a system. BBM commands are listed in Table 4.

Table 4. BITBUS™ Monitor Commands

I/O	
AIO	And I/O
OIO	Or I/O
RIO	Read I/O
UIO	Update I/O
WIO	Write to I/O
XIO	Exclusive OR I/O
MEMORY MANAGEMENT	
LOAD	Download to code memory
RCMEM	Read code memory
RIMEM	Read internal memory
RXMEM	Read data memory
WCMEM	Write to code memory
WIMEM	Write to internal memory
WXMEM	Write to data memory
TASK MANAGEMENT	
CTASK	Create a task
DTASK	Delete a task
SYS	Display node task status

MESSAGE MANAGEMENT	
DMSG	Display a message
RMSG	Receive a message
SMSG	Send a message
TMSG	Sends, receives, displays a message
MISCELLANEOUS COMMANDS	
DELAY	Suspend Activity
EXIT	Exit BBM
FLUSH	Clears an iSBX/iPCX interface
HELP	Provide on-line help
INCLUDE	Open/execute a BBM file
LIST	Creates a copy of the BBM session
LOCK	Lockout (protect) a node
NODEINFO	Node information
PAUSE	Wait until <CR>
RESET	SW reset at a node
RESYNC	Set a node offline
SETPORT/ SETSBX	Set port I/O address
SHELL	XENIX/DOS shell escape from BBM
SYMBOLS	Display/create/change the value of a user symbol
UNLOCK	Unprotect
VERBOSE	Controls echo and prompts

I/O ACCESS

Six commands are provided for writing to and reading from I/O ports on remote nodes. With these commands, an operator can test the I/O connected to a BITBUS node or monitor the status of an input port. The I/O commands allow an operator to quickly isolate a problem at a remote node.

MEMORY ACCESS

Seven memory access commands are provided. These commands allow the operator to download and upload both code (programs) and data (variables) between the host system and remote BITBUS nodes. Internal RAM memory within the 8044BEM microcontroller can also be accessed. In addition, the BBM supports code download to both static RAM and E^2PROM devices. The memory access commands are especially useful for on-target application development.

The BITBUS Monitor enables the user to reference a memory location by using a symbolic reference or label. For example, if a task running on a node includes a program variable called "rate", the operator can modify this variable simply by typing:

```
WIMEM <node address> .rate 6CH
```

In this case, the program will execute with a value of 6C hex for "rate".

Symbolic references can also be used for other BBM parameters, such as node address, port address, and data. Symbolic access allows the user to more easily test and modify programs at run time.

TASK MANAGEMENT

Four commands are available to monitor and control the running of tasks on the nodes.

The DCX 51 real time multitasking executive found on all BITBUS boards can support up to 7 user tasks (in addition to the RAC task). Each of these tasks have an initial Task Descriptor (ITD) which assigns a function ID to the task plus other important run-time parameters used by the executive. By chaining ITDs together, multiple tasks can become active upon power up.

The BBM commands allow tasks to selectively be made active (CTASK) or inactive (DTASK). In addition, the SYS command can be used to display which nodes are present and operational in a system and display the function IDs for active tasks on each node. The task management commands are especially useful when developing/troubleshooting multitasking control programs.

MESSAGE OPERATIONS

These four commands are used to send and receive messages to and from tasks on remote nodes.

MISCELLANEOUS COMMANDS

The BBM includes 15 commands that are used to control the operating status of nodes, and to support various troubleshooting functions. These commands include:

The HELP command—an on-line facility that displays the complete BBM command directory or detailed information on using the commands.

The SHELL command—allows an operator to do a shell escape to DOS or XENIX, perform the needed operating system function, and return to the monitor.

The RESET, FLUSH, and RESYNC commands—used to clear a node that is hung.

OPERATING ENVIRONMENT

The BITBUS Monitor will run on DOS, iRMX 86/286, XENIX and iPDS-based systems. Both 5¼" and 8" media is provided for iRMX and XENIX systems. The iPDS version of the monitor does not include the following BBM commands (or equivalent UBI calls): DELAY, LIST, PAUSE, RCMEM, RESYSC, SETPORT, SYMBOLS, TMSG, VERBOSE, WCMEM.

PC Bridge

The PC Bridge is a communications program that runs on a PC-DOS or MS-DOS system, and is used to establish a communication link between the PC and an Intel iRMX 86/286 or XENIX-based microcomputer system. The software engineer can use the Bridge in two ways. First, he can develop host or node programs on the PC and download the code to the host system or remote nodes. He can also use the PC as a virtual terminal to the host system. The PC Bridge effectively expands the development environment for the software engineer.

The link between the PC and the host microcomputer can either be over an RS232 cable (supplied) or via a modem link. The PC Bridge transfers data at up to 19.2K baud (asynchronous) and supports XON/XOFF flow control.

OBJHEX

OBJHEX is an object code to hex code conversion utility similar to the OH51 hex converter supplied with Intel "8051" languages. OBJHEX has the additional ability to retain the object module's symbol table during the conversion process. The table is stored at the host system and enables the BITBUS Monitor to symbolically access program memory. OBJHEX runs on both DOS and iRMX86 (5¼", 8" media)-based systems.

UDI2DOS

UDI2DOS converts Intel object code (8086 OMF) to the .exe format so that it will run within a DOS environment.

SPECIFICATIONS

Media Provided

	BBM	UBI	BIH	PC Bridge	OBJHEX	UDI2DOS
Series II						
III			X			
IV						
iPDS	A	A	A			
iRMX 5¼"	X	X	X	X	X	
8"	X	X	X	X	X	
XENIX 5¼"	X	X		B	X	
8"	X	X		B	X	
DOS	X	X	X	X	X	X

NOTES:
A. iPDS uses Release 1 Toolbox.
B. Supports operation with XENIX. XENIX disks not required.

Documentation (supplied)

BITBUS Toolbox Overview and Installation Guide	460235-001
BITBUS Monitor User's Guide	148686-002
Universal BITBUS Interface User's Guide	460236-001
BITBUS Interface Handlers User's Guide	148685-002
PC Bridge Communications Utility User's Guide	149236-001
BITBUS OBJHEX Conversion Utility User's Guide	460237-001

Compatible Software

Intel ASM, PL/M, and C languages (8086/80286/80386 versions)

Order Codes

Order Number	Description
DCS100SU	BITBUS Toolbox Host Software Utilities, single-use license for development only. Includes RS232 cables to connect an Intel microcomputer system with an IBM* PC-XT* or PC-AT*, and full documentation. See above for media provided.
DCS100BY	BITBUS Toolbox Host Software Utilities. Same as above, except sold with a buyout license. Allows incorporation of UBI and BIH procedure libraries—no additional incorporation fee is required.

DCS110 BITWARE
DCS120 PROGRAMMERS SUPPORT PACKAGE

- **Supports Calls to the 8044BEM Microcontroller On-Chip, Multitasking DCX 51 Executive**
- **Fully Compatible with Intel's ASM51 and PL/M51 Languages**
- **DCS110 also Includes DCM44 Code to Support Emulation/Debug of BITBUS™ Node Code using Intel In-Circuit Emulators**
- **For DOS, iRMX®, iPDS™, and Series III/IV Development Environments**

The DCS110 and DCS120 packages are designed to support software development of distributed control BITBUS applications. Both products include a DCX51 interface library so that BITBUS application programs can make calls to the DCX51 Executive. DCS110 also includes a DCM44 downloadable file that enables an Intel in-circuit emulator such as the ICE™ 5100/044 to emulate a BITBUS environment. By using an in-circuit emulator together with DCS110, the developer can easily and quickly debug BITBUS application code.

280731-1

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Order Number: 280731-001

DCX 51 ENVIRONMENT

The 8044BEM microcontroller, used on every BITBUS board, includes in firmware a preconfigured version of the DCX 51 Executive. DCX 51 provides a variety of services to the application code, including: task management; interrupt management; inter-task communications; memory management; and timing services. Up to 7 user tasks can run concurrently under DCX 51. Each task has a unique Initial Task Descriptor (ITD) that describes to the executive several run-time parameters (e.g. stack space, priority level, etc.). By also specifying an Initial Data Descriptor (IDD), the executive can be partially reconfigured. Modifiable run-time constants include the system clock rate, clock priority, internal memory buffer size, and user (internal) memory size. DCX 51 calls are listed in Table 1.

By running applications under DCX 51, the designer can make optimal use of the 8044BEM microcontroller. If a task needs to wait for a message, an interrupt, or a time period, DCX 51 will temporarily assign access to the 8044 to another task. In this way, multiple tasks can access the microcontroller.

Table 1. DCX 51 Procedure Calls

Call Name	Description
Task Management Calls	
RQ$CREATE$TASK	Create and schedule a new task.
RQ$DELETE$TASK	Delete specified task from system.
RQGETFUNCTION$IDS	Obtain the function IDs of tasks currently in the system.
Intertask Communication Calls	
RQ$ALLOCATE	Obtain a message buffer from the system buffer pool.
RQ$DEALLOCATE	Return a message buffer to the system buffer pool.
RQ$SEND$MESSAGE	Send a message to specified task.
RQ$WAIT	Wait for a message event.
Memory Management Calls	
RQGETMEM	Get available memory from the system memory pool.
RQ$RELEASE$MEM	Release memory to the system memory pool.
Interrupt Management Calls	
RQ$DISABLE$INTERRUPT	Temporarily disable an interrupt.
RQ$ENABLE$INTERRUPT	Re-enable an interrupt.
RQ$WAIT	Wait for an interrupt event.
Timer Management Calls	
RQSETINTERVAL	Establish a time interval.
RQ$WAIT	Wait for an interval event.

Interfacing to the DCX 51 Executive

To interface with the executive, DCS110 and DCS120 both include a DCX 51 interface library plus a set of "include" files. The interface library, which is linked to the application modules, allow the code to access DCX 51 procedures. The "include" files consist of DCX 51 declaration and macro definition files that help simplify source code development. These files are listed in Table 2.

DCS110 Bitware Software Package

In addition to the DCX 51 interface files, DCS110 also includes a DCM44 object file to support debug of node code using an Intel in-circuit emulator. DCM44 is the firmware found in all 8044BEM BITBUS microcontrollers and together with an Intel in-circuit emulator, successfully duplicates the 8044BEM environment. Emulators that are supported include the ICE™ 5100/044, the ICE 44, and the EMV 44.

Developing Applications Software

Using DCS110 or DCS120 software to develop BITBUS applications software is a straightforward, multi-step process as diagrammed in Figure 1. The designer uses a text editor to write the application code either in ASM 51 or PL/M 51. The source code modules are then assembled/compiled along with the DCX 51 "include" files. The final step is to link together all of the modules, the DCX 51 interface library, and the DCM44I.LIB file. The linked/located absolute object module can then be downloaded to the target board or burned into EPROM.

Table 2. DCS110/120 Files

Filename	Description
DCX 51 Support Files:	
DCX51I.LIB	Interface library to the DCX 51 executive. Provides the linker with the address of data variables and entry points for DCX51 procedures called from other object modules.
DCX51A.EXT DCX51A.LIT DCX51P.LIT	External and literal declaration files. These files support DCX 51 calls from ASM 51 and PL/M 51 code.
DCXB0P.EXT DCXB1P.EXT DCXB2P.EXT DCXB3P.EXT	DCX 51 External procedure declarations for PL/M 51 modules using 8044 register banks 0, 1, 2 or 3.
DCX51A.MAC	Initial Task Descriptor (ITD) and Initial Data Descriptor (IDD) macro definitions.
APPL1.A51 APPL2.A51	Sample application, parts 1 and 2; template for generating ITDs and IDD.
DCM44I.LIB	This file maps out reserved memory needed by the 8044BEM firmware and is linked to other user object modules using the RL51 Linker.
DCM44 Firmware Files (DCS110 Only):	
DCM44	DCM44 (BITBUS) code for Intel ICE™/EMV emulators.

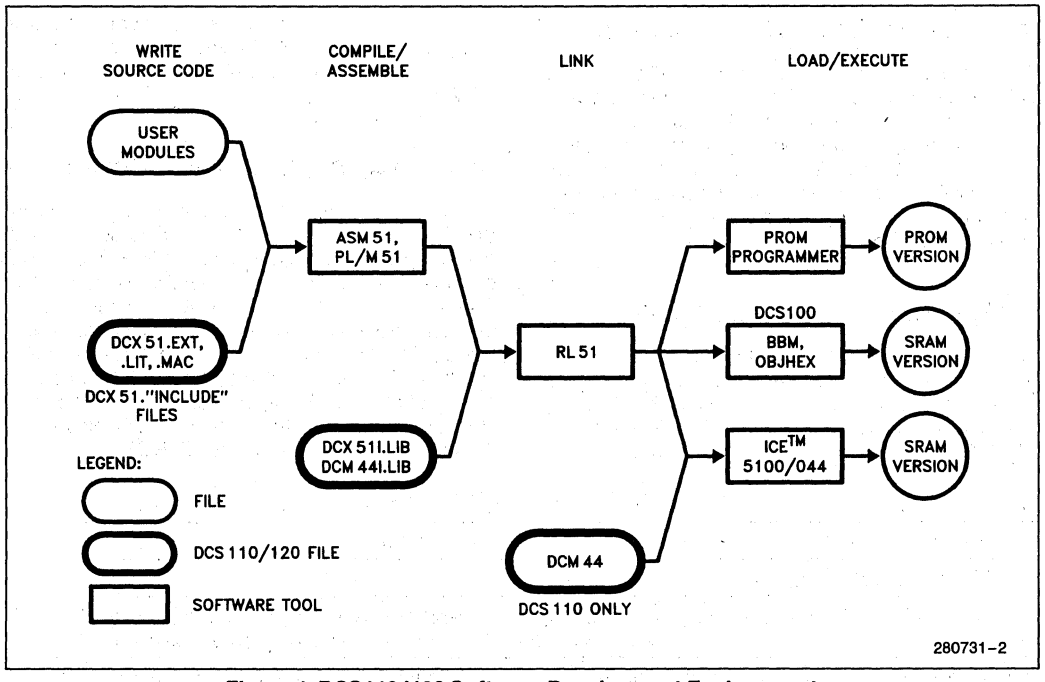


Figure 1. DCS110/120 Software Development Environment

Development Environments

Both DCS110 and DCS120 are shipped with media to support software development on PC/MS-DOS, iRMX 86, iPDS, and Intellec® Series III/IV systems. DCS110 is available with a single-use license for application development and debug. Designers planning to incorporte DCX 51 files in their application should purchase the DCS120 "buyout" product.

Order Codes	Description
DCS110SU	Bitware Software Package. Includes DCM44 code to emulate a BITBUS environment when using an Intel in-circuit emulator and interface files to support procedure calls to DCX 51. Provided with documentation and PC-DOS, iRMX 86 (5¼", 8"), iPDS, and Series III/IV media. Single-use license.
DCS120BY	Programmers Support Package. Includes interface files to support procedure calls to DCX 51. Provided with documentation and PC-DOS, iRMX 86 (5¼", 8"), iPDS, and Series III/IV media. Buyout license allows incorporation of software into product—no additional incorporation fee is required.

COMPATIBLE SOFTWARE TOOLS

DCS100	BITBUS Toolbox Host Software Utilities for PC/MS-DOS, iRMX 86/286, XENIX*, iPDS, and Series III/IV host systems.
AEDIT	Source Code and Text Editor for all Intel host environments (consult data sheet for order codes).

*XENIX is a trademark of Microsoft Corp.

8051 LANGUAGES

(Note: All products also include RL51 Linker/Relocator, LIB51 Librarian, and OH51 object to hex code converter)

D86ASM51	ASM 51 Assembler for PC-DOS host system
R86ASM51	ASM 51 Assembler for iRMX 86 host system
I86ASM51	ASM 51 Assembler for Series III/IV host systems
MC151ASM	ASM 51 Assembler for iPDS and Series II host systems
D86PLM51	PL/M 51 Compiler for PC-DOS host system
R86PLM51	PL/M 51 Compiler for IRMX 86 host system
I86PLM51	PL/M 51 Compiler for Series III/IV host systems
iMDX352	PL/M 51 Compiler for iPDS and Series II host systems

IN-CIRCUIT EMULATORS AND PROM PROGRAMMERS

(Note: + indicates that the product is no longer available)

ICE5100/044	In-Circuit Emulator for the RUPI™-44 Family (hosted on PC-DOS, and Series III/IV—see data sheet for order codes)
ICE-44+	8044 In-Circuit Emulator (hosted on Series II–IV systems)
iPDSEMV44CON+	Kit to add 8044 support to an EMV-51/51A emulator (iPDS host)
iUP-200A, iUP-201A	Universal PROM programmer (hosted on PC-DOS, iPDS, and Series III/IV; see data sheet for order codes)

8051
SOFTWARE PACKAGES

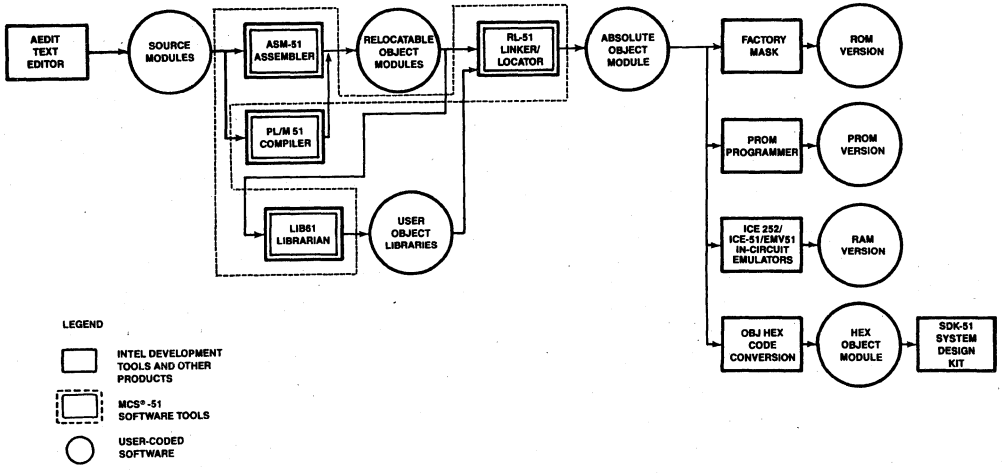
- **Choice of hosts: PCDOS 3.0 based IBM* PC XT/AT*, iRMX®86, iPDS™ System, Series II, Series III, and Series IV**
- **Supports all members of the Intel MCS® -51 architecture**

PL/M51 Software Package Contains the following:

- **PL/M51 Compiler which is designed to support all phases of software implementation**
- **RL51 Linker and Relocator which enables programmers to develop software in a modular fashion**
- **LIB51 Librarian which lets programmers create and maintain libraries of software object modules**

8051 Software Development Package Contains the following:

- **8051 Macro Assembler which gives symbolic access to 8051 hardware features**
- **RL51 Linker and Relocator program which links modules generated by the assembler**
- **LIB51 Librarian which lets programmers create and maintain libraries of software object modules**



162771-1

Figure 1. MCS® -51 Program Development Process

*IBM and AT are registered trademarks of International Business Machine Corporation.

October 1987
Order Number: 162771-005

PL/M 51 SOFTWARE PACKAGE

- **High-level programming language for the Intel MCS® -51 single-chip microcomputer family**
- **Compatible with PL/M 80 assuring MCS® -80/85 design portability**
- **Enhanced to support boolean processing**
- **Tailored to provide an optimum balance among on-chip RAM usage, code size and code execution time**
- **Produces relocatable object code which is linkable to object modules generated by all other 8051 translators**
- **Allows programmer to have complete control of microcomputer resources**
- **Extends high-level language programming advantages to microcontroller software development**
- **Improved reliability, lower maintenance costs, increased programmer productivity and software portability**
- **Includes the linking and relocating utility and the library manager**
- **Supports all members of the Intel MCS® -51 architecture**

PL/M 51 is a structured, high-level programming language for the Intel MCS-51 family of microcomputers. The PL/M 51 language and compiler have been designed to support the unique software development requirements of the single-chip microcomputer environment. The PL/M language has been enhanced to support Boolean processing and efficient access to the microcomputer functions. New compiler controls allow the programmer complete control over what microcomputer resources are used by PL/M programs.

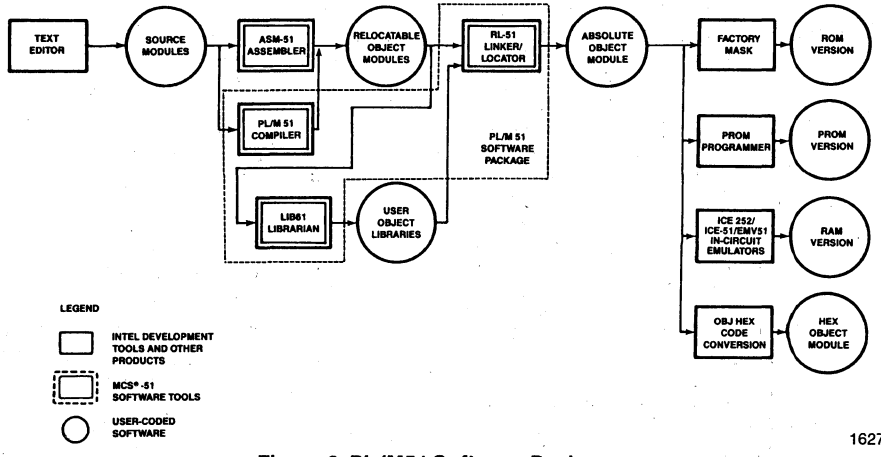
PL/M 51 is largely compatible with PL/M 80 and PL/M 86. A significant proportion of existing PL/M software can be ported to the MCS-51 with modifications to support the MCS-51 architecture. Existing PL/M programmers can start programming for the MCS-51 with a small relearning effort.

PL/M 51 is the high-level alternative to assembly language programming for the MCS-51. When code size and code execution speed are not critical factors, PL/M 51 is the cost-effective approach to developing reliable, maintainable software.

The PL/M 51 compiler has been designed to support efficiently all phases of software implementation with features like a syntax checker, multiple levels of optimization, cross-reference generation and debug record generation.

ICE™ 5100, ICE 51, and EMV51 are available for on-target debugging.

Software available for PC DOS 3.0 based IBM* PC XT/AT* Systems.



162771-2

Figure 2. PL/M51 Software Package

PL/M 51 COMPILER

FEATURES

Major features of the Intel PL/M 51 compiler and programming language include:

Structured Programming

PL/M source code is developed in a series of modules, procedures, and blocks. Encouraging program modularity in this manner makes programs more readable, and easier to maintain and debug. The language becomes more flexible, by clearly defining the scope of user variables (local to a private procedure, for example).

Language Compatibility

PL/M 51 object modules are compatible with object modules generated by all other MCS-51 translators. This means that PL/M programs may be linked to programs written in any other MCS-51 language.

Object modules are compatible with In-Circuit Emulators and Emulation Vehicles for MCS-51 processors: the DEBUG compiler control provides these tools with symbolic debugging capabilities.

Supports Three Data Types

PL/M makes use of three data types for various applications. These data types range from one to sixteen bits and facilitate various arithmetic, logic, and address functions:

— Bit: a binary digit

— Byte: 8-bit unsigned number or,

— Word: 16-bit unsigned number.

Another powerful facility allows the use of BASED variables that map more than one variable to the same memory location. This is especially useful for passing parameters, relative and absolute addressing, and memory allocation.

Two Data Structuring Facilities

PL/M 51 supports two data structuring facilities. These add flexibility to the referencing of data stored in large groups.

— Array: Indexed list of same type data elements

— Structure: Named collection of same or different type data elements

— Combinations of Both: Arrays of structures or structures of arrays.

Interrupt Handling

A procedure may be defined with the INTERRUPT attribute. The compiler will generate code to save and restore the processor status, for execution of the user-defined interrupt handler routines.

Compiler Controls

The PL/M 51 compiler offers controls that facilitate such features as:

— Including additional PL/M 51 source files from disk

— Cross-reference

— Corresponding assembly language code in the listing file

Program Addressing Control

The PL/M 51 compiler takes full advantage of program addressing with the ROM (SMALL/MEDIUM/LARGE) control. Programs with less than 2 KB code space can use the SMALL or MEDIUM option to generate optimum addressing instructions. Larger programs can address over the full 64 KB range.

Code Optimization

The PL/M 51 compiler offers four levels of optimization for significantly reducing overall program size.

— Combination or "folding" of constant expressions; "Strength reductions" (a shift left rather than multiply by 2)

— Machine code optimizations; elimination of superfluous branches

— Automatic overlaying of on-chip RAM variables

— Register history: an off-chip variable will not be reloaded if its value is available in a register.

Error Checking

The PL/M 51 compiler has a very powerful feature to speed up compilations. If a syntax or program error is detected, the compiler will skip the code generation and optimization passes. This usually yields a 2X performance increase for compilation of programs with errors.

A fully detailed set of programming and compilation error messages is provided by the compiler and user's guide.

BENEFITS

PL/M 51 is designed to be an efficient, cost-effective solution to the special requirements of MCS-51 Microsystem Software Development, as illustrated by the following benefits of PL/M use:

Low Learning Effort

PL/M 51 is easy to learn and to use, even for the novice programmer.

Earlier Project Completion

Critical projects are completed much earlier than otherwise possible because PL/M 51, a structured high-level language, increases programmer productivity.

Lower Development Cost

Increases in programmer productivity translate immediately into lower software development costs because less programming resources are required for a given programmed function.

Increased Reliability

PL/M 51 is designed to aid in the development of reliable software (PL/M programs are simple statements of the program algorithm). This substantially reduces the risk of costly correction of errors in systems that have already reached full production status, as the more simply stated the program is, the more likely it is to perform its intended function.

Easier Enhancements and Maintenance

Programs written in PL/M tend to be self-documenting, thus easier to read and understand. This means it is easier to enhance and maintain PL/M programs as the system capabilities expand and future products are developed.

RL51 LINKER AND RELOCATOR

- **Links modules generated by the assembler and the PL/M compiler**
- **Locates the linked object to absolute memory locations**
- **Enables modular programming of software-efficient program development**
- **Modular programs are easy to understand, maintainable and reliable**

The MCS-51 linker and relocator (RL51) is a utility which enables MCS-51 programmers to develop software in a modular fashion. The utility resolves all references between modules and assigns absolute memory locations to all the relocatable segments, combining relocatable partial segments with the same name.

With this utility, software can be developed more quickly because small functional modules are easier to understand, design and test than large programs.

The total number of allowed symbols in user-developed software is very large because the assembler number of symbols' limit applies only per module, not to the entire program. Therefore programs can be more readable and better documented. RL51 can be invoked either manually or through a batch file for improved productivity.

Modules can be saved and used on different programs. Therefore the software investment of the customer is maintained.

RL51 produces two files. The absolute object module file can be directly executed by the MCS-51 family. The listing file shows the results of the link/locate process.

LIB51 LIBRARIAN

The LIB51 utility enables MCS-51 programmers to create and maintain libraries of software object modules. With this utility, the customer can develop standard software modules and place them in libraries, which programs can access through a standard interface. When using object libraries, the linker will call only object modules that are required to satisfy external references.

Consequently, the librarian enables the customer to port and reuse software on different projects—thereby maintaining the customer's software investment.

ORDERING INFORMATION

Order Code	Operating Environment
D86PLM51	PL/M51 Software for PC DOS 3.0 Systems
R86PLM51	PL/M51 Software for iRMX 86 Systems

Documentation Package

PL/M 51 User's Guide

MCS-51 Utilities User's Guide

SUPPORT:

Hotline Telephone Support, Software Performance Report (SPR), Software Updates, Technical Reports, and monthly Technical Newsletters are available.

8051 SOFTWARE DEVELOPMENT PACKAGE

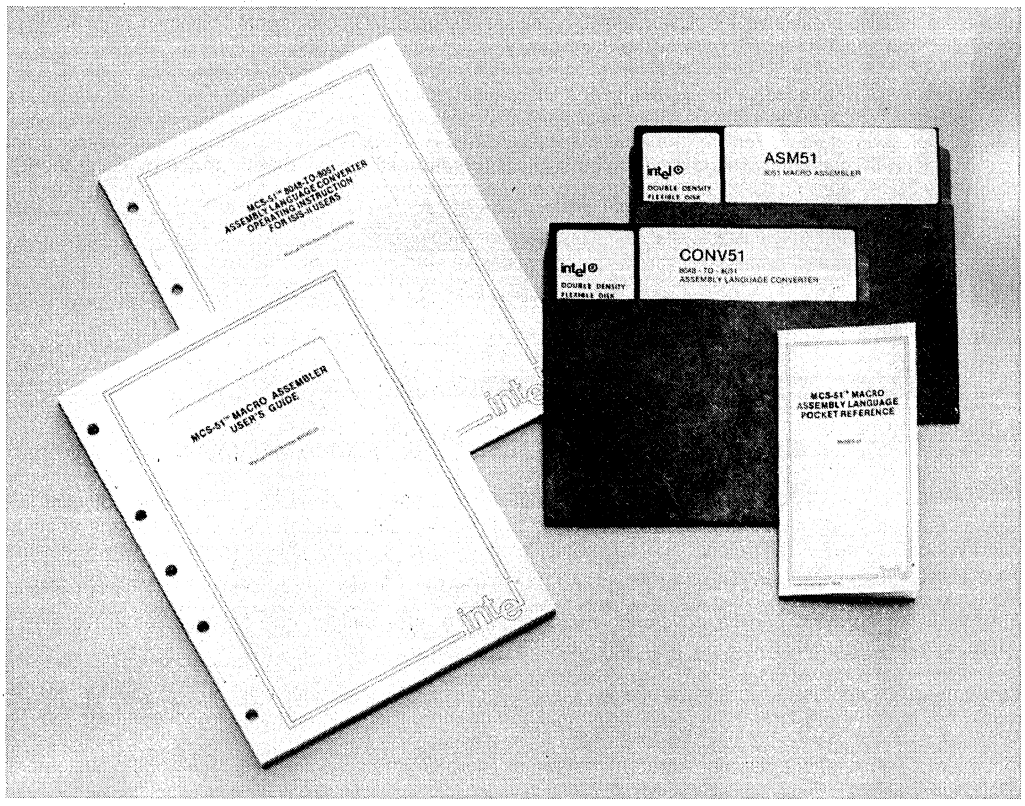
- **Symbolic relocatable assembly language programming for 8051 microcontrollers**
- **Extends Intellec® Microcomputer Development System to support 8051 program development**
- **Produces Relocatable Object Code which is linkable to other 8051 Object Modules**
- **Encourage modular program design for maintainability and reliability**
- **Macro Assembler features conditional assembly and macro capabilities**
- **Supports all members of the Intel MCS® 51 architecture**

The 8051 software development package provides development system support for the powerful 8051 family of single chip microcomputers. The package contains a symbolic macro assembler and relocation/linkage utilities.

The assembler produces relocatable object modules from 8051 macro assembly language instructions. The object code modules can be linked and located to absolute memory locations. This absolute object code may be used to program the 8751 EPROM version of the chip. The assembler output may also be debugged using the new family of ICE 5100 emulators or with the ICE-51™ in-circuit emulator.

The converter translates 8048 assembly language instructions into 8051 source instructions to provide software compatibility between the two families of microcontrollers.

Software available for PC DOS 3.0 based IBM* PC XT/AT Systems.



162771-3

8051 MACRO ASSEMBLER

- **Supports 8051 family program development on Intellec® Microcomputer Development Systems**
- **Gives symbolic access to powerful 8051 hardware features**
- **Produces object file, listing file and error diagnostics**
- **Object files are linkable and locatable**
- **Provides software support for many addressing and data allocation capabilities**
- **Symbolic Assembler supports symbol table, cross-reference, macro capabilities, and conditional assembly**

The 8051 Macro Assembler (ASM51) translates symbolic 8051 macro assembly language modules into linkable and locatable object code modules. Assembly language mnemonics are easier to program and are more readable than binary or hexadecimal machine instructions. By allowing the programmer to give symbolic names to memory locations rather than absolute addresses, software design and debug are performed more quickly and reliably. Furthermore, since modules are linkable and relocatable, the programmer can do his software in modular fashion. This makes programs easy to understand, maintainable and reliable.

The assembler supports macro definitions and calls. This is a convenient way to program a frequently used code sequence only once. The assembler also provides conditional assembly capabilities.

Cross referencing is provided in the symbol table listing, showing the user the lines in which each symbol was defined and referenced.

ASM51 provides symbolic access to the many useful addressing features of the 8051 architecture. These features include referencing for bit and byte locations, and for providing 4-bit operations for BCD arithmetic. The assembler also provides symbolic access to hardware registers, I/O ports, control bits, and RAM addresses. ASM51 can support all members of the 8051 family.

Math routines are enhanced by the MULtiply and DIVide instructions.

If an 8051 program contains errors, the assembler provides a comprehensive set of error diagnostics, which are included in the assembly listing or on another file. Program testing may be performed by using the iUP Universal Programmer and iUP F87/51 personality module to program the 8751 EPROM version of the chip.

ICE 5100, ICE51 and EMV51 are available for program debugging.

RL51 LINKER AND RELOCATOR PROGRAM

- **Links modules generated by the assembler**
- **Locates the linked object to absolute memory locations**
- **Enables modular programming of software for efficient program development**
- **Modular programs are easy to understand, maintainable and reliable**

The 8051 linker and relocator (RL51) is a utility which enables 8051 programmers to develop software in a modular fashion. The linker resolves all references between modules and the relocator assigns absolute memory locations to all the relocatable segments, combining relocatable partial segments with the same name.

With this utility, software can be developed more quickly because small functional modules are easier to understand, design and test than large programs.

The number of symbols in the software is very large because the assembler symbol limit applies only per module not the entire program. Therefore programs can be more readable and better documented.

Modules can be saved and used on different programs. Therefore the software investment of the customer is maintained.

RL51 produces two files. The absolute object module file can be directly executed by the 8051 family. The listing file shows the results of the link/locate process.

LIB51 LIBRARIAN

The LIB51 utility enables MCS-51 programmers to create and maintain libraries of software object modules. With this utility, the customer can develop standard software modules and place them in libraries, which programs can access through a standard interface. When using object libraries, the linker will call only object modules that are required to satisfy external references.

Consequently, the librarian enables the customer to port and reuse software on different projects—thereby maintaining the customer's software investment.

ORDERING INFORMATION

Order Code	Operating Environment
D86ASM51	8051 Assembler for PCDOS 3.0 Systems
R86ASM51	8051 Assembler for iRMX 86 Systems

Documentation Package:

MCS-51 Macro Assembler User's Guide

MCS-51 Utilities User's Guide for 8080/8085 Based Development System

MCS-51 8048-to-8051 Assembly Language Converter Operating Instructions for ISIS-II Users

SUPPORT:

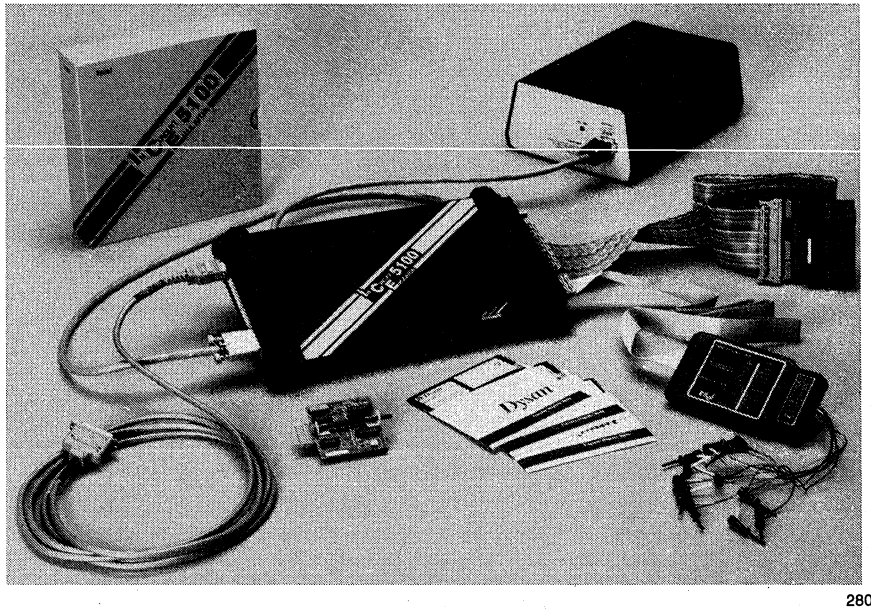
Hotline Telephone Support, Software Performance Reporting (SPR), Software Updates, Technical Reports, Monthly Newsletter available.

ICE™-5100/044 In-Circuit Emulator for the RUPI™-44 Family

- **Precise, Full-Speed, Real-Time Emulation of the RUPI™-44 Family of Peripherals**
- **64 KB of Mappable High-Speed Emulation Memory**
- **254 24-bit Frames of Trace Memory (16 Bits Trace Program Execution Addresses and 8 Bits Trace Eternal Events)**
- **Serial Link to Intel Series III/IV or IBM* PC AT or PC XT (and PC DOS Compatibles)**
- **ASM-51 and PL/M-51 Language Support**
- **Built-in CRT-Oriented Text Editor**
- **Symbolic Debugging Enables Access to Memory Locations and Program Variables**
- **Four Address Breakpoints Plus In-Range, Out-of-Range, and Page Breaks**
- **Equipped with the Integrated Command Directory (ICD™) That Provides**
  — On-Line Help
  — Syntax Guidance and Checking
  — Command Recall
- **On-Line Disassembler and Single-Line Assembler to Help with Code Patching**
- **Provides an Ideal Environment for Debugging BITBUS™ Applications Code**

The ICE™-5100/044 in-circuit emulator is a high-level, interactive debugger that is used to develop and test the hardware and software of a target system based on the RUPI™-44 family of peripherals. The ICE-5100/044 emulator can be serially linked to an Intellec® Series III/IV or an IBM PC AT or PC XT. The emulator can communicate with the host system at standard baud rates up to 19.2K. The design of the emulator supports all of the RUPI-44 components at speeds up to and including 12 MHz.

*IBM is a registered trademark of International Business Machines Corporation. Intel Corporation assumes no responsibility for the use of any circuitry other than circuitry embodied in an Intel product. No other patent licenses are implied. Information contained herein supersedes previously published specifications on these devices from Intel.



280325-1

November 1986
Order Number: 280325-001

PRODUCT OVERVIEW

The ICE-5100/044 emulator provides full emulation support for the RUPI-44 family of peripherals, including 8044-based BITBUS™ board products. The RUPI-44 family consists of the 8044, the 8744, and the 8344.

The ICE-5100/044 emulator enables hardware and software development to proceed simultaneously. With the ICE-5100/044, prototype hardware can be added to the system as it is designed and software can be developed prior to the completion of the hardware prototype. Software and hardware integration can occur while the product is being developed.

The ICE-5100/044 emulator assists four stages of development:

- Software debugging
- Hardware debugging
- System integration
- System test

Software Debugging

The ICE-5100/044 emulator can be operated without being connected to the target system and before any of the user's hardware is available (provided external data RAM is not needed). In this stand-alone mode, the ICE-5100/044 emulator can be used to facilitate program development.

Hardware Debugging

The ICE-5100/044 emulator's AC/DC parametric characteristics match the microcontroller's. The emulator's full-speed operation makes it a valuable tool for debugging hardware, including time-critical serial port, timer, and external interrupt interfaces.

System Integration

Integration of software and hardware can begin when the emulator is plugged into the microcontroller socket of the prototype system hardware. Hardware can be added, modified, and tested immediately. As each section of the user's hardware is completed, it can be added to the prototype. Thus, the hardware and software can be system tested in real-time operation as each section becomes available.

System Test

When the prototype is complete, it is tested with the final version of the system software. The ICE-5100/044 emulator is then used for real-time emulation of the microcontroller to debug the system as a completed unit.

The final product verfication test can be performed using the ROM or EPROM version of the microcontroller. Thus, the ICE-5100/044 emulator provides the ability to debug a prototype or production system at any stage in its development without introducing extraneous hardware or software test tools.

PHYSICAL DESCRIPTION

The ICE-5100/044 emulator consists of the following components (see Figure 1):

- Power supply
- AC and DC power cables
- Controller pod
- Serial Cable (host-specific)
- User probe assembly (consisting of the processor module and the user cable)
- Crystal power accessory (CPA)
- 40-pin target adaptor
- Clips assembly
- Software (includes the ICE-5100/044 emulator software, diagnostic software, and a tutorial)

The controller pod contains 64 KB of emulation memory, 254- by 24-bit frames of trace memory, and the control processor. In addition, the controller pod houses a BNC connector that can be used to connect up to 10 multi-ICE compatible emulators for synchronous starting and stopping of emulation.

The serial cable connects the host system to the controller pod. The serial cable supports a subset of the RS-232C signals.

The user probe assembly consists of a user cable and a processor module. The processor module houses the emulation processor and the interface logic. The target adaptor connects to the processor module and provides an electrical and mechanical interface to the target microcontroller socket.

The crystal power accessory (CPA) is a small, detachable board that connects to the controller pod and enables the ICE-5100/044 emulator to run in stand-alone mode. The target adaptor plugs into the socket on the CPA; the CPA then supplies clock and power to the user probe.

The clips assembly enables the user to trace external events. Eight bits of data are gathered on the rising edge of $\overline{PSEN}$ during opcode fetches. The clips information can be displayed using the CLIPS option with the PRINT command.

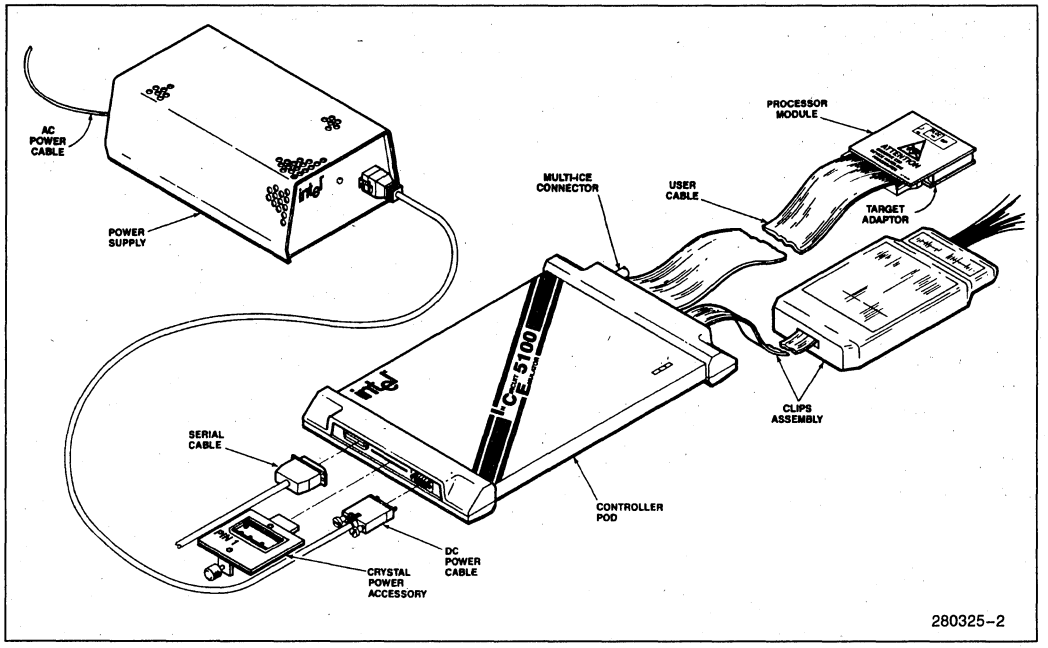


Figure 1. The ICE™-5100/044 Emulator Hardware

The ICE-5100-044 emulator software supports mnemonics, object file formats, and symbolic references generated by Intel's ASM-51 and PL/M-51 programming languages. Along with the ICE-5100/044 emulator software is a customer confidence test disk with diagnostic routines that check the operation of the hardware.

The on-line tutorial is written in the ICE-5100 command language. Thus, the user is able to interact with and use the ICE-5100/044 emulator while executing the tutorial.

A comprehensive set of documentation is provided with the ICE-5100/044 emulator.

ICE™-5100/044 EMULATOR FEATURES

The ICE-5100/044 emulator has been created to assist a product designer in developing, debugging and testing designs incorporating the RUPI-44 family of peripherals. The following sections detail some of the ICE-5100/044 emulator features.

Emulation

Emulation is the controlled execution of the user's software in the target hardware or in an artificial hardware environment that duplicates the microcontroller of the target system. Emulation is a transparent process that happens in real-time. The execution of the user software is facilitated with the ICE-5100/044 command language.

Memory Mapping

There is a 64 KB of memory that can be mapped to the CODE memory space in 4 KB blocks on 4 KB boundaries. By mapping memory to the ICE-5100/044 emulator, software development can proceed before the user hardware is availabie.

Memory Examination and Modification

The memory space for the 8044 microcontroller and its target hardware is fully accessible through the emulator. The ICE-5100/044 emulator refers to four physically distinct memory spaces, as follows:

- CODE—references program memory
- IDATA—references internal data memory
- RDATA—references special function register memory
- XDATA—references external data memory

ICE-5100/044 emulator commands that access memory use one of the special prefixes (e.g., CODE) to specify the memory space.

The microcontroller's special function registers and register bits can be accessed mnemonically (e.g., DPL, TCON, CY, P1.2) with the ICE-5100/044 emulator software.

Data can be displayed or modified in one of three bases: hexadecimal, decimal, or binary. Data can also be displayed or modified in one of two formats: ASCII or unsigned integer. Program code can be disassembled and displayed as ASM-51 assembler mnemonics. Code can be modified with standard ASM-51 statements using the built-in single-line assembler.

Symbolic references can be used to specify memory locations. A symbolic reference is a procedure name, line number, program variable, or label in the user program that corresponds to a location.

Some typical symbolic functions include:

- Changing or inspecting the value of a program variable by using its symbolic name to access the memory location.
- Defining break and trace events using symbolic references.
- Referencing variables as primitive data types. The primitive data types are ADDRESS, BIT, BOOLEAN, BYTE, CHAR (character), and WORD.

The ICE-5100/044 emulator maintains a virtual symbol table (VST) for program symbols. A maximum of 61 KB of host memory space is available for the VST. If the VST is larger than 61 KB, the excess is stored on available host system disk space and is paged in and out as needed. The size of the VST is limited only by the disk capacity of the host system.

Breakpoint Specifications

Breakpoints are used to halt a user program in order to examine the effect of the program's execution on the target system. The ICE-5100/044 emulator supports three different types of break specifications:

- Specific address break—specifying a single address point at which emulation is to be stopped.
- Range break—an arbitrary range of addresses can be specified to halt emulation. Program execution within or, optionally, outside the range halts emulation.
- Page break—up to 256 page breaks can be specified. A page break is defined as a range of addresses that is 256-bytes long and begins on a 256-byte address boundary.

Break registers are user-defined debug definitions used to create and store breakpoint definitions. Break registers can contain multiple breakpoint definitions and can optionally call debug procedures when emulation halts.

Trace Specifications

Tracing can be triggered using specifications similar to those used for breaking. Normally, the ICE-5100/044 emulator traces program activity while the user program is executing. With a trace specification, tracing can be triggered to occur only when specific conditions are met during execution. Up to 254 24-bit frames of trace information are collected in a buffer during emulation. Sixteen of the 24 bits trace instruction execution addresses, and 8 bits capture external events (CLIPS).

```
        /* Print newest four instructions in the buffer */
hlt>PRINT NEWEST 4
FRAME    ADDR      CODE      INSTRUCTIONS
(28)     300A      C02A      PUSH      2AH
(30      300C      2532      ADD       A, 32H
(32)     300E      F52A      MOV       2AH, A
(34)     3010      B53210    CJNE      A,32H, $+10H
hlt>
hlt>PRINT CLIPS OLDEST 2     /* Buffer display showing clips */
FRAME    ADDR      CODE      INSTRUCTIONS   CLIPS     (76543210)
(00)     007AH     0508      INC  INDX PTR             10101111
(01)     007CH     80E6      SJMP (#28)                00100010
```

280325-3

Figure 2. Selected Trace Buffer Displays

The trace buffer display is similar to an ASM-51 program listing as shown in Figure 2. The PRINT command enables the user to selectively display the contents of the trace buffer. The user has the option of displaying the clips information as well as dissassembled instructions.

Procedures

Debugging procedures (PROCs) are a user-defined group of ICE-5100/044 commands that are executed as one command. PROCs enable the user to define several commands in a named block structure. The commands are executed by entering thename of the PROC. The PROC bodies are a simple DO . . . END construct.

```
hlt>GO
FROM     ARM  FOREVER   TIL  USING     TRACE     ;    <execute>

hlt>GO FROM
<expr>

hlt>GO FROM 13H
<operator>    ARM  FOREVER   TIL  USING     TRACE     ;    <execute>

hlt>GO FROM 13H USING
BRKREG<brkreg name>

hlt>GO FROM 13H USING brl
,   TRACE     ;    <execute>

hlt>GO FROM 13H USING brl TRACE
<expr>   OUTSIDE   PAGE FROM TIL  <trcreg name>  ;    <execute>

hlt>GO FROM 13H USING brl TRACE traceit
;   <execute>
```

280325-4

Figure 3. The Integrated Command Directory for the GO Command

PROCs can simulate missing hardware or software, set breakpoints, collect debug information, and execute high-level software patches. PROCs can be copied to text files on disk, then recalled for use in later test sessions. PROCs can also serve as program diagnostics, implementing ICE-5100/044 emulator commands or user-defined definitions for special purposes.

On-Line Syntax Menu

A special syntax menu, called the Integrated Command directory (ICD), similar to the one used for the I²ICE™ system and the VLSiCE-96 emulator, aids in creating syntactically correct command lines. Figure 3 shows an example of the ICD and how it changes to reflect the options available for the GO command.

Help

The HELP command provides ICE-5100/044 emulation command assistance via the host system terminal. On-line HELP is available for the ICE-5100/044 emulator commands shown in Figure 4.

BITBUS™ Applications Support

The ICE-5100/044 emulator provides an ideal environment for developing applications code for BITBUS board products such as the RCB-44/10, the RCB-44/20, the PCX-344, and the iSBX™-344 board.

The BITBUS firmware, available separately as BITWARE, can be loaded into the ICE-5100/044 emulator's memory along with the user's code to enable rapid debug of 8044 BITBUS applications code.

DESIGN CONSIDERATIONS

The height of the processor module and the target adaptor need to be considered for target systems. Allow at least 1½ inches (3.8 cm) of space to fit the processor module and target adaptor. Figure 5 shows the dimensions of the processor module.

Execution of user programs that contain interrupt routines causes incorrect data to be stored in the trace buffer. When an interrupt occurs, the next instruction to be executed is placed into the trace buffer before it is actually executed. Following completion of the interrupt routine, the instruction is executed and again placed into the trace buffer.

ELECTRICAL CONSIDERATIONS

The emulation processor's user-pin timings and loadings are identical to the 8044 component, except as follows.

- Up to 25 pF of additional pin capacitance is contributed by the processor module and target adaptor assemblies.
- Pin 31, $\overline{EA}$, has approximately 32 pF of additional capacitance loading due to sensing circuitry.
- Pins 18 and 19, XTAL1 and XTAL2 respectively, have approximately 15-16 pF of additional capacitance when configured for crystal operation.

```
hlt>HELP

HELP is available for:

ADDRESS     APPEND    ASM         BASE       BIT         BOOLEAN      BRKREG
BYTE        CHAR      CI          CNTL_C     COMMENTS    CONSTRUCTS   COUNT
CURHOME     CURX      CURY        DCI        DEBUG       DEFINE       DIR
DISPLAY     DO        DYNASCOPE   EDIT       ERROR       EVAL         EXIT
EXPRESSION  GO        HELP        IF         INCLUDE     INVOCATION   ISTEP
KEYS        LABEL     LINES       LIST       LITERALLY   LOAD         LSTEP
MAP         MENU      MODIFY      MODULE     MSPACE      MTYPE        NAMESCOPE
OPERATOR    PAGING    PARTITION   PRINT      PROC        PSEUDO_VAR   PUT
REFERENCE   REGS      REMOVE      REPEAT     RESET       RETURN       SAVE
STRING      SYMBOLIC  SYNCSTART   TEMPCHECK  TRCREG      TYPES        VARIABLE
VERIFY      VERSION   WAIT        WORD       WRITE
hlt>
```

280325-5

Figure 4. HELP Menu

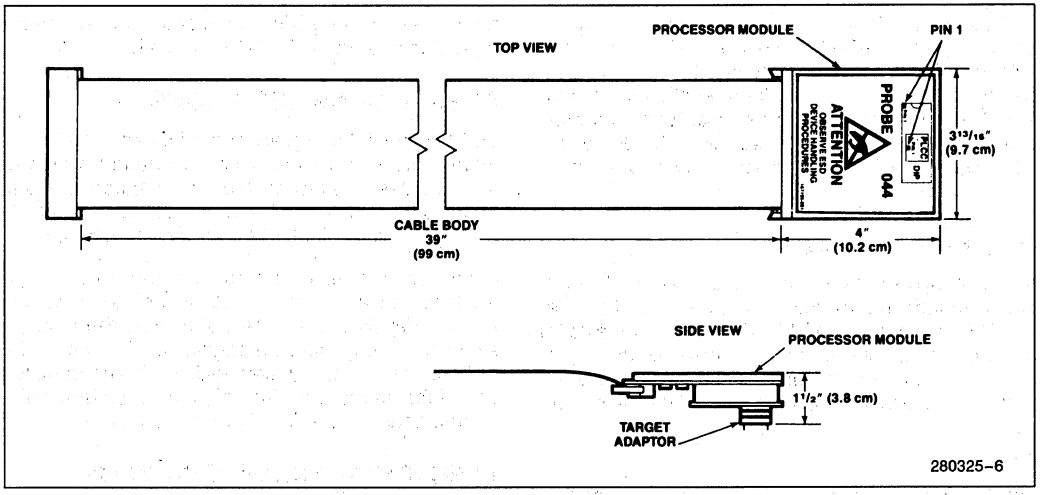


Figure 5. Processor Module Dimensions

HOST REQUIREMENTS

- IBM PC AT or PC XT (or PC DOS compatible) with 512 KB of available RAM and a hard disk running under the DOS 3.0 (or later) operating system.
- Intellec Series III/IV microcomputer development system running the ISIS or iNDX operating system respectively, with at least 512 KB of application memory resident.
- Disk drives—dual floppy or one hard disk and one floppy drive required.

ICE™-5100/044 EMULATOR SOFTWARE PACKAGE

- ICE-5100/044 emulator software
- ICE-5100/044 confidence tests
- ICE-5100 tutorial software

EMULATOR PERFORMANCE

Memory

Mappable full-speed emulation code memory	64 KB	Mappable to user or ICE-5100/044 emulator memory in 4 KB blocks on 4 KB boundaries.
Trace memory		254 x 24 bit frames
Virtual Symbol Table		A maximum of 61 KB of host memory space is available for the virtual symbol table (VST). The rest of the VST resides on disk and is paged in and out as needed.

PHYSICAL CHARACTERISTICS

Controller Pod

Width:	8-1/4"	(21 cm)
Height:	1-1/2"	(3.8 cm)
Depth:	13-1/2"	(34.3 cm)
Weight:	4 lbs	(1.85 kg)

User Cable

The user cable is 3 feet (approximately 1 m)

Processor Module

(With the target adaptor attached)

Width:	3-13/16"	(9.7 cm)
Height:	4"	(10.2 cm)
Depth:	1-1/2"	(3.8 cm)

Power Supply

Width:	7-5/8"	(18.1 cm)
Height:	4"	(10.06 cm)
Depth:	11"	(27.97 cm)
Weight	15 lbs	(6.1 kg)

Serial Cable

The serial cable is 12 feet (3.6 m).

ELECTRICAL CHARACTERISTICS

Power Supply

100-120V or 200-240V (selectable)
50-60 Hz
2 amps (AC max) @ 120V
1 amp (AC max) @ 240V

ENVIRONMENTAL CHARACTERISTICS

Operating temperature	+10°C to +40°C (50°F to 104°F)
Operating humidity	Maximum of 85% relative humidity, non-condensing

ORDERING INFORMATION

Emulator Hardware and Software

Order Code	Description
I044KITAD	This kit contains the ICE-5100/044 user probe assembly, power supply and cables, serial cables, target adaptor, CPA, ICE-5100 controller pod, software, and documentation for use with an IBM PC AT or PC XT. The kit also includes the 8051 Software Development Package and the AEDIT text editor for use on DOS systems. [Requires software license.]
I044KITD	This kit is the same as the I044KITAD excluding the 8051 Software Development Package and the AEDIT text editor. [Requires software license.]
I044KITAS	This kit contains the ICE-5100/044 user probe assembly, power supply and cables, serial cables, target adaptor, CPA, ICE-5100 controller pod, software, and documentation for use with Intel hosts (Series III/IV). The kit also includes the 8051 Software Development Package and the AEDIT text editor for use on the Series III/IV. [Requires software license.]
I044KITS	This kit is the same as the I044KITAS excluding the 8051 Software Development Package and the AEDIT text editor. [Requires software license.]

Software Only

Order Code	Description
SA044D	This kit contains the host, probe, diagnostic, and tutorial software on 5¼" disks for use on an IBM PC AT or PC XT (requires DOS 3.0 or later). [Requires software license.]
SA044S	This kit contains the host, probe, diagnostic, and tutorial software on 8" disks (both single-density and double-density) for use on a Series III, and on 5-¼" disks for use on a Series IV. [Requires software license.]

Other Useful Intel® MCS®-51 Debug and Development Support Products

Order Code	Description
D86ASM51	**8051 Software Development Package** (DOS version)—Consists of the ASM-51 macro assembler which gives symbolic access to 8051 hardware features; the RL51 linker and relocator program that links modules generated by ASM-51; CONV51 which enables software written for the MCS-48 family to be up-graded to run on the 8051, and the LIB51 Librarian which programmers can use to create and maintain libraries of software object modules. Use with the DOS operating system (version 3.0 or later).
D86PLM51	**PL/M-51 Software Package** (DOS version)—Consists of the PL/M-51 compiler which provides high-level programming language support; the LIB51 utility that creates and maintains libraries of software object modules, and the RL51 linker and relocator program that links modules generated by ASM-51 and PL/M-51 and locates the linked object modules to absolute memory locations. Use with the DOS operating system (version 3.0 or later).
I86ASM51	**8051 Software Development Package** (ISIS version)—Same as the D86ASM51 package except this one is for use with the Series III.
I86PLM51	**PL/M-51 Sofware Package**—Same as the D86PLM51 package except this one is for use with the Series III and Series IV.
D86EDINL	AEDIT text editor for use with the DOS operating system.

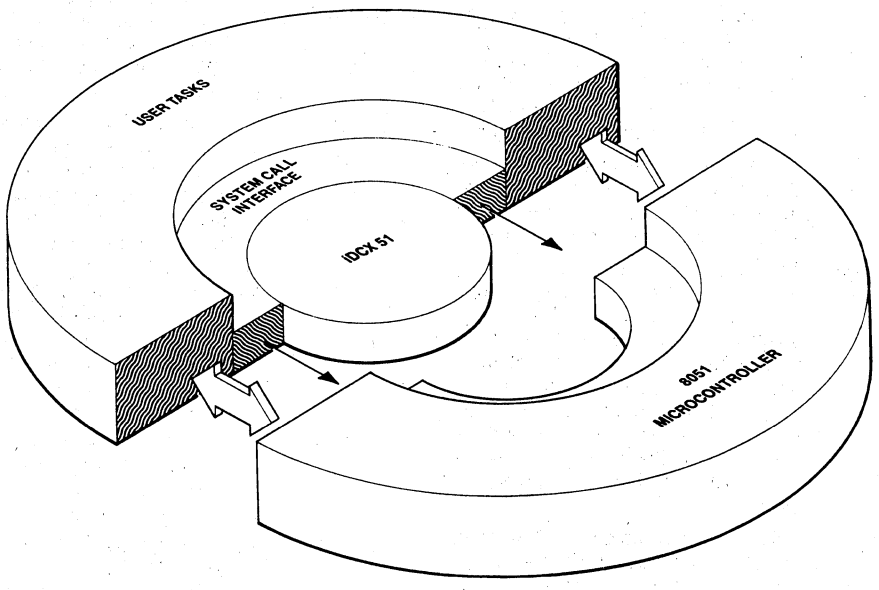
iDCX 51
DISTRIBUTED CONTROL EXECUTIVE

- **Supports MCS®-51 and RUPI™-44 Familes of 8-Bit Microcontrollers**
- **Real-Time, Multitasking Executive — Supports up to 8 Tasks at Four Priority Levels**
- **Local and Remote Task Communication**
- **Small—2.2K Bytes**
- **Reliable**
- **Simple User Interface**
- **Dynamic Reconfiguration Capability**
- **Compatible with BITBUS™/Distributed Control Modules (iDCM) Product Line**

The iDCX 51 Executive is compact, easy to use software for development and implementation of applications using the high performance 8-bit family of 8051 microcontrollers, including the 8051, 8044, and 8052. Like the 8051 family, the iDCX 51 Executive is tuned for real-time control applications requiring manipulation and scheduling of more than one task, and fast response to external stimuli.

The MCS-51 microcontroller family coupled with iDCX 51 is a natural combination for applications such as data acquisition and monitoring, process control, robotics, and machine control. The iDCX 51 Executive can significantly reduce applications development time, particularly BITBUS distributed control environments.

The iDCX 51 Executive is available in two forms, either as configurable software on diskette or as preconfigured firmware within the 8044 BEM BITBUS microcontroller.



280176-1

Figure 1. iDCX 51 Distributed Control Executive

*XENIX™ is a trademark of Microsoft Corporation.

October 1987
Order Number: 280176-003

MICROCONTROLLER SUPPORT

The iDCX 51 Executive is designed to support the MCS-51 and RUPI-44 families of 8-bit microcontrollers. MCS-51 microcontrollers that are supported include the 8051, 80C51, 8052, 8031, 8032, and 8751 devices. The RUPI-44 microcontrollers include the 8044, 8344, and 8744 devices. All of these microcontrollers share a common 8051 core.

ARCHITECTURE

Real-time and Multitasking

Real-time control applications must be responsive to the external environment and typically involve the execution of more than one activity (task or set of tasks) in response to different external stimuli. Control of an industrial drying process is an example. This process could require monitoring of multiple temperatures and humidity; control of fans, heaters, and motors that must respond accordingly to a variety of inputs. The iDCX 51 Executive fully supports applications requiring response to stimuli as they occur, i.e., in real-time. This real-time response is supported for multiple tasks often needed to implement a control application.

Some of the facilities precisely tailored for development and implementation of real-time control application systems provided by the iDCX 51 Executive are: task management, interrupt handling, message passing, and when integrated with communications support, message passing with different microcontrollers. Also, the iDCX 51 Executive is driven by events: interrupts, timers, and messages ensuring the application system always responds to the environment appropriately.

Task Management

A task is a program defined by the user to execute a particular control function or functions. Multiple programs or tasks may be required to implement a particular function such as "controlling Heater 1". The iDCX 51 Executive recognizes three different task states as one of the mechanisms to accomplish scheduling of up to eight tasks. Figure 2 illustrates the different task states and their relationship to one another.

The scheduling of tasks is priority based. The user can prioritize tasks to reflect their relative importance within the overall control scheme. For instance, if Heater 1 must go off line prior to Heater 2 then the task associated with Heater 1 shutdown could be assigned a higher priority ensuring the correct shutdown sequence. The RQ WAIT system call is also a scheduling tool. In this example the task implementing Heater 2 shutdown could include an instruction to wait for completion of the task that implements Heater 1 shutdown.

The iDCX 51 Executive allows for PREEMPTION of a task that is currently being executed. This means that if some external event occurs such as a catastrophic failure of Heater 1, a higher priority task associated with the interrupt, message, or timeout resulting from the failure will preempt the running task. Preemption ensures the emergency will be responded to immediately. This is crucial for real-time control application systems.

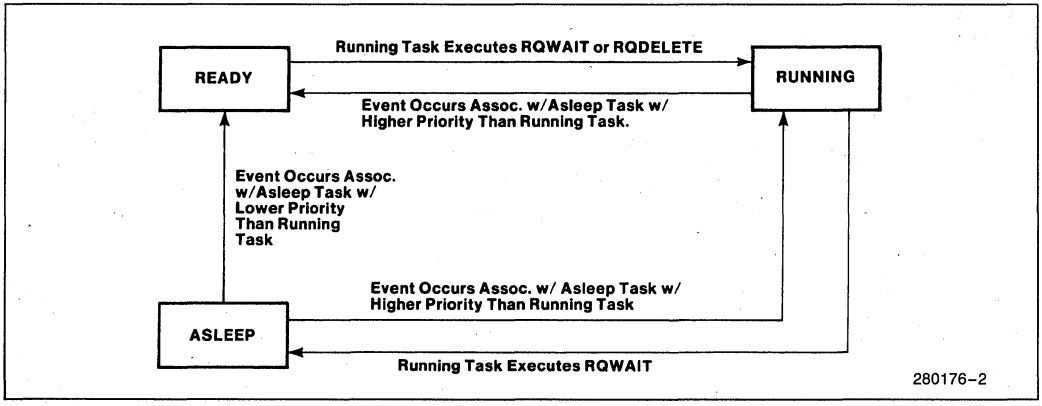


Figure 2. Task State Transition Diagram

Interrupt Handling

The iDCX 51 Executive supports five interrupt sources as shown in Table 1. Four of these interrupt sources, excluding timer 0, can be assigned to a task. When one of the interrupts occurs the task associated with it becomes a running task (if it were the highest priority task in a ready state). In this way, the iDCX 51 Executive responds to a number of internal and external stimuli including time intervals designed by the user.

Table 1. iDCX 51 Interrupt Sources

Interrupt Source	Interrupt Number
External Request 0	00H
Timer 0	01H
External Request 1	02H
Timer 1	03H
Internal Serial Port 1	04H

Message Passing

The iDCX 51 Executive allows tasks to interface with one another via a simple message passing facility. This message passing facility can be extended to different processors when communications support is integrated within a BITBUS/iDCM system, for example. This facility provides the user with the ability to link different functions or tasks. Linkage between tasks/functions is typically required to support development of complex control applications with multiple sensors (input variables) and drivers (output variables). For instance, the industrial drying process might require a dozen temperature inputs, six moisture readings, and control of: three fans, two conveyor motors, a dryer motor, and a pneumatic conveyor. The data gathered from both the temperature and humidity sensors could be processed. Two tasks might be required to gather the data and process it. One task could perform a part of the analysis, then include a pointer to the next task to complete the next part of the analysis. The tasks could continue to move between one another.

REMOTE TASK COMMUNICATION

The iDCX 51 Executive system calls can support communication to tasks on remote controllers. This feature makes the iDCX 51 Executive ideal for applications using distributed architectures. Providing communication support saves significant application development time and allows for more effective use of this time. Intel's iDCM product line combines hardware and software to provide this function.

In an iDCM system, communication between nodes occurs via the BITBUS microcontroller interconnect. The BITBUS microcontroller interconnect is a high performance serial control bus specifically intended for use in applications built on distributed architectures. The iDCX 51 Executive provides BITBUS support.

BITBUS™/iDCM COMPATIBLE

A pre-configured version of the iDCX 51 Executive implements the BITBUS message format and provides all iDCX 51 facilities mentioned previously: task management, interrupt handling, and message passing. This version of the Executive is supplied in firmware on the 8044 BEM with the iDCM hardware products: the iSBX™ 344A BITBUS Controller MULTIMODULE™; the iDCX 344A BITBUS controller board for the PC; and the iRCB boards.

Designers who want to use the iDCX executive on an Intel BITBUS board should purchase either DCS110 or DSC120 BITBUS software. Both of these products include an interface library to iDCX 51 procedures and other development files. It is not necessary to purchase the iDCX 51 Executive.

SIMPLE USER INTERFACE

The iDCX 51 Executive's capabilities are utlilized through system calls. These interfaces have been defined for ease of use and simplicity. Table 2 includes a listing of these calls and their functions. Note that tasks may be created at system initialization or run-time using the CREATE TASK call.

Other Functions such as GET FUNCTION IDS, ALLOCATE/DEALLOCATE BUFFER, and SEND MESSAGE, support communication for distributed architectures.

Table 2. iDCX 51 System Calls

Call Name	Description
TASK MANAGEMENT CALLS	
RQ$CREATE$TASK	Create and schedule a new task.
RQ$DELETE$TASK	Delete specified task from system.
RQGETFUNCTION$IDS	Obtain the function IDs of tasks currently in the system.
RQ$ALLOCATE	Obtain a message buffer from the system buffer pool.
RQ$DEALLOCATE	Return a message buffer to the system buffer pool.
RQ$SEND$MESSAGE	Send a message to specified task.
RQ$WAIT	Wait for a message event.
MEMORY MANAGEMENT CALLS	
RQGETMEM	Get available system memory pool memory.
RQ$RELEASE$MEM	Release system memory pool memory.
INTERRUPT MANAGEMENT CALLS	
RQ$DISABLE$INTERRUPT	Temporarily disable an interrupt.
RQ$ENABLE$INTERRUPT	Re-enable an interrupt.
RQ$WAIT	Wait for an interrupt event.
TIMER MANAGEMENT CALLS	
RQSETINTERVAL	Establish a time interval.
RQ$WAIT	Wait for an interval event.

Another feature that eases application development is automatic register bank allocation. The Executive will assign tasks to register banks automatically unless a specific request is made. The iDCX 51 Executive keeps track of the register assignments allowing the user to concentrate on other activities.

SYSTEM CONFIGURATION

The user configures an iDCX 51 system simply by specifying the initial set of task descriptors and configuration values, and linking the system via the RL 51 Linker and Locator Program with user programs.

Each task that will be running under control of the executive has an Initial Task Description (ITD) that describes it. The ITD specifies to the executive the amount of stack space to reserve, the priority level of the task (1–4), the internal memory register bank to be associated with the task, the internal or external interrupt associated with the task, and a function ID (assigned by the user) that uniquely labels the task. The ITD can also include a pointer to the ITD for the next task. In this way an ITD "chain" can be formed. For example, if four ITD's are chained together, then when the system is initialized, all four tasks will be put into a READY state. Then, the highest priority task will run.

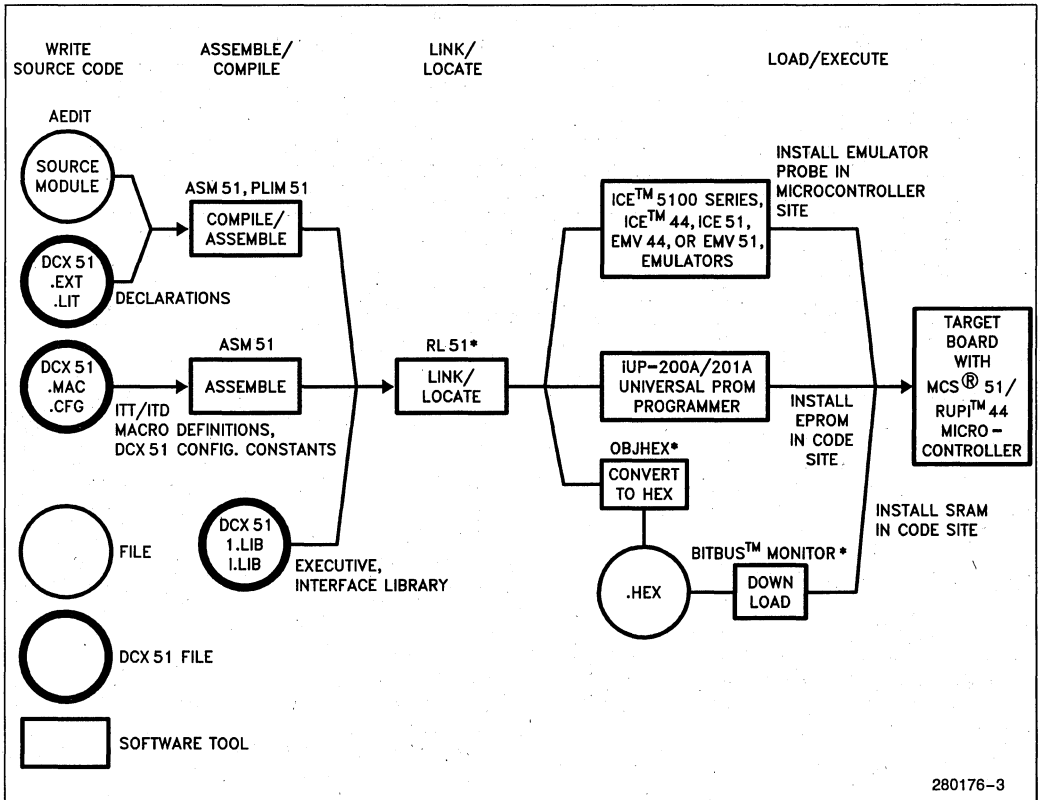
The DCX 51 user can control several system constants during the configuration process (Table 3). Most of these constants are fixed, but by including an Initial Data Descriptor (IDD) in an ITD chain, the system clock priority, clock time unit, and buffer size can be modified at run-time.

This feature is useful for products that use the same software core, but need minor modification of the executive to better match the end application. The initial data descriptor also allows the designer, who is using an 8044 BEM BITBUS Microcontroller, to modify the preconfigured (on-chip) iDCX 51 Executive.

Programs may be written in ASM 51 or PL/M 51. Intel's 8051 Software Development Package contains both ASM 51 and RL 51. Figure 3 shows the software generation process.

Table 3. DCX 51 Configuration Constants

Constant Name	Description
RQ CLOCK PRIORITY	The priority level of the system clock.
RQ CLOCK TICK	The number of time cycles in the system clock basic time unit (a "tick").
RQ FIRST ITD	The absolute address of the first ITD in the ITD chain.
RQ MEM POOL ADR	The start address of the System Memory Pool (SMP) in Internal Data RAM.
RQ MEM POOL LEN	The length of the SMP.
RQ RAM IDD	The absolute RAM address of where iDCX 51 checks for an Initial Data Descriptor (IDD) during initialization.
RQ SYS BUF SIZE	The size, in bytes, of each buffer in the system buffer pool.



NOTE:
*RL 51 is included with ASM51 and PL/M 51; OBJHEX and the BITBUS Monitor are part of the DCS100 BITBUS Toolbox.

Figure 3. Software Generation Process

SOPHISTICATED INTERNAL MEMORY MANAGEMENT

The amount of internal memory available ranges from 128 to 256 bytes depending on the type of microcontroller used.

Internal memory is used for the executive, stack spare for "running" tasks, space for message buffers, and reserved memory for variables storage. Other memory is used for register space. Except for register space, the allocation of internal memory is controlled by the executive, user-specified task/data descriptors and system configuration constants.

To optimize use of this limited resource, iDCX 51 provides dynamic (run-time) memory management.

INITIALIZATION AND DYNAMIC MEMORY MANAGEMENT

At initialization (see Figure 4), the iDCX 51 Executive creates the System Memory Pool (SMP) out of the remaining initial free space (i.e. memory not used by the iDCX 51 Executive or for register space). Next, stack space is created for each of the initial tasks that will be running on the system. If reserved memory is requested (using an IDD), that memory is also set aside. Finally, multiple buffers (size specified during iDCX 51 configuration or using an IDD) are allocated from any remaining memory. These buffers form the System Buffer Pool (SBP) that can be used to create additional stack space or to locate messages sent between tasks.

During run-time, the iDCX 51 Executive dynamically manages this space. If a task is deleted, its stack space is returned to the System Buffer Pool for use by other tasks or as a message buffer.

As new tasks are dynamicallly created, the executive reserves the needed stack space. If no space is available, the executive deallocates a buffer from the System Buffer Pool and then allocates the needed stack space.

To send or receive a message, the executive allocates one or more buffers from the SBP for space to locate the message. With iDCX 51, messages can be optionally located in external (off-chip) memory. The pre-configured executive in the 8044 BEM BITBUS microcontroller, however, always locates messages in internal memory.

RELIABLE

Real-time control applications require reliability. The nucleus requires about 2.2K bytes of code space, 40 bytes on-chip RAM, and 218 bytes external RAM.

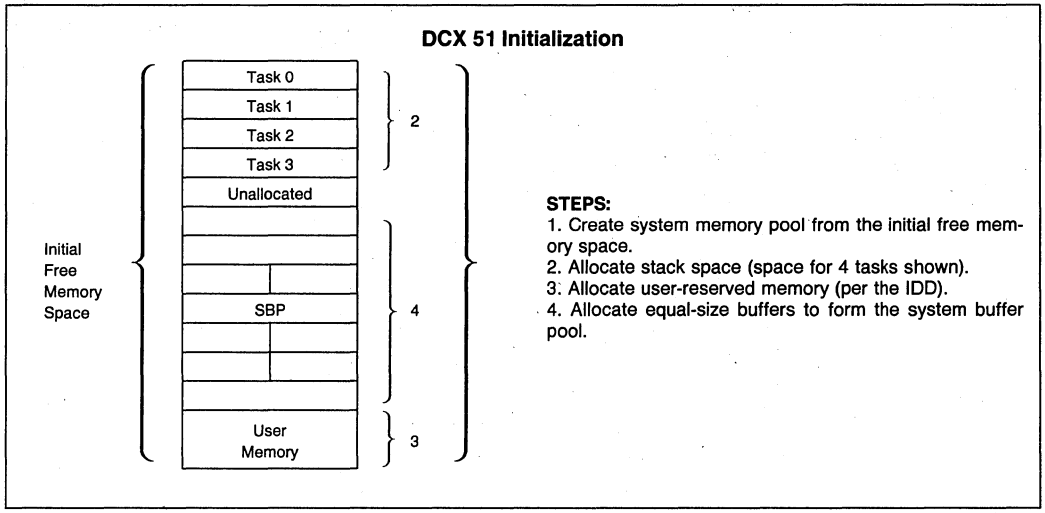


Figure 4. iDCX 51 Initialization of Internal Memory

Streamlined code increases performance and reliability, and flexibility is not sacrificed as code may be added to either on-chip or external memory.

The iDCX 51 architecture and simple user interface further enhance reliability and lower cost. For example, the straightforward structure of the user interfaces, and the transparent nature of the scheduling process contribute to reliability of the overall system by minimizing programming effort. Also, modularity increases reliability of the system and lowers cost by allowing user tasks to be refined independent of the system. In this way, errors are identified earlier and can be easily corrected in each isolated module.

In addition, users can assign tasks a Function ID that allows tracking of the tasks associated with a particular control/monitorig function. This feature reduces maintenance and trouble shooting time thus increasing system run time and decreasing cost.

OPERATING ENVIRONMENT

The iDCX 51 Executive supports applications development based on any member of the high performance 8051 family of microcontrollers. The Executive is available on diskette with user linkable libraries or in the 8044 BITBUS Enhanced Microcontroller preconfigured in on-chip ROM. (The 8044 BEM is an 8044 component that consists of an 8051 microcontroller and SDLC controller on one chip with integral firmware.)

When in the iDCM environment (Figure 5), the preconfigured iDCX 51 Executive can communicate with other BITBUS series controller boards. The BITBUS board at the master node can be associated with either an iRMX™, PC-DOS or XENIX* host system.

DEVELOPMENT ENVIRONMENT

Intel provides a complete development environment for the MCS-51 and RUPI-44 families of microcontrollers. The iDCX 51 Executive is only one of many of the software development products available. The executive is compatible with the following software development utilities available from Intel:

- 8051 Macro Assembler (ASM 51)
- PL/M 51 Compiler
- RL 51 Linker and Relocator Program
- LIB 51

Intel hardware development tools currently available for MCS-51 and RUPI-44 microcontroller development are:

- ICE-5100/252 Emulator for the MCS-51 family of microcontrollers
- ICE-5100/044 Emulator for the RUPI-44 family of microcontrollers (8044, 8344, 8744)
- iUP-200A/201A PROM Programmer, 21X software, and iUP programming modules

The DCX 51 Executive is also compatible with older hardware development tools (no longer available), which include:

- EMV-51/44 Emulation Vehicles
- ICE-51/44 In-Circuit Emulators

Table 4 shows the possible MCS-51 and RUPI-44 families development environments: host systems, operating systems, available software utilities, and hardware debug tools.

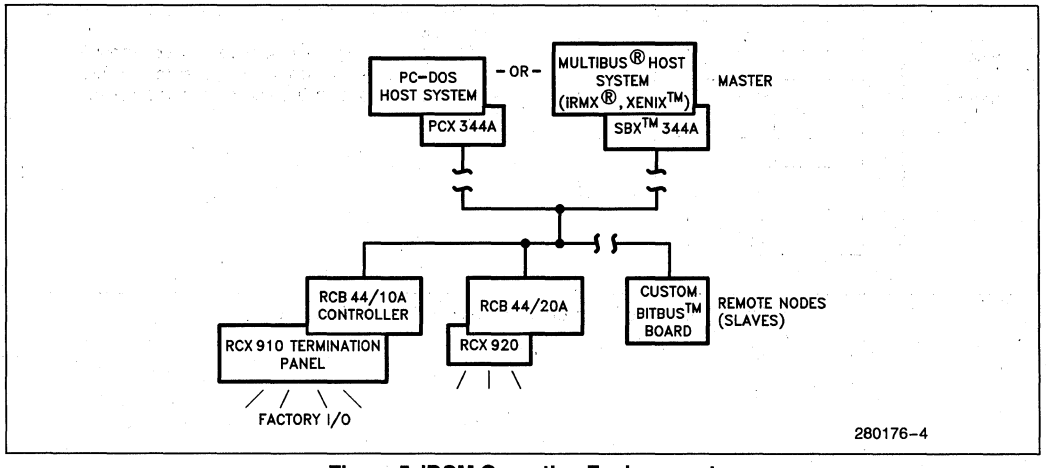


Figure 5. iDCM Operating Environment

SPECIFICATIONS

Supported Microcontrollers

8031	80C31
8051	80C51
8032	8751
8744	8044
8344	8052

Compatible DCM BITBUS™ Software

DCS 100 BITBUS Toolbox Host Software Utilities

DCS 110 BITWARE DCM44 Code for BITBUS emulation

Reference Manual (Supplied)

460367-001— iDCX 51 Distributes Control Executive User's Guide for Release 2.0.

ORDERING INFORMATION

Part Number	Description
DCX51SU	Executive for 8051 Family of Microcontrollers. Single User License, Development Only. Media Supplied for All Host Systems (Table 3).
DCX51RF	Royalty (Incorporation) Fee for iDCX Executive. Set of 50 incorporations. IDCX 51 RF does not ship with software (Order DCX 51SU).

Table 4. MCS®-51/RUPI™-44 Families Development Environments

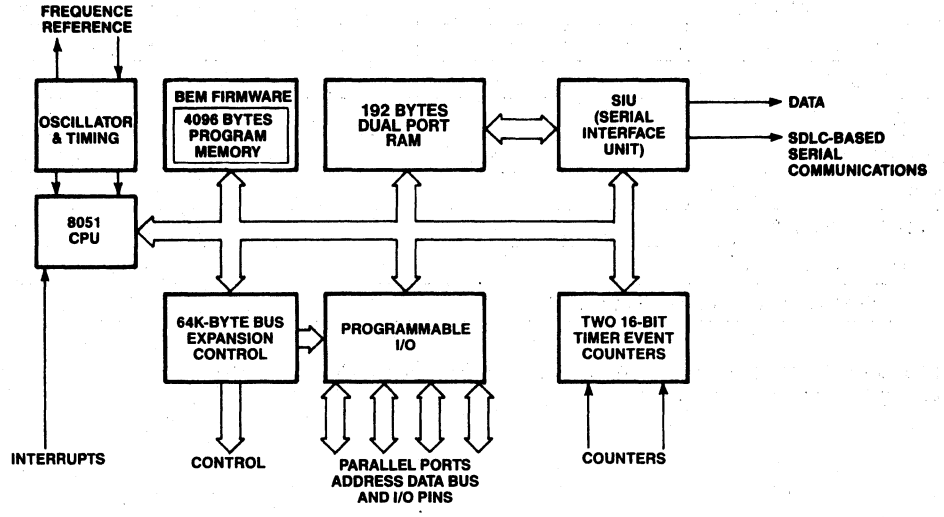
Development Utilities	Host Systems				
	PC/MS-DOS	iRMX® 86	iPDS™	Intellec®	
				Series II	Series III/IV
SOFTWARE					
ASM 51 + Utilities(1)	✓	✓	✓	✓	✓
PL/M 51 + Utilities(1)	✓	✓	✓	✓	✓
iDCX 51 Executive	✓	✓	✓		✓
HARDWARE					
ICE-5100/044/252	✓				✓
iUP-200A/201A	✓				✓
EMV-51(2), EMV-44(2)				✓	✓
ICE-51(2), ICE-44(2)				✓	✓
iPDS + iUP-F87/44A PROM Programmer			✓		

NOTES:
1. Utilities include RL 51, LIB 51, and AEDIT. Software for Series II systems is down-revision version.
2. These products are no longer available.

8044 BITBUS™ ENHANCED MICROCONTROLLER

- **Dual Processor Microcontroller Architecture**
- **High Performance 8-Bit CPU**
- **Embedded Parallel Communications Firmware**
- **Tuned for Distributed Real-Time Control**
- **BITBUS™ Firmware Included On-Chip**
- **Power-Up Diagnostics**
- **DCX 51 Distributed Control Executive Included On-Chip**
- **MCS®-51 Software Compatible**

The 8044 BITBUS Enhanced Microcontroller (BEM) is a powerful 8-bit microcontroller with on-chip firmware. The dual processor architecture of the 8044 combined with the inherent the processing power of an 8051 CPU is well suited for distributed data acquisition and control applications in both the factory and laboratory. The firmware integral includes facilities for: diagnostics, task management, message passing, and user-transparent parallel and serial communication services.



280129–1

Figure 1. BEM Block Diagram

*IBM is a trademark of International Business Machines Corporation.

October 1987
Order Number: 280129-003

OPERATING ENVIRONMENT

Introduction

The BITBUS Interconnect Serial Control Bus Specification defines an integrated architecture optimized for implementing real-time distributed control systems. The architecture includes a message structure and protocol for multitasking environments, and a predefined interface for I/O access and control. As with traditional bus specifications the mechanical, electrical, and data protocols have been defined. Over a twisted pair of wires the bus can support up to 250 nodes at three different bit rates dependent on application performance requirements. Figure 2 illustrates the BITBUS Interconnect architecture.

The 8044 BITBUS Enhanced Microcontroller (BEM) or DCM Controller provides the user with the smallest BITBUS building block—a BITBUS component solution. With its dual processor architecture, this unique single chip provides both communication and computational engines (Figure 3). Real-time control and computational power are provided by the on-chip 8-bit 8051 CPU. The Serial Interface Unit (SIU) executes a majority of the communications functions in hardware resulting in a high performance solution for distributed control applications where communication and processing power are equally important. The BEM's firmware implements the BITBUS message structure and protocol, and the pre-defined I/O command set.

Firmware

The 8044 microcontroller requires specific hardware to interface to BITBUS. The BEM's firmware also requires a particular hardware environment in order to execute correctly, just as the iDCX 86 Operating System or other operating systems required a specific hardware environment, i.e., interrupt controller, timers, etc. Based upon the hardware provided, Basic or Extended firmware environments result.

The Basic firmware environment supports the minimum configuration for the BEM to execute as a

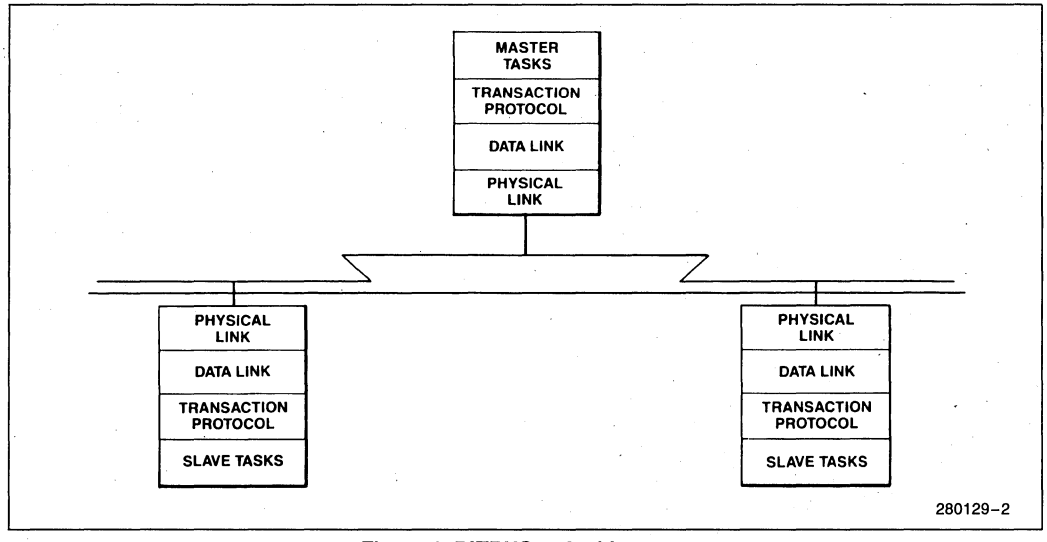


Figure 2. BITBUS™ Architecture

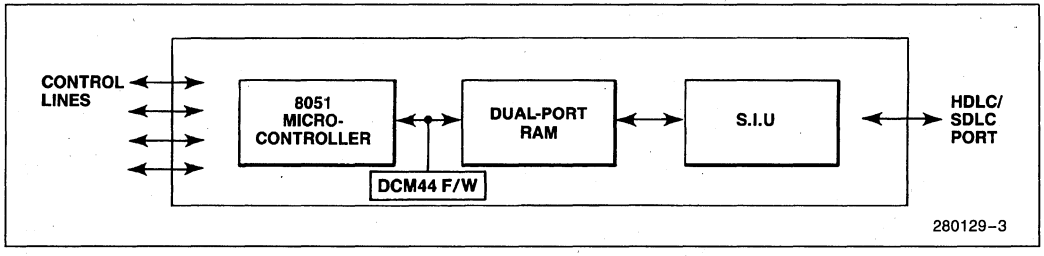


Figure 3. 8044's Dual Processor Architecture

BITBUS device. The Extended firmware environment requires hardware incremental to the Basic environment and allows the user to take full advantage of all the features included in the BEM's firmware. The designer may implement the Basic or Extended firmware environment as desired as long as the programmatic requirements of the firmware are met (see below).

Figure 4 shows one example of an Extended firmware environment. This particular example represents the BITBUS Core as used on Intel's iSBX™ 344A BITBUS Controller MULTIMODULE™ Board and iRCB 44/10A BITBUS Remote Controller Board.

BASIC FIRMWARE ENVIRONMENT	
Memory Bus	Parallel ports of 8044
BITBUS Node Address	0FFFFH external data space
Configuration	0FFFEH external data space
System RAM	0–02FFH external data space
Diagnostic LED #1	Port 1.0 (Pin 1)
Diagnostic LED #2	Port 1.1 (Pin 2)
EXTENDED FIRMWARE ENVIRONMENT	
Memory Bus	Parallel ports of 8044
BITBUS Node Address	0FFFFH external data space
Configuration	0FFFEH external data space
System RAM	0–02FFH external data space
Diagnostic LED #1	Port 1.0 (Pin 1)
Diagnostic LED #2	Port 1.1 (Pin 2)
User Task Interface	First Task Descriptor—0FFF0H to 0FFFFH in External data space Other Task Descriptors and User Code—01000H to 0FFEFH in external code space
User RAM Availability	On-Chip—02AH to 02FH bit space Off-Chip—BITBUS Master: 0400H to 0FFEFH external data space BITBUS Slave: 0100H to 0FFEFH external data space
Remote Access and Control Interface	Memory-Mapped I/O—0FF00H to 0FFFFH external data space

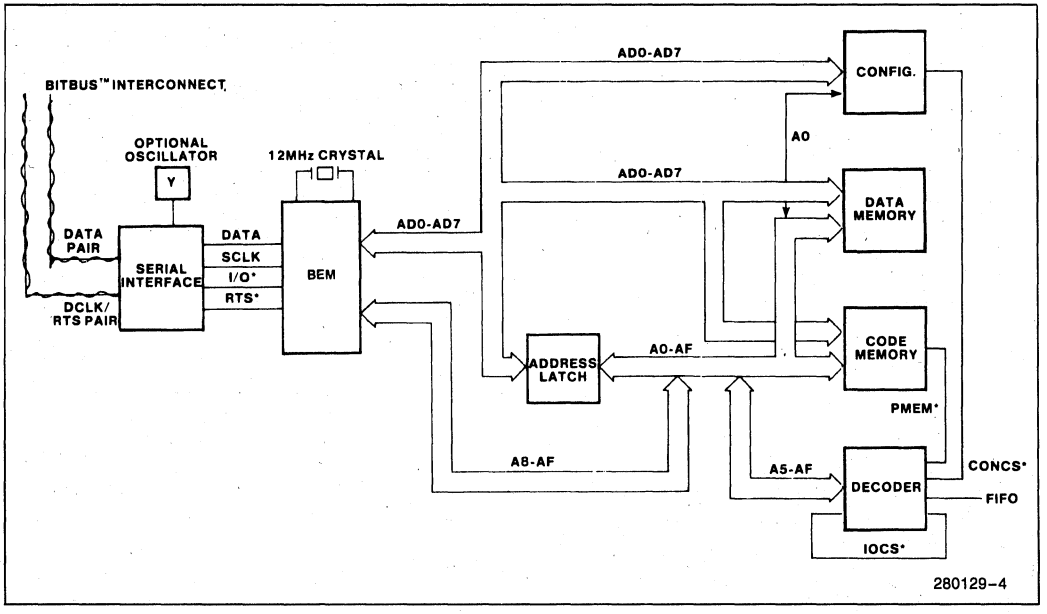


Figure 4. Extended Firmware Environment Example

EXTENDED FIRMWARE ENVIRONMENT (Continued)	
Parallel Interface to Extension Device	FIFO Command Byte—0FF01H external data space FIFO Data Byte—0FF00H external data space Receive Data Intr—INT0 (pin 12) Transmit Data Intr—INT1 (pin 13) Command/Data Bit—P1.2

FUNCTIONAL DESCRIPTION

High Performance 8044 Microcontroller

The 8044 combines the powerful 8051 microcontroller with an intelligent serial communications controller to provide a single-chip solution that efficiently implements distributed processing or distributed control systems. The microcontroller is a self-sufficient unit containing ROM, RAM, ALU, and peripherals. The 8044's architecture and instruction set are identical to the 8051's. The serial interface of the 8051 is replaced with an intelligent communications processor, the Serial Interface Init (SIU), on the 8044. This unique dual processor architecture results in high performance and reliability for distributed control and processing environments. The intelligent SIU offloads the CPU from communication tasks, thus dedicating more of its compute power to external processes.

Major features of the 8051 microcontroller are:

- 8-bit CPU
- On-chip oscillator
- 4K bytes of RAM
- 192 bytes of ROM
- 32 I/O lines
- 64K address space external data memory
- 64K address space external program memory
- Two Programmable 16-bit counters
- Five source interrupt structure with two priority levels
- Bit addressability for Boolean functions
- 1 μs instruction cycle time for 60% instructions
  2 μs instruction cycle time for 40% instructions
- 4 μs cycle time for 8 by 8 unsigned multiple and divide

As noted in the Operating Environment discussion, the BITBUS firmware requires various CPU resources, i.e., memory, timers, and I/O dependent upon the firmware environment selected.

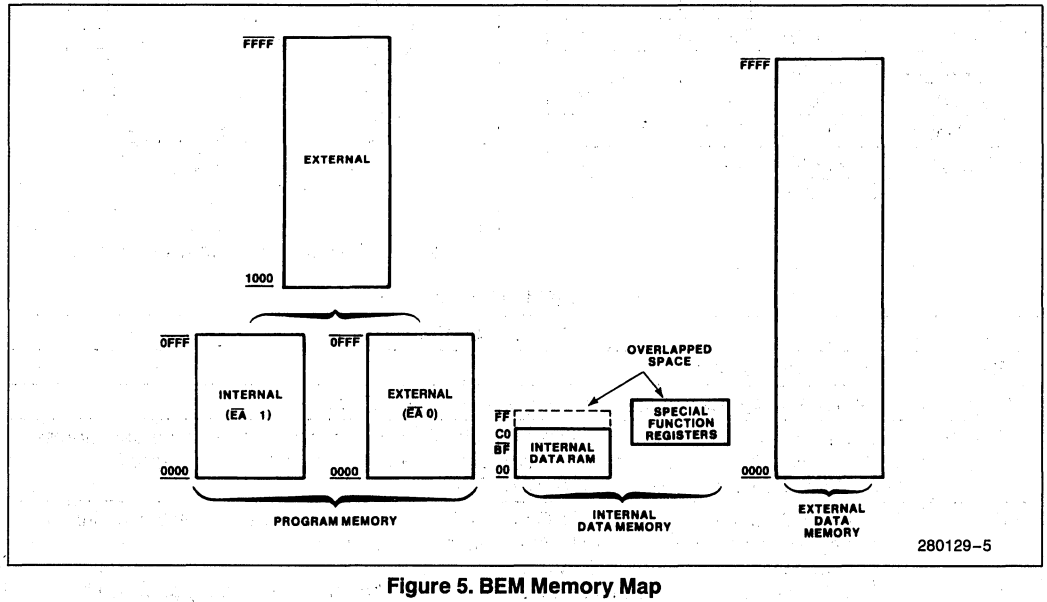


Figure 5. BEM Memory Map

Memory Architecture

The 8044 microcontroller maintains separate data and code memory spaces. Internal data memory and program memory reside on the controller. External memory resides outside the controller. The BEM firmware uses the available internal code memory space and most of the remaining internal data memory with the exception of bit space 02AH to 02FH. Figure 5 shows the BEM's memory map.

I/O ADDRESSING REQUIREMENTS

The table below provides the BEM's I/O port addresses.

Table 1. BEM I/O Addressing

Function	Address	Bit	Byte
Red LED P1.0	90H	X	
Green LED P1.1	91H	X	
TCMD	92H	X	
RFNF#	B3H	X	
TFNF#	B2H	X	
RDY/NE*	B4H	X	
Node Address	FFFFH		X
Configuration	FFFEH		X
Reserved	FFE0H–FFFDH		X
Digital I/O	FFC0H–FFDFH		X
SBX #4	FFB0H–FFBFH		X
SBX #3	FFB0H–FFAFH		X
SBX #2	FF90H–FF9FH		X
SBX #1	FF80H–FF8FH		X
User Defined	FF40H–FF7FH		X
Reserved	FF02H–FF3FH		X
FIFO Command	FF01H		X
FIFO Data	FF00H		X

SIGNAL FUNCTIONS

The 8044 BEM's pin configuration and pin description follow.

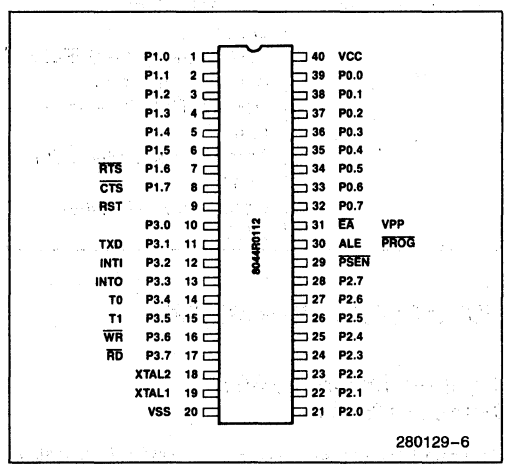


Figure 6A. BEM DIP Pin Configuration

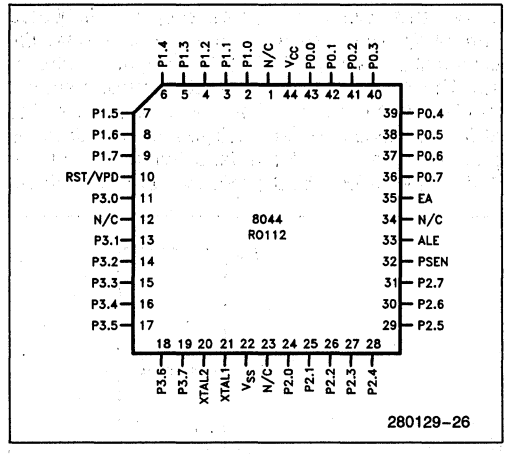


Figure 6B. BEM PLCC Pin Configuration

Table 2. BEM Pin Description

Name	Description
VSS	Circuit ground potential.
V_{CC}	+5V power supply during operation and program verification.
PORT 0	Port 0 is an 8-bit open drain bidirectional I/O port. It is also the multiplexed low-order address and data bus when using external memory. It is used for data output during program verification. Port 0 can sink/source eight LS TTL loads.
PORT 1	Port 1 is an 8-bit quasi-bidirectional I/O port. It is used for the low-order address byte during program verification. Port 1 can sink/source four LS TTL loads. In non-loop mode two of the I/O lines serve alternate functions: —$\overline{RTS}$ (P1.6) Request-to Send output. A low indicates that the 8044 is ready to transmit. —$\overline{CTS}$ (P1.7) Clear-to-Send input. A low indicates that a receiving station is ready to receive.

Table 2. BEM Pin Description (Continued)

Name	Description
PORT 2	Port 2 is an 8-bit quasi-bidirection I/O port. It also emits the high-order address byte when accessing external memory. It is used for the high-order address and the control signals during program verification. Port 2 can sink/source four LS TTL loads.
PORT 3	Port 3 is an 8-bit quasi-bidirectional I/O port. It also contains the interrupt, timer, serial port and RD and WR pins that are used by various options. The output latch corresponding to a secondary function must be programmed to a one (1) for that function to operate. Port 3 can sink/source four LS TTL loads. In addition to I/O some of the pins also serve alternate functions as follows: • I/$\overline{O}$ R x D (P3.0). In point-to-point or multipoint configurations, this pin controls the direction of pin P3.1. Serves as Receive Data input in loop and diagnostic modes. • DATA T x D (P3.1). In point-to-point or multipoint configurations, this pin functions as data input/output. In loop mode, it serves as transmit pin. A '0' written to this pin enables diagnostic mode. • $\overline{INT0}$ (P3.2). Interrupt 0 input or gate control input for counter 0. • $\overline{INT1}$ (P3.3). Interrupt 1 input or gate control input for counter 1. • TO (P3.4). Input to counter 0. • SCLK T1 (P3.5). In addition to I/O, this pin provides input to counter 1 or serves as SCLK (serial clock) input. • $\overline{WR}$ (P3.6). The write control signal latches the data byte from Port 0 into the External Data Memory. • $\overline{RD}$ (P3.7). The read control signal enables External Data Memory to Port 0.
RST	A high on this pin for two machine cycles while the oscillator is running resets the device. A small external pulldown resistor ($\approx$ 8.2 KΩ) from RST to VSS permits power-on reset when a capacitor ($\approx$ 10 μf) is also connected from this pin to V_{CC}.
ALE/$\overline{PROG}$	Provides Address Latch Enable output used for latching the address into external memory during normal operation. It is activated every six oscillator periods except during an external data memory access. It also receives the program pulse input for programming the EPROM version.
$\overline{PSEN}$	The Program Store Enable output is a control signal that enables the external Program Memory to the bus during external fetch operations. It is activated every six oscillator periods, except during external data memory accesses. Remains high during internal program execution.
$\overline{EA}$/VPP	When held at a TTL high level, the 8044 executes instructions from the internal ROM when the PC is less than 4096. When held at a TTL low level, the 8044 fetches all instructions from external Program Memory. The pin also receives the 21V EPROM programming supply voltage on the 8744.
XTAL 1	Input to the oscillator's high gain amplifier. Required when a crystal is used. Connect to VSS when external source is used on XTAL 2.
XTAL 2	Output from the oscillator's amplifier. Input to the internal timing circuitry. A crystal or external source can be used.

Firmware

The BEM's Basic firmware environment provides two services: BITBUS Communications and Power-Up Diagnostics. The Extended firmware environment provides the Basic firmware services plus Parallel Communications and User Software Services (iDCX 51 Executive, Remote Access and Control functions). A discussion of each service follows.

Basic Firmware Services

POWER-UP DIAGNOSTICS INCREASE RELIABILITY

For added reliability and simplified system start up, the BEM firmware includes power-up diagnostics. At chip reset the BEM diagnostic firmware checks the integrity of the 8044's instruction set, ROM, internal

RAM, and external RAM. LED indicator lights may be used to show the progress of the diagnostics. Intel's BITBUS boards use one red LED, and one green LED as indicators for test progress. Since the test halts if a fault is found, the last LED state indicates the trouble area.

No programmatic interface exists for the power-up diagnostics. Only LEDs (or other indicators) connected to the outputs of Port 1 of the 8044 are required. For the test sequence shown in Table 3, the red LED is connected to pin P1.0, and the green LED is connected to pin P1.1.

Table 3. Power-Up Test Sequence

Test Sequence	State of Port* After Test Completion	
	Red LED (Pin 1.0)	Green LED (Pin 1.1)
Power-on	On	On
Prior to Start of Tests	Off	Off
Test 1—Instruction Set	On	On
Test 2—ROM Checksum Test	On	Off
Test 3—Internal RAM	Off	Off
Test 4—External RAM	Off	On

*Ports are Active Low.

BITBUS™ INTERFACE SIMPLIFIES DESIGN OF DISTRIBUTED CONTROL SYSTEMS

The BITBUS Serial Control Bus is a serial bus optimized for high speed transfer of short messages in a hierarchical system. From the perspective of systems using the BITBUS bus there are three external protocols that must be adhered to: physical, data link, and transaction control as shown in Figure 2. The physical interface includes all bus hardware requirements, e.g. cable and connector definition, transceiver specification. The data link interface refers to the device to device transfer of frames on the bus. The transaction control interface indentifies the rules for transmitting messages on the bus as well as the format of the messages passed.

For maximum reliability and to facilitate standardization the following existing standards were chosen as portions of the BITBUS Specification: International Electrotechnical Commission (IEC) mechanical board and connector specifications, the Electronic Industry Association (EIA) RS-485 Electrical Specification and IBM*'s Serial Data Link Control protocol for the physical and data link levels of the BITBUS interface.

BITBUS™ Physical Interface

Implementation of the electrical interface to BITBUS requires external hardware. Specifically, an EIA Standard RS-485 driver and transceiver and an optional clock source for the synchronous mode of operation. A self clocked mode of operation is also available. Different modes of operation facilitate a variety of performance/distance options as noted in Table 4. Figure 7 illustrates the BEM's BITBUS interface hardware requirements.

Table 4. BITBUS™ Interconnect Modes of Operation

	Speed Kb/s	Max. Dist Between Repeaters M/ft	Max # Nodes Between Repeaters	Max # Repeaters
Synchronous	2400	30/100	28	0
Self-Clocked	375 62.5	300/1000 1200/4000	28 28	2 10

BITBUS™ Data Link Service

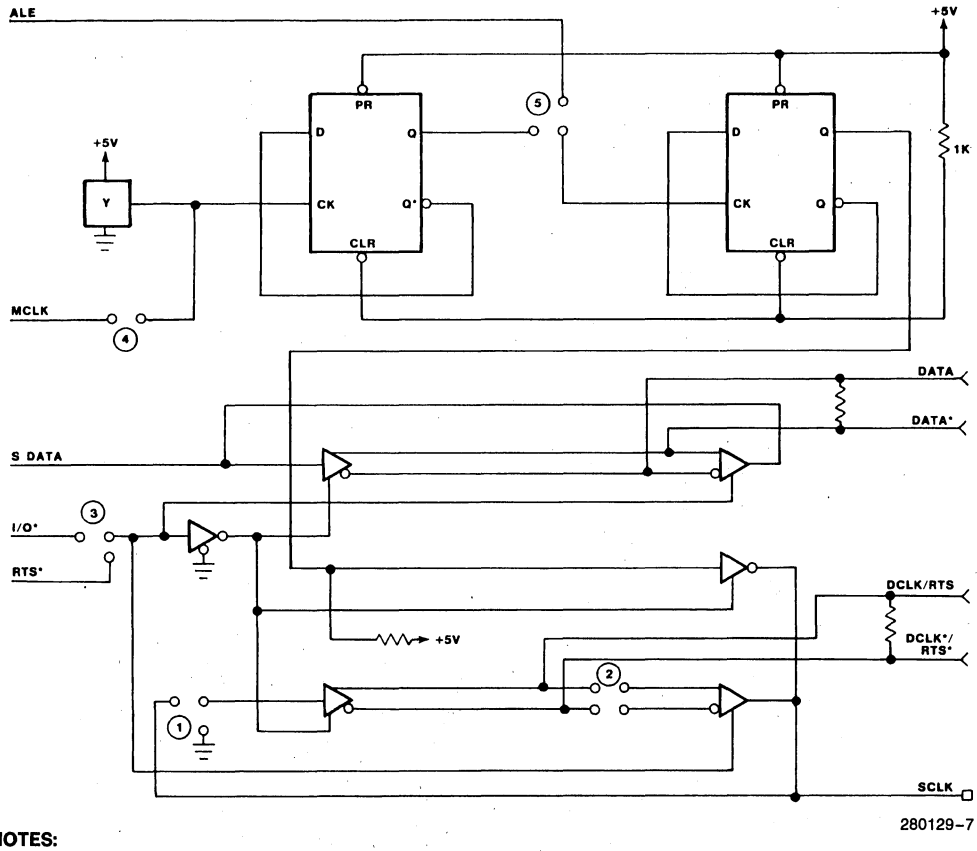
The 8044's serial interface unit (SIU) implements a majority of the data link interface, a subset of IBM's Serial Data Link Protocol (SDLC), in hardware resulting in a significant performance advantage compared with multichip solutions. Multichip solutions require both hardware and software glue that degrade performance, decrease reliability, and increase cost. This portion of the BITBUS interface requires no user involvement for execution.

For a detailed discussion of the protocol executed by the BITBUS data link service refer to "The BITBUS Interconnect Serial Control Bus Specification". A basic subset of SDLC with the REJECT option is implemented. The standard frame format transferred across the BITBUS is shown in Figure 8. The information field carries the BITBUS message.

BITBUS™ Transaction Control Service

For added reliability, the BITBUS interface incorporates error checking at the message level in addition to the imbedded error checking provided by SDLC at the data link level. The message control interface defines the format and function of messages transmitted in frames across the BITBUS bus. (Figure 9)

The transaction protocol requires that for every order message transmitted across the bus a reply message must be transmitted in return. Error types and error detection mechanisms are also designated by this interface.



NOTES:
1. Connect to ground for self-clocked mode and SCLK for synchronous mode.
2. Remove for self-clocked operation with repeater(s).
3. Connect to RTS* for synchronous mode or I/O* for self-clocked mode.
4. Selects MCLK as serial clock source.
5. Selects ALE or oscillator as serial clock source.

Figure 7. BITBUS™ Interface Hardware Requirements

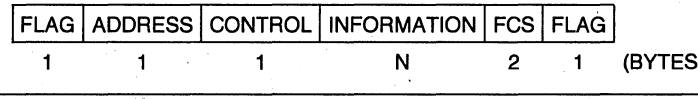


Figure 8. BITBUS™ Frame Format

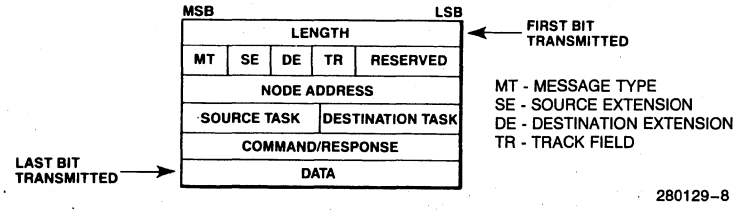


Figure 9. BITBUS™ Message Format

BITBUS™ Interface Configuration

The BEM's firmware also simplifies designation of the bus mode of operation (Speed/distance option) as well as the node address, memory configuration and parallel interface parameters by reading two external locations for this information as shown in Figure 10. The designer no longer needs to directly manipulate the 8044's serial mode register (SMD), status/command register (STS), and send/receive counter register (NSNR). These two 8-bit locations are derived by multiplexing the 8044's port 0 address lines AD0–AD7.

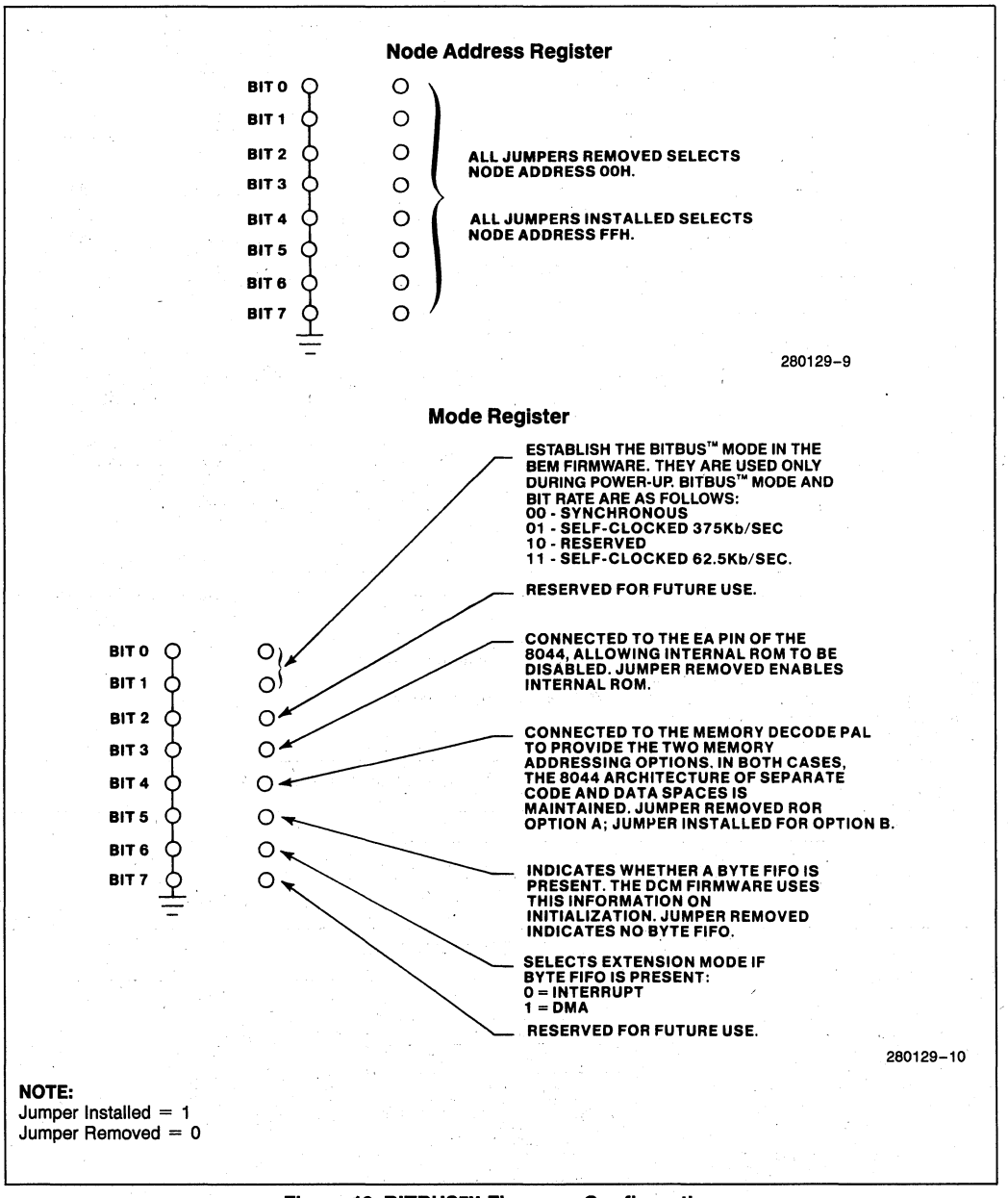


Figure 10. BITBUS™ Firmware Configuration

Extended Firmware Services

PARALLEL COMMUNICATION INTERFACE EXTENDS DISTRIBUTED CONTROL CAPABILITY

The BEM's firmware also includes a parallel interface for expanding the capabilities of distributed systems. For example, this interface allows other processors to be employed in BITBUS systems if more processing power is required as shown in Figure 11. This interface provides the means for connection to other buses: iSBX bus, STD bus, IBM's PC bus.

The interface consists of a byte-FIFO queue through which BITBUS messages can be passd via embedded communications firmware. From the BEM's perspective the user simply designates the correct routing information in the BITBUS message header and the message is directed to the communications firmware and passed through the parallel interface. One example of an implementation that uses this interface is the iSBX BITBUS Controller MULTIMODULE Board via the iSBX bus.

Parallel Interface Hardware

To implement the Parallel Interface, the user must provide hardware for two FIFOs (one byte minimum) in external data memory, and control signals to/from the 8044's Pins: INT0 (P3.2), INT1 (P3.3), and P1.2. Key hardware elements required are: decoder for the registers' external addresses, temporary storage for bytes passing through the interface, a way to designate bytes as command or data, and a means to generate the control signals. FIFO's must be used to move the data through the interface although the depth of the FIFO need not exceed one byte.

Interface hardware must also be provided for the "extension" side of the interface. Implementation of this hardware is left to the user with the restriction that the operation of the BEM side remains independent.

Parallel Byte Stream and Message Protocol

The two byte registers (FIFOs) provide the path for bytes to move through the parallel interface. Bytes are read or written from the registers designated: FIFO Data Byte (FF00H) and FIFO Command Byte (FF01H). INT0, INT1 and P1.2 provide control signals to the firmware for moving the bytes through the registers. These signals are referred to as the Parallel Interface Control Bits:

Pin	Function	Internal Bit Address
INT0	RFNF	B3H
INT1	TFNE	B2H
P1.2	TCMD	92H

The hardware uses RFNF to control the output of bytes from the BEM. RFNF is set when the FIFO Data or FIFO Command Byte Registers can receive information. RFNF remains clear when the FIFO Data or Command Bytes are not available. Transmission of a BITBUS message across the parallel interface consists of successively outputing message bytes to the FIFO Data Byte Register until all bytes are sent. The firmware then writes a value of 0 to the Command Byte register indicating all the message bytes have been sent. The first data byte in the message indicates the number of bytes in the message.

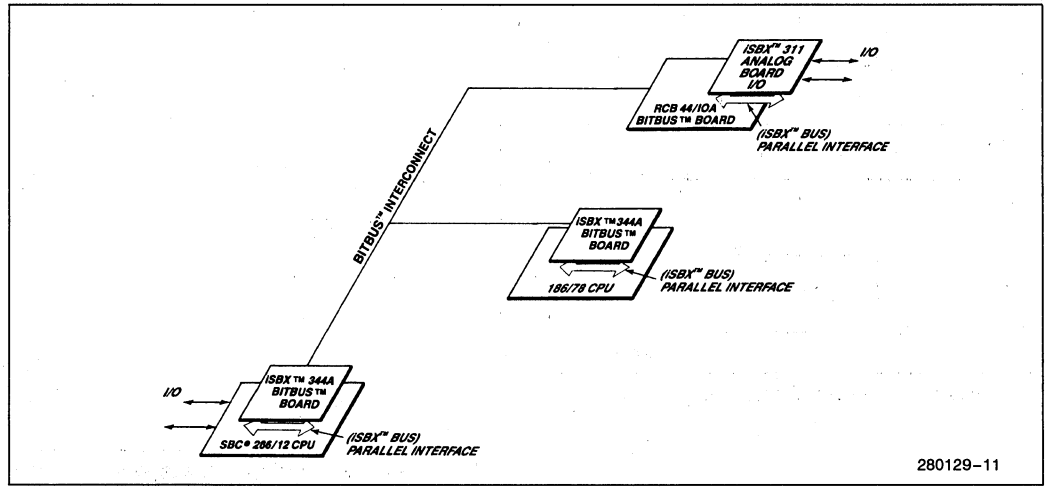


Figure 11. Extending the Capability of BITBUS™ System with the Parallel Communications Interface

TFNE controls the input of data bytes to the BEM. This bit is set when bytes are available for reading. When no bytes are available this bit is clear. TCMD indicates whether the next byte read is a Data Byte or Command Byte. BITBUS messages are received by inputing data bytes until a command byte is received. Data bytes are read from the FIFO Data Byte Register. Command Bytes are read from the FIFO Command Byte Register.

Figure 12 provides one example of a Byte FIFO Interface. This specific example illustrates the interface provided on the iSBX 344A BITBUS Controller MULTIMODULE Board. Figure 13 shows transmission of bytes from the BEM across the parallel interface. Figure 14 shows transmission of bytes to the BEM.

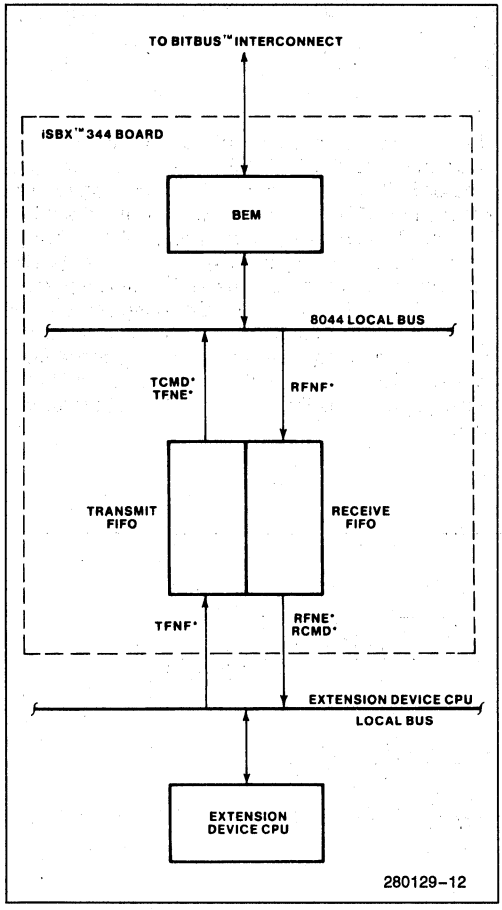


Figure 12. Byte FIFO Interface Example

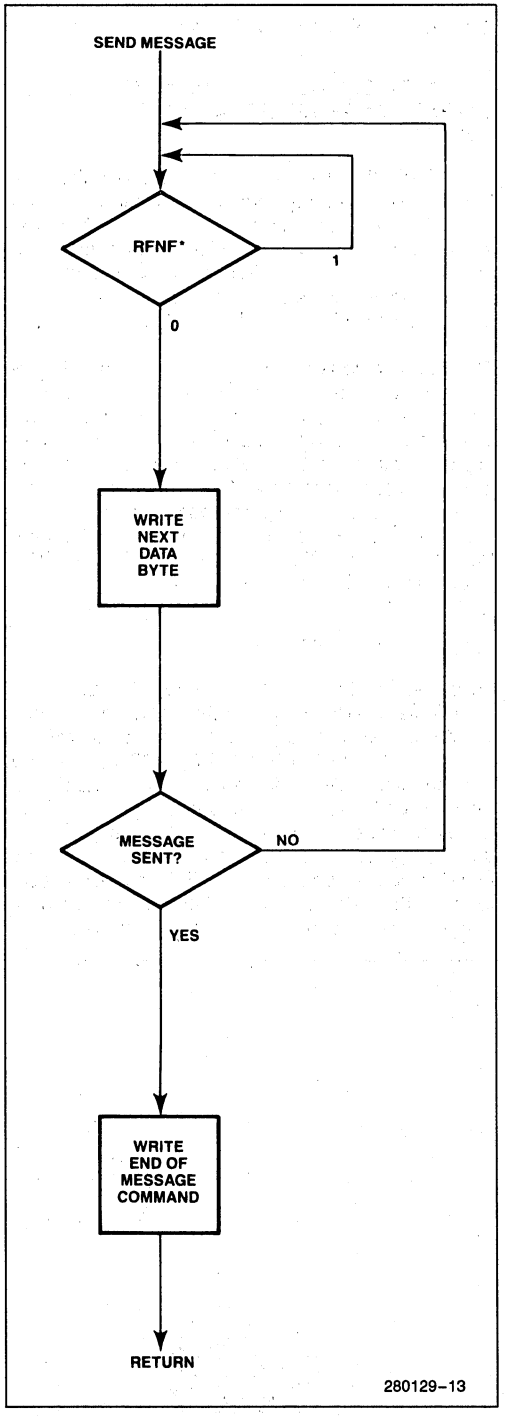


Figure 13. Transmitting a Message from BEM

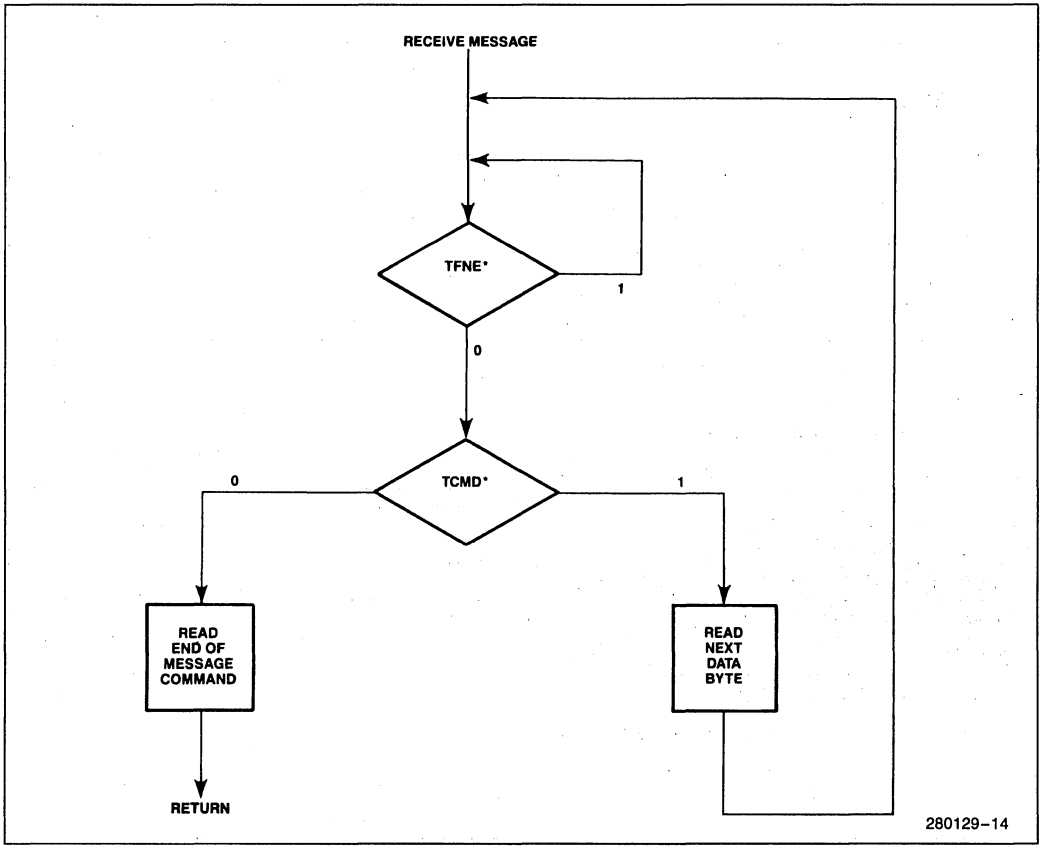


Figure 14. Transmitting a Message to BEM

USER SOFTWARE SERVICES

Multitasking, I/O Access and Control Capabilities

The Extended firmware environment of the BEM provides a multitasking facility via the iDCX 51 Real-time, Multitasking Executive. Operating system calls are listed in Table 5. Other services provided by the Executive: interrupt handling, task scheduling, and intertask communication facilitate smooth development of distributed systems. In addition to the Executive's intertask communication service provided by the RQSENDMESSAGE call, other portions of the firmware extend the communication capability across the parallel and BITBUS interfaces. This embedded communications firmware greatly simplifies and speeds sending messages to different microcontrollers or microprocessors in the system.

To further ease the development of distributed control applications, a pre-defined task (Remote Access and Control Task) provides the means of invoking iDCX 51 Executive services, or accessing I/O and memory from tasks on other devices. The Remote Access and Control functions execute under the iDCX 51 Executive as Task 0. Figure 13 illustrates this concept in a BITBUS system. Table 6 shows the functions provided by the RAC task. All I/O command accesses are memory mapped to locations 0FF00H to 0FFFFH in the BEM's external memory.

Table 5. iDCX™ 51 Calls

Call Name	Description
TASK MANAGEMENT CALLS	
RQ$CREATE$TASK	Create and schedule a new task.
RQ$DELETE$TASK	Delete specified task from system.
RQGETFUNCTION$IDS	Obtain the function IDs of tasks currently in system.
INTERTASK COMMUNICATION CALLS	
RQ$ALLOCATE	Obtain a message buffer from the system buffer pool.
RQ$DEALLOCATE	Return a message buffer to the system buffer pool.
RQ$SEND$MESSAGE	Send a message to specified task.
RQ$WAIT	Wait for a message event.
MEMORY MANAGEMENT CALLS	
RQGETMEM	Get available system memory pool memory.
RQ$RELEASE$MEM	Release system memory pool memory.
INTERRUPT MANAGEMENT CALLS	
RQ$DISABLE$INTERRUPT	Temporarily disable an interrupt.
RQ$ENABLE$INTERRUPT	Re-enable an interrupt.
RQ$WAIT	Wait for an interrupt event.
TIMER MANAGEMENT CALLS	
RQSETINTERVAL	Establish a time interval.
RQ$WAIT	Wait for an interval event.

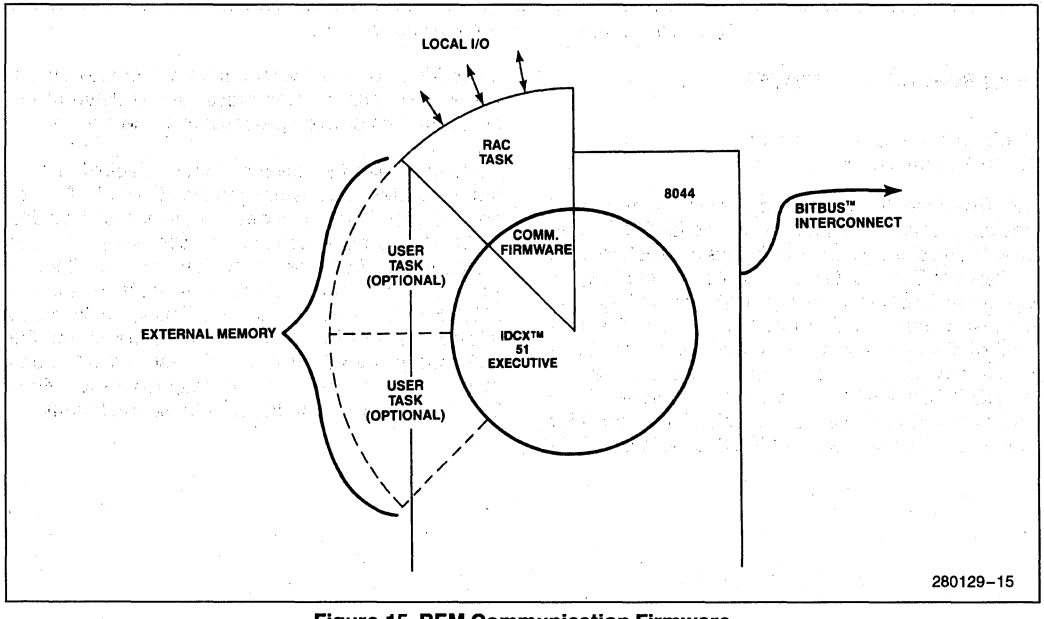


Figure 15. BEM Communication Firmware

Table 6. RAC Functions

Name	Function
RESET_STATION	Perform a software reset.
CREATE_TASK	Perform an RQ$CREATE$TASK system call.
DELETE_TASK	Perform an RQ$DELETE$TASK system call.
GET_FUNCTION_ID	Perform an RQGETFUNCTION$IDS call.
RAC_PROTECT	Suspend or resume RAC services.
READ_IO	Return values from specified I/O ports.
WRITE_IO	Write to the specified I/O ports.
UPDATE_IO	Update the specified I/O ports.
UPLOAD_MEMORY	Return the values in specified memory area.
DOWNLOAD_MEMORY	Write values to specified memory area.
OR_I/O	OR values into specified I/O ports.
AND_I/O	AND values into specified I/O ports.
XOR_I/O	XOR values into specified I/O ports.
READ_INTERNAL	Read values at specified internal RAM areas.
WRITE_INTERNAL	Write values to specified internal RAM areas.
NODE_INFO	Return device related information.
OFFLINE	Set node offline.
UPLOAD_CODE	Read values from code memory space.
DOWNLOAD_CODE	Write values to specified EEPROM memory.

NOTES:
Internal memory locations are included in the 192 bytes of data RAM provided in the microcontroller. External memory refers memory outside the microcontroller—the 28-pin sockets of the iSBX 344A module and the iRCB 44/10A and iRCB 44/20A boards. Each RAC Access Function may refer to 1, 2, 3, 4, 5, or 6 individual I/O or memory locations in a single command.

In addition to allowing creation and deletion of tasks on remote system nodes, the RAC functions allow memory upload and download. This feature eases programming changes in distributed systems and enhances overall system flexibility. Diagnostics can also be downloaded to remote nodes to facilitate system debug.

Another feature optimized for distributed control environments is the GET FUNCTION IDS service. The function ID capability provides the user with the ability to identify specific tasks by function rather than node address and task number. This constant identifier facility remains valid even if functions are moved to different physical locations, eg. another system node.

Aside from the iDCX 51 Executive system calls the user interfaces to the BEM through the task initialization interface; the Initial Task Descriptor. The first user task descriptor must be located at location 0FFF0H in external memory code space so that on power up user code may be automatically detected.

The Initial Task Descriptor (ITD) allows the user to specify the original attributes of a task. Table 7 shows the ITD task structure.

Table 7. ITD Structure

Pattern	Word	value identifying an ITD: "AA55H"
Initial PC	Word	address of first task instruction
Stack-Length	Byte	# bytes of system RAM for tasks stack
Function ID	Byte	value 1-255 associates task w/function
Register Bank	Bit(4)	assigns one register bank to task
Priority	Bit(4)	task priority level
Interrupt Vector	Word	specifies interrupt associated w/task
Next ID	Word	address of the next ITD in linked-list

ABSOLUTE MAXIMUM RATINGS*

Ambient Temperature Under Bias .....0 to 70°C
Storage Temperature .....−65°C to +150°C
Voltage on Any Pin with Respect to Ground (V_{SS}) .....−0.5V to +7V
Power Dissipation .....2 Watts

**Notice: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

D.C. CHARACTERISTICS T_A = 0°C to 70°C, V_{CC} = 5V ±10%, V_{SS} = 0V

Symbol	Parameter	Min	Max	Units	Test Conditions
VIL	Input Low Voltage	−0.5	0.8	V	
VIH	Input High Voltage (Except RST and XTAL2)	2.0	V_{CC} + 0.5	V	
VIH1	Input High Voltage to PST For Reset, XTAL2	2.5	V_{CC} + 0.5		XTAL1 = V_{SS}
VOL	Output Low Voltage Ports 1, 2, 3 (Note 1)		0.45	V	I_{OL} = 1.6 mA
VOL1	Output Low Voltage Port 0, ALE, \PSEN (Note 1)		0.45	V	I_{OL} = 3.2 mA
VOH	Output High Voltage Ports 1, 2, 3	2.4		V	I_{OH} = −80 μA
VOH1	Output High Voltage Port 0, ALE, \PSEN	2.4		V	I_{OH} = −400 μA
IIL	Logical 0 Input Current Ports 1, 2, 3		−500	μA	XTAL1 at V_{SS} Vin = 0.45V
IIH1	Input High Current to RST/VPD For Reset		500	μA	Vin < V_{CC} − 1.5V
ILI	Input Leakage Current to Port 0, \EA		±10	μA	0.45V<Vin<V_{CC}
ICC	Power Supply Current		170	mA	All Outputs Disconnected, EA = V_{CC}
CIO	Capacitance of I/O Buffer		10	pF	fc = 1 MHz
IIL2	Logical 0 Input Current XTAL2		−3.6	mA	XTAL1 at V_{SS} Vin = 0.45V

NOTE:
1. Capacitive loading on Ports 0 and 2 may cause spurious noise pulses to be superimposed on the VOLs of ALE and Ports 1 and 3. The noise is due to external bus capacitance discharging into the Port 0 and Port 2 pins when these pins make 1-to-0 transitions during bus operations. In the worst cases (capacitive loading > 100 pF), the noise pulse on the ALE line may exceed 0.8V. In such cases it may be desirable to qualify ALE with a Schmitt Trigger, or use an address latch with a Schmitt Trigger STROBE input.

A.C. CHARACTERISTICS T_A to 0°C to 70°C, V_{CC} = 5V ±10%, V_{SS} = 0V, C_L for Port 0, ALE and $\overline{PSEN}$ Outputs = 100 pF; C_L for All Other Outputs = 80 pF

PROGRAM MEMORY

Symbol	Parameter	12 MHz Clock			Variable Clock 1/TCLCL = 3.5 MHz to 12 MHz		
		Min	Max	Units	Min	Max	Units
TLHLL	ALE Pulse Width	127		ns	2TCLCL−40		ns
TAVLL	Address Setup to ALE	43		ns	TCLCL−40		ns
TLLAX(1)	Address Hold after ALE	48		ns	TCLCL−35		ns
TLLIV	ALE to Valid Instr in		233	ns		4TCLCL−100	ns
TLLPL	ALE to $\overline{PSEN}$	58		ns	TCLCL−25		ns
TPLPH	$\overline{PSEN}$ Pulse Width	215		ns	3TCLCL−35		ns
TPLIV	$\overline{PSEN}$ to Valid Instr in		125	ns		3TCLCL−125	ns
TPXIX	Input Instr Hold after $\overline{PSEN}$	0		ns	0		ns
TPXIZ(2)	Input Instr Float after $\overline{PSEN}$		63	ns		TCLCL−20	ns
TPXAV(2)	Address Valid after $\overline{PSEN}$	75		ns	TCLCL−8		ns
TAVIV	Address to Valid Instr in		302	ns		5TCLCL−115	ns
TAZPL	Address Float to $\overline{PSEN}$	−25		ns	−25		ns

NOTES:
1. TLLAX for access to program memory is different from TLLAX for data memory.
2. Interfacing RUPI-44 devices with float times up to 75 ns is permissible. This limited bus contention will not cause any damage to Port 0 drivers.

EXTERNAL DATA MEMORY

Symbol	Parameter	12 MHz Clock			Variable Clock 1/TCLCL = 3.5 MHz to 12 MHz		
		Min	Max	Units	Min	Max	Units
TRLRH	$\overline{RD}$ Pulse Width	400		ns	6TCLCL−100		ns
TWLWH	$\overline{WR}$ Pulse Width	400		ns	6TCLCL−100		ns
TLLAX(1)	Address Hold after ALE	48		ns	TCLCL−35		
TRLDV	$\overline{RD}$ to Valid Data in		252	ns		5TCLCL−165	ns
TRHDX	Data Hold after $\overline{RD}$	0		ns	0		ns
TRHDZ	Data Float after $\overline{RD}$		97	ns		2TCLCL−70	ns
TLLDV	ALE to Valid Data in		517	ns		8TCLCL−150	ns
TAVDV	Address to Valid Data in		585	ns		9TCLCL−165	ns
TLLWL	ALE to $\overline{WR}$ or $\overline{RD}$	200	300	ns	3TCLCL−50	3TCLCL+50	ns
TAVWL	Address to $\overline{WR}$ or $\overline{RD}$	203		ns	4TCLCL−130		ns
TWHLH	$\overline{WR}$ or $\overline{RD}$ High to ALE High	43	123	ns	TCLCL−40	TCLCL+40	ns
TQVWX	Data Valid to $\overline{WR}$ Transition	23		ns	TCLCL−60		ns
TQVWH	Data Setup before $\overline{WR}$	433		ns	7TCLCL−150		ns
TWHQX	Data Hold after $\overline{WR}$	33		ns	TCLCL−50		ns
TRLAZ	RD Low to Address Float		25	ns		25	ns

NOTE:
1. TLLAX for access to program memory is different from TLLAX for access data memory.

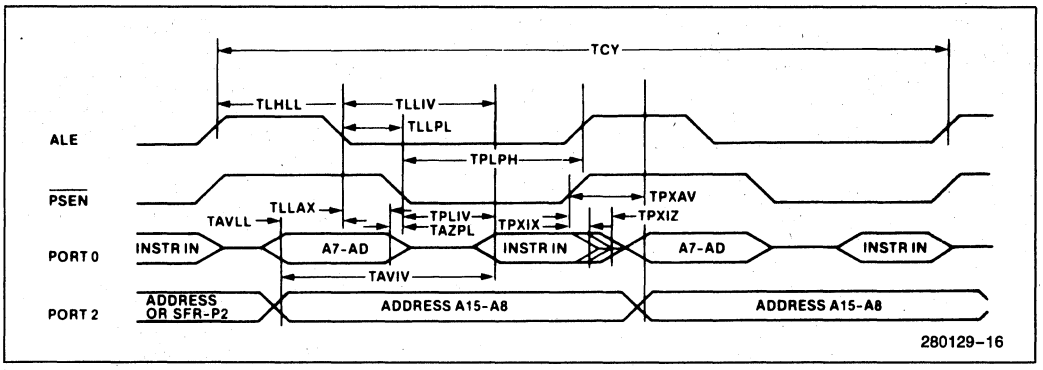
SERIAL INTERFACE

Symbol	Parameter	Min	Max	Units
TDCY	Data Clock	420		ns
TDCL	Data Clock Low	180		ns
TDCH	Data Clock High	100		ns
tTD	Transmit Data Delay		140	ns
tDSS	Data Setup Time	40		ns
tDHS	Data Hold Time	40		ns

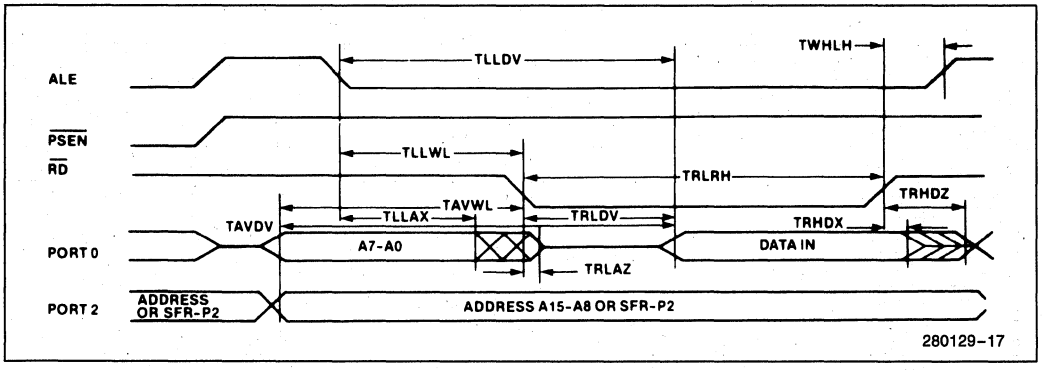
WAVEFORMS

Memory Access

PROGRAM MEMORY READ CYCLE

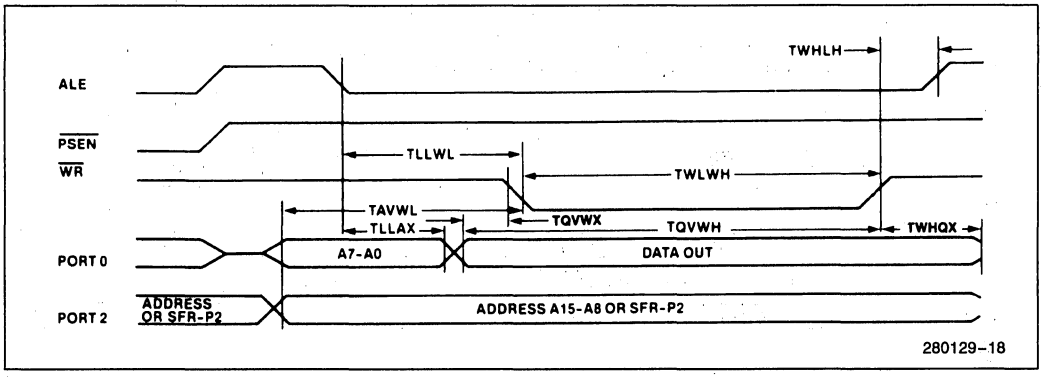


DATA MEMORY READ CYCLE



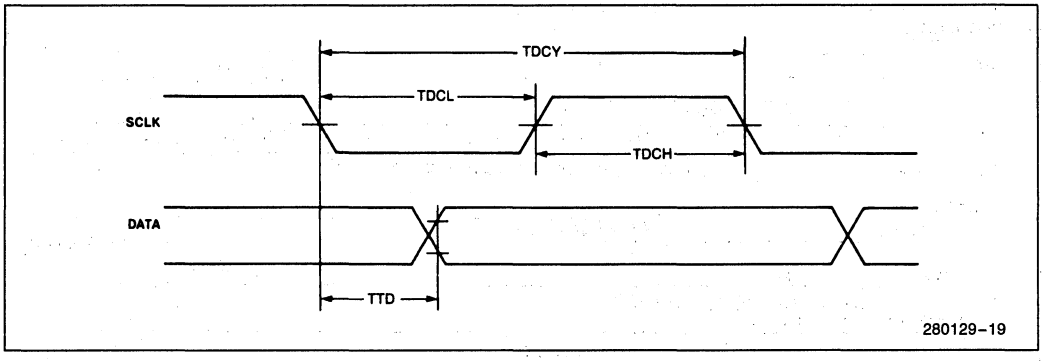
WAVEFORMS (Continued)

DATA MEMORY WRITE CYCLE

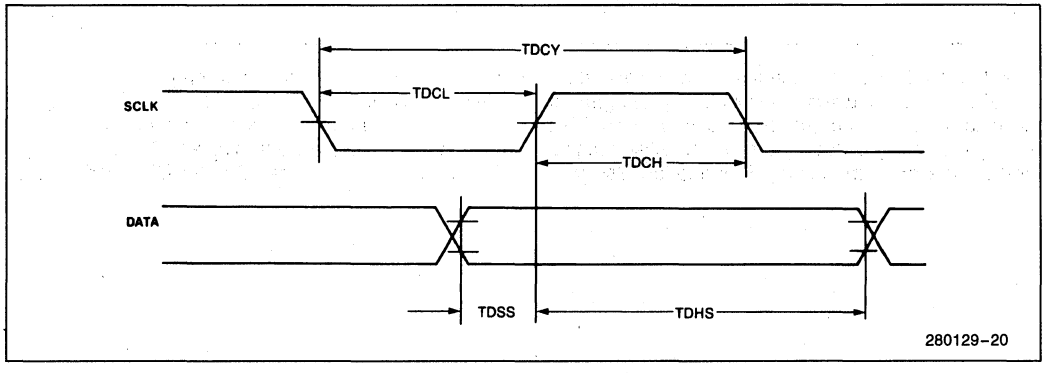


SERIAL I/O WAVEFORMS

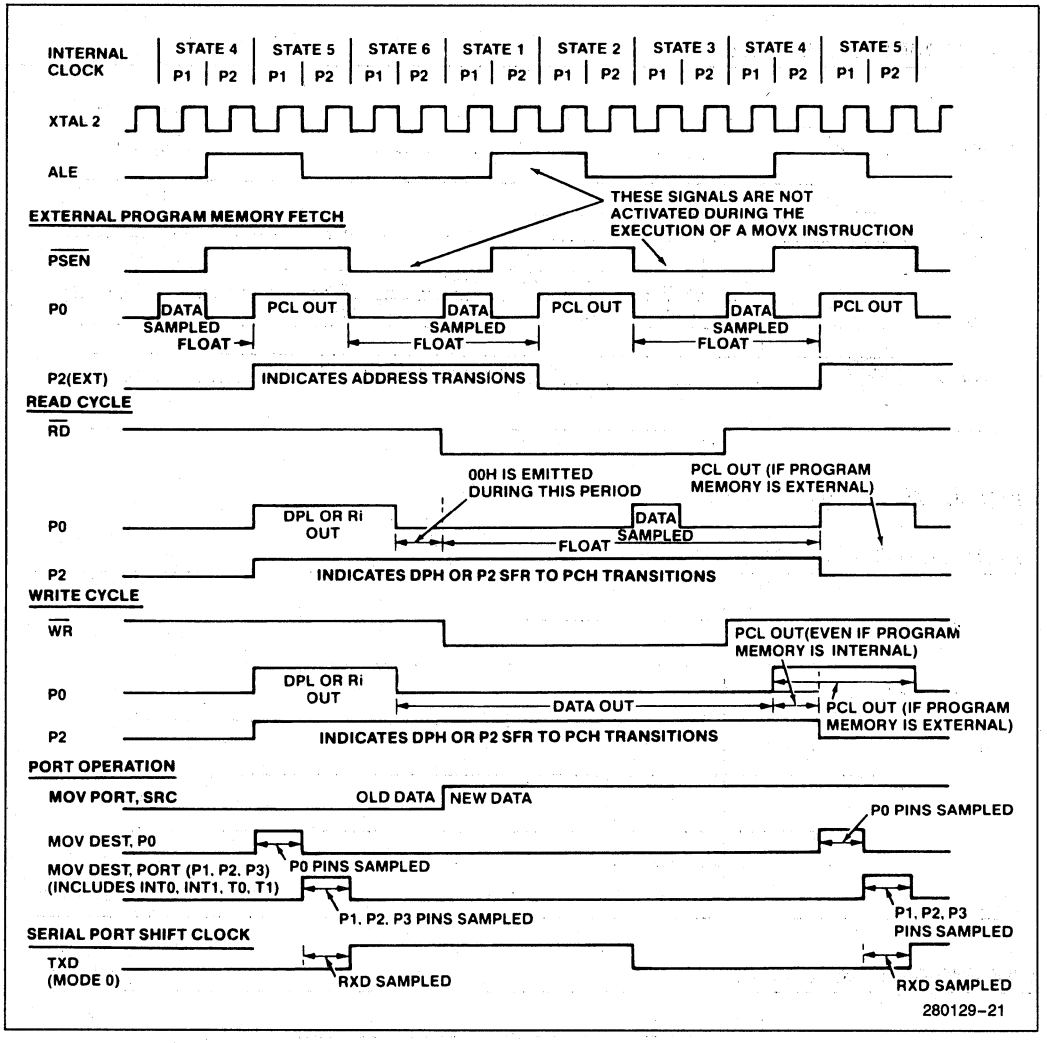
SYNCHRONOUS DATA TRANSMISSION



SYNCHRONOUS DATA RECEPTION



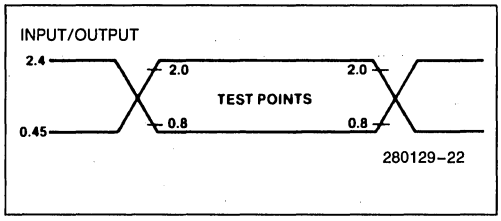
CLOCK WAVEFORMS

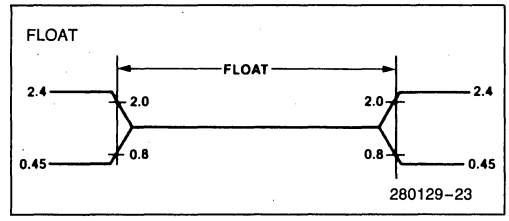


280129-21

This diagram indicates when signals are clocked internally. The time it takes the signals to propagate to the pins, however, ranges from 25 to 125 ns. This propagation delay is dependent on variables such as temperature and pin loading. Propagation also varies from output to output and component to component. Typically though, (T_A = 25°C, fully loaded) RD and WR propagation delays are approximately 50 ns. The other signals are typically 85 ns. Propagation delays are incorporated in the AC specifications.

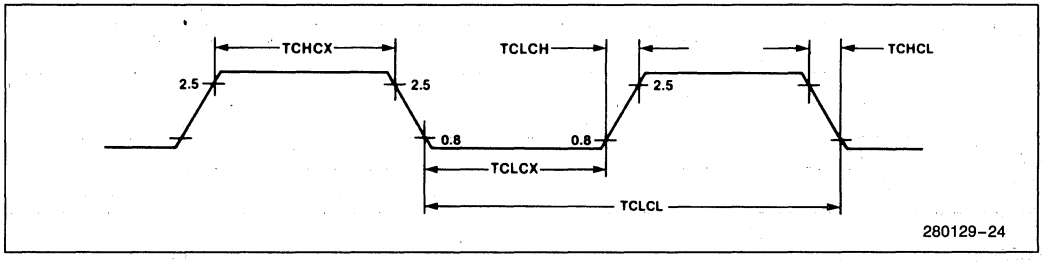
A.C. TESTING INPUT, OUTPUT, FLOAT WAVEFORMS





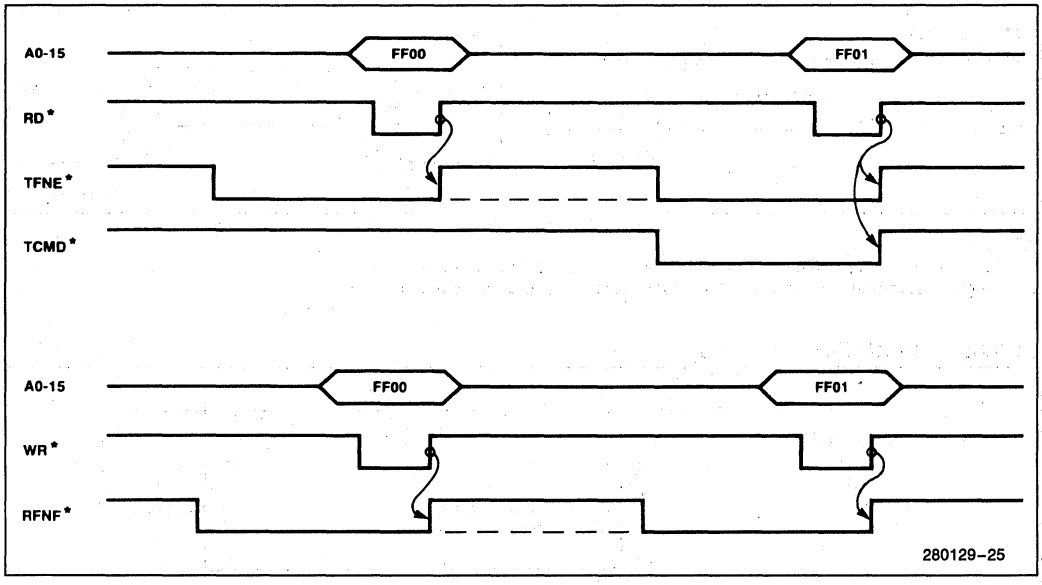
NOTES:
1. A.C. testing inputs are driven at 2.4V for a logic "1" and 0.45V for a logic "0".
2. Timing measurements are made at 2.0V for a logic "1" and 0.8V for a logic "0".

EXTERNAL CLOCK DRIVE XTAL2



Symbol	Parameter	Variable Clock Freq = 3.5 MHz to 12 MHz		Units
		Min	Max	
TCLCL	Oscillator Period	83.3	285.7	ns
TCHCX	High Time	30	TCLCL−TCLCX	ns
TCLCX	Low Time	20	TCLCL−TCHCX	ns
TCLCH	Rise Time		20	ns
TCHCL	Fall Time		20	ns

BEM PARALLEL INTERFACE LOGIC TIMING



SPECIFICATIONS

Package: 40 pin DIP, 44 pin PLCC
Process: +5V, silicon gate HMOSII

Related Documents (Not Supplied)

Order Number

146312-001— Guide to Using the Distributed Control Modules

231663-002— 8044AH/8344AH/8744H Data Sheet

210941-002 — OEM System Handbook

210918-006 — Embedded Controller Handbook

231166-001 — VLSI Solutions for Distributed Control Applications

ORDERING INFORMATION

Part Number	Description
P,N8044AH,R 0112	BITBUS Enhanced Microcontroller

8044AH/8344AH/8744H
HIGH PERFORMANCE 8-BIT MICROCONTROLLER WITH ON-CHIP SERIAL COMMUNICATION CONTROLLER

- **8044AH—Includes Factory Mask Programmable ROM**
- **8344AH—For Use with External Program Memory**
- **8744H—Includes User Programmable/Eraseable EPROM**

8051 MICROCONTROLLER CORE

- **Optimized for Real Time Control 12 MHz Clock, Priority Interrupts, 32 Programmable I/O Lines, Two 16-bit Timer/Counters**
- **Boolean Processor**
- **4K × 8 ROM, 192 × 8 RAM**
- **64K Accessible External Program Memory**
- **64K Accessible External Data Memory**
- **4 μs Multiply and Divide**

SERIAL INTERFACE UNIT (SIU)

- **Serial Communication Processor that Operates Concurrently to CPU**
- **2.4 Mbps Maximum Data Rate**
- **375 Kbps using On-Chip Phase Locked Loop**
- **Communication Software in Silicon:**
  - **Complete Data Link Functions**
  - **Automatic Station Response**
- **Operates as an SDLC Primary or Secondary Station**

The RUPI-44 family integrates a high performance 8-bit Microcontroller, the Intel 8051 Core, with an Intelligent/high performance HDLC/SDLC serial communication controller, called the Serial Interface Unit (SIU). See Figure 1. This dual architecture allows complex control and high speed data communication functions to be realized cost effectively.

Specifically, the 8044's Microcontroller features: 4K byte On-Chip program memory space; 32 I/O lines; two 16-bit timer/event counters; a 5-source; 2-level interrupt structure; a full duplex serial channel; a Boolean processor; and on-chip oscillator and clock circuitry. Standard TTL and most byte-oriented MCS-80 and MCS-85 peripherals can be used for I/O amd memory expansion.

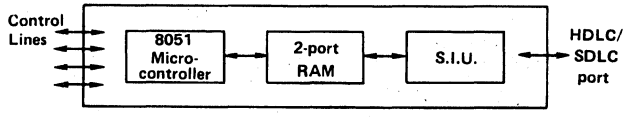
The Serial Interface Unit (SIU) manages the interface to a high speed serial link. The SIU offloads the On-Chip 8051 Microcontroller of communication tasks, thereby freeing the CPU to concentrate on real time control tasks.

The RUPI-44 family consists of the 8044, 8744, and 8344. All three devices are identical except in respect of on-chip program memory. The 8044 contains 4K bytes of mask-programmable ROM. User programmable EPROM replaces ROM in the 8744. The 8344 addresses all program memory externally.

The RUPI-44 devices are fabricated with Intel's reliable +5 volt, silicon-gate HMOSII technology and packaged in a 40-pin DIP.

The 8744H is available in a hermetically sealed, ceramic, 40-lead dual in-line package which includes a window that allows for EPROM erasure when exposed to ultraviolet light (See Erasure Characteristics). During normal operation, ambient light may adversely affect the functionality of the chip. Therefore applications which expose the 8744H to ambient light may require an opaque label over the window.

8044's Dual Controller Architecture



231663-1

Figure 1. Dual Controller Architecture

October 1987
Order Number: 231663-004

Table 1. RUPI™-44 Family Pin Description

VSS

Circuit ground potential.

VCC

+5V power supply during operation and program verification.

PORT 0

Port 0 is an 8-bit open drain bidirectional I/O port. It is also the multiplexed low-order address and data bus when using external memory. It is used for data output during program verification. Port 0 can sink/source eight LS TTL loads (six in 8744).

PORT 1

Port 1 is an 8-bit quasi-bidirectional I/O port. It is used for the low-order address byte during program verification. Port 1 can sink/source four LS TTL loads.

In non-loop mode two of the I/O lines serve alternate functions:

— $\overline{RTS}$ (P1.6). Request-to-Send output. A low indicates that the RUPI-44 is ready to transmit.

— $\overline{CTS}$ (P1.7) Clear-to-Send input. A low indicates that a receiving station is ready to receive.

PORT 2

Port 2 is an 8-bit quasi-bidirection I/O port. It also emits the high-order address byte when accessing external memory. It is used for the high-order address and the control signals during program verification. Port 2 can sink/source four LS TTL loads.

PORT 3

Port 3 is an 8-bit quasi-bidirectional I/O port. It also contains the interrupt, timer, serial port and RD and WR pins that are used by various options. The output latch corresponding to a secondary function must be programmed to a one (1) for that function to operate. Port 3 can sink/source four LS LTT loads.

In addition to I/O, some of the pins also serve alternate functions as follows:

— I/$\overline{O}$ RxD (P3.0). In point-to-point or multipoint configurations, this pin controls the direction of pin P3.1. Serves as Receive Data input in loop and diagnostic modes.

— DATA TxD (P3.1) In point-to-point or multipoint configurations, this pin functions as data input/output. In loop mode, it serves as transmit pin. A '0' written to this pin enables diagnostic mode.

— $\overline{INT0}$ (P3.2). Interrupt 0 input or gate control input for counter 0.

— $\overline{INT1}$ (P3.3). Interrupt 1 input or gate control input for counter 1.

— TO (P3.4). Input to counter 0.

— SCLK T1 (P3.5). In addition to I/O, this pin provides input to counter 1 or serves as SCLK (serial clock) input.

— $\overline{WR}$ (P3.6). The write control signal latches the data byte from Port 0 into the External Data Memory.

— $\overline{RD}$ (P3.7). The read control signal enables External Data Memory to Port 0.

RST

A high on this pin for two machine cycles while the oscillator is running resets the device. A small external pulldown resistor ($\approx$8.2KΩ) from RST to V_{SS} permits power-on reset when a capacitor ($\approx 10\mu f$) is also connected from this pin to V_{CC}.

ALE/$\overline{PROG}$

Provides Address Latch Enable output used for latching the address into external memory during normal operation. It is activated every six oscillator periods except during an external data memory access. It also receives the program pulse input for programming the EPROM version.

$\overline{PSEN}$

The Program Store Enable output is a control signal that enables the external Program Memory to the bus during external fetch operations. It is activated every six oscillator periods, except during external data memory accesses. Remains high during internal program execution.

$\overline{EA}$/VPP

When held at a TTL high level, the RUPI-44 executes instructions from the internal ROM when the PC is less than 4096. When held at a TTL low level, the RUPI-44 fetches all instructions from external Program Memory. The pin also receives the 21V EPROM programming supply voltage on the 8744.

Table 1. RUPI™-44 Family Pin Description (Continued)

XTAL 1	XTAL 2
Input to the oscillator's high gain amplifier. Required when a crystal is used. Connect to VSS when external source is used on XTAL 2.	Output from the oscillator's amplifier. Input to the internal timing circuitry. A crystal or external source can be used.

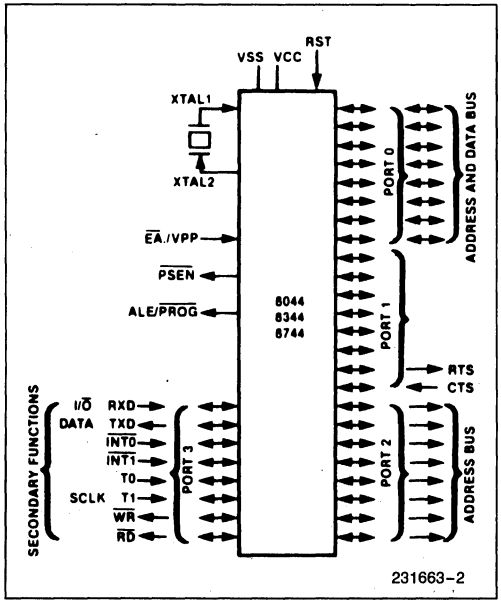


Figure 2. Logic Symbol

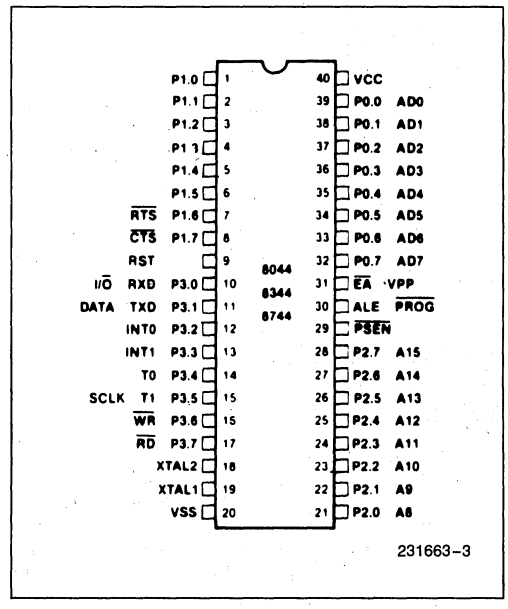


Figure 3A. DIP Pin Configuration

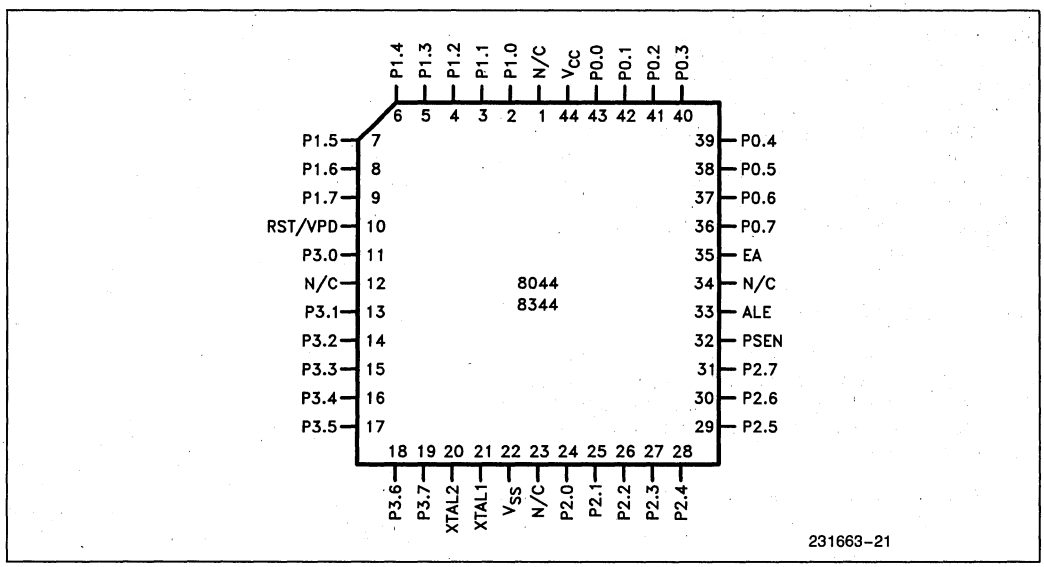


Figure 3B. PLCC Pin Configuration

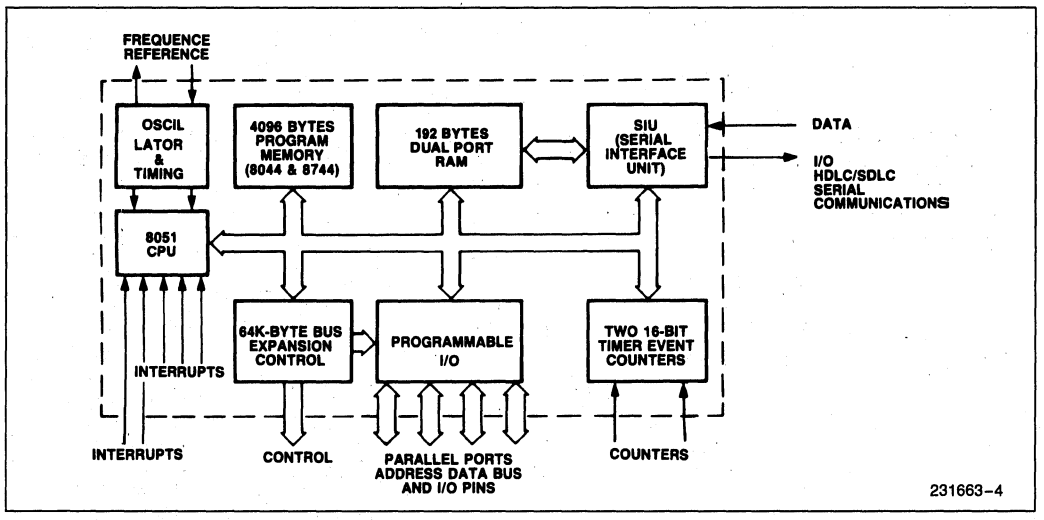


Figure 4. Block Diagram

FUNCTIONAL DESCRIPTION

General

The 8044 integrates the powerful 8051 microcontroller with an intelligent Serial Communication Controller to provide a single-chip solution which will efficiently implement a distributed processing or distributed control system. The microcontroller is a self-sufficient unit containing ROM, RAM, ALU, and its own peripherals. The 8044's architecture and instruction set are identical to the 8051's. The 8044 replaces the 8051's serial interface with an intelligent SDLC/HDLC Serial Interface Unit (SIU). 64 more bytes of RAM have been added to the 8051 RAM array. The SIU can communicate at bit rates up to 2.4 M bps. The SIU works concurrently with the Microcontroller so that there is no throughput loss in either unit. Since the SIU possesses its own intelligence, the CPU is off-loaded from many of the communications tasks, thus dedicating more of its computing power to controlling local peripherals or some external process.

The Microcontroller

The microcontroller is a stand-alone high-performance single-chip computer intended for use in sophisticated real-time application such as instrumentation, industrial control, and intelligent computer peripherals.

The major features of the microcontroller are:

- 8-bit CPU
- on-chip oscillator
- 4K bytes of ROM
- 192 bytes of RAM
- 32 I/O lines
- 64K address space for external Data Memory
- 64K address space for external Program Memory
- two fully programmable 16-bit timer/counters
- a five-source interrupt structure with two priority levels
- bit addressability for Boolean processing

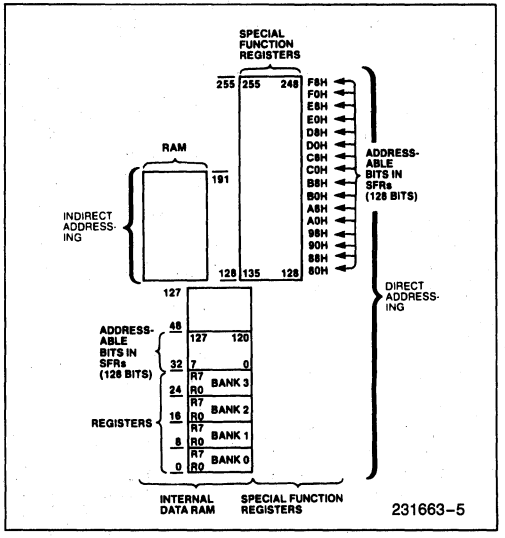


Figure 5. Internal Data Memory Address Space

- 1 μs instruction cycle time for 60% of the instructions 2 μs instruction cycle time for 40% of the instructions
- 4 μs cycle time for 8 by 8 bit unsigned Multiply/Divide

INTERNAL DATA MEMORY

Functionally the Internal Data Memory is the most flexible of the address spaces. The Internal Data Memory space is subdivided into a 256-byte Internal Data RAM address space and a 128-bit Special Function Register address space as shown in Figure 5.

The Internal Data RAM address space is 0 to 255. Four 8-Register Banks occupy locations 0 through 31. The stack can be located anywhere in the Internal Data RAM address space. In addition, 128 bit locations of the on-chip RAM are accessible through Direct Addressing. These bits reside in Internal Data RAM at byte locations 32 through 47. Currently locations 0 through 191 of the Internal Data RAM address space are filled with on-chip RAM.

Parallel I/O

The 8044 has 32 general-purpose I/O lines which are arranged into four groups of eight lines. Each group is called a port. Hence there are four ports; Port 0, Port 1, Port 2, and Port 3. Up to five lines from Port 3 are dedicated to supporting the serial channel when the SIU is invoked. Due to the nature of the serial port, two of Port 3's I/O lines (P3.0 and P3.1) do not have latched outputs. This is true whether or not the serial channel is used.

Port 0 and Port 2 also have an alternate dedicated function. When placed in the external access mode, Port 0 and Port 2 become the means by which the 8044 communicates with external program memory. Port 0 and Port 2 are also the means by which the 8044 communicates with external data memory. Peripherals can be memory mapped into the address space and controlled by the 8044.

Table 2. MCS®-51 Instruction Set Description

Mnemonic		Description	Byte	Cyc
ARITHMETIC OPERATIONS				
ADD	A,Rn	Add register to Accumulator	1	1
ADD	A,direct	Add direct byte to Accumulator	2	1
ADD	A,@Ri	Add indirect RAM to Accumulator	1	1
ADD	A,#data	Add immediate data to Accumulator	2	1
ADDC	A,Rn	Add register to Accumulator with Carry	1	1
ADDC	A,direct	Add direct byte to A with Carry flag	2	1
ADDC	A,@Ri	Add indirect RAM to A with Carry flag	1	1
ADDC	A,#data	Add immediate data to A with Carry flag	2	1
SUBB	A,Rn	Subtract register from A with Borrow	1	1
SUBB	A,direct	Subtract direct byte from A with Borrow	2	1
SUBB	A,@Ri	Subtract indirect RAM from A with Borrow	1	1
SUBB	A,#data	Subtract immed data from A with Borrow	2	1
INC	A	Increment Accumulator	1	1
INC	Rn	Increment register	1	1
INC	direct	Increment direct byte	2	1
INC	@Ri	Increment indirect RAM	1	1
INC	DPTR	Increment Data Pointer	1	2
DEC	A	Decrement Accumulator	1	1
DEC	Rn	Decrement register	1	1
DEC	direct	Decrement direct byte	2	1
DEC	@Ri	Decrement indirect RAM	1	1
MUL	AB	Multiply A & B	1	4
DIV	AB	Divide A by B	1	4
DA	A	Decimal Adjust Accumulator	1	1

Table 2. MCS®-51 Instruction Set Description (Continued)

Mnemonic		Description	Byte	Cyc
LOGICAL OPERATIONS				
ANL	A,Rn	AND register to Accumulator	1	1
ANL	A,direct	AND direct byte to Accumulator	2	1
ANL	A,@RI	AND indirect RAM to Accumulator	1	1
ANL	A,#data	AND immediate data to Accumulator	2	1
ANL	direct,A	AND Accumulator to direct byte	2	1
ANL	direct,#data	AND immediate data to direct byte	3	2
ORL	A,Rn	OR register to Accumulator	1	1
ORL	A,direct	OR direct byte to Accumulator	2	1
ORL	A,@Ri	OR indirect RAM to Accumulator	1	1
ORL	A,#data	OR immediate data to Accumulator	2	1
ORL	direct,A	OR Accumulator to direct byte	2	1
ORL	direct,#data	OR immediate data to direct byte	3	2
XRL	A,Rn	Exclusive-OR register to Accumulator	1	1
XRL	A,direct	Exclusive-OR direct byte to Accumulator	2	1
XRL	A,@RI	Exclusive-OR indirect RAM to A	1	1
XRL	A,#data	Exclusive-OR immediate data to A	2	1
XRL	direct,A	Exclusive-OR Accumulator to direct byte	2	1
XRL	direct,#data	Exclusive-OR immediate data to direct	3	2
CLR	A	Clear Accumulator	1	1
CPL	A	Complement Accumulator	1	1

Mnemonic		Description	Byte	Cyc
LOGICAL OPERATIONS (Continued)				
RL	A	Rotate Accumulator Left	1	1
RLC	A	Rotate A Left through the Carry flag	1	1
RR	A	Rotate Accumulator Right	1	1
RRC	A	Rotate A Right through Carry flag	1	1
SWAP	A	Swap nibbles within the Accumulator	1	1
DATA TRANSFER				
MOV	A,Rn	Move register to Accumulator	1	1
MOV	A,direct	Move direct byte to Accumulator	2	1
MOV	A,@RI	Move indirect RAM to Accumulator	1	1
MOV	A,#data	Move immediate data to Accumulator	2	1
MOV	Rn,A	Move Accumulator to register	1	1
MOV	Rn,direct	Move direct byte to register	2	2
MOV	Rn,#data	Move immediate data to register	2	1
MOV	direct,A	Move Accumulator to direct byte	2	1
MOV	direct,Rn	Move register to direct byte	2	2
MOV	direct,direct	Move direct byte to direct	3	2
MOV	direct,@Ri	Move indirect RAM to direct byte	2	2
MOV	direct,#data	Move immediate data to direct byte	3	2
MOV	@Ri,A	Move Accumulator to indirect RAM	1	1
MOV	@Ri,direct	Move direct byte to indirect RAM	2	2

Table 2. MCS®-51 Instruction Set Description (Continued)

Mnemonic		Description	Byte	Cyc
DATA TRANSFER (Continued)				
MOV	@Ri,#data	Move immediate data to indirect RAM	2	1
MOV	DPTR,#data16	Load Data Pointer with a 16-bit constant	3	2
MOVC	A,@A+DPTR	Move Code byte relative to DPTR to A	1	2
MOVC	A,@A+PC	Move Code byte relative to PC to A	1	2
MOVX	A,@Ri	Move External RAM (8-bit addr) to A	1	2
MOVX	A,@DPTR	Move External RAM (16-bit addr) to A	1	2
MOVX	@Ri,A	Move A to External RAM (8-bit addr)	1	2
MOVX	@DPTR,A	Move A to External RAM (16-bit) addr	1	2
PUSH	direct	Push direct byte onto stack	2	2
POP	direct	Pop direct byte from stack	2	2
XCH	A,Rn	Exchange register with Accumulator	1	1
XCH	A,direct	Exchange direct byte with Accumulator	2	1
XCH	A,@Ri	Exchange indirect RAM with A	1	1
XCHD	A,@Ri	Exchange low-order Digit ind RAM w A	1	1
BOOLEAN VARIABLE MANIPULATION				
CLR	C	Clear Carry flag	1	1
CLR	bit	Clear direct bit	2	1
SETB	C	Set Carry Flag	1	1
SETB	bit	Set direct Bit	2	1
CPL	C	Complement Carry Flag	1	1
CPL	bit	Complement direct bit	2	1
ANL	C,bit	AND direct bit to Carry flag	2	2
ANL	C,/bit	AND complement of direct bit to Carry	2	2
ORL	C/bit	OR direct bit to Carry flag	2	2
ORL	C,/bit	OR complement of direct bit to Carry	2	2
MOV	C,/bit	Move direct bit to Carry flag	2	1
MOV	bit,C	Move Carry flag to direct bit	2	2
PROGRAM AND MACHINE CONTROL				
ACALL	addr11	Absolute Subroutine Call	2	2
LCALL	addr16	Long Subroutine Call	3	2
RET		Return from subroutine	1	2
RETI		Return from interrupt	1	2
AJMP	addr11	Absolute Jump	2	2
LJMP	addr16	Long Jump	3	2
SJMP	rel	Short Jump (relative addr)	2	2
JMP	@A+DPTR	Jump indirect relative to the DPTR	1	2
JZ	rel	Jump if Accumulator is Zero	2	2
JNZ	rel	Jump if Accumulator is Not Zero	2	2
JC	rel	Jump if Carry flag is set	2	2
JNC	rel	Jump if No Carry flag	2	2
JB	bit,rel	Jump if direct Bit set	3	2
JNB	bit,rel	Jump if direct Bit Not set	3	2
JBC	bit,rel	Jump if direct Bit is set & Clear bit	3	2
CJNE	A,direct,rel	Compare direct to A & Jump if Not Equal	3	2
CJNE	A,#data,rel	Comp, immed, to A & Jump if Not Equal	3	2

Table 2. MCS®-51 Instruction Set Description (Continued)

Mnemonic	Description	Byte	Cyc
PROGRAM AND MACHINE CONTROL (Continued)			
CJNE Rn,#data,rel	Comp, immed, to reg & Jump if Not Equal	3	2
CJNE @Ri,#data, rel	Comp, immed, to ind. & Jump if Not Equal	3	2
DJNZ Rn,rel	Decrement register & Jump if Not Zero	2	2
DJNZ direct,rel	Decrement direct & Jump if Not Zero	3	2
NOP	No operation	1	1

Notes on data addressing modes:

Rn — Working register R0-R7

direct — 128 internal RAM locations, any I/O port, control or status register

@Ri — Indirect internal RAM location addressed by register R0 or R1

Notes on data addressing modes:
(Continued)

#data — 8-bit constant included in instruction

#data16 — 16-bit constant included as bytes 2 & 3 of instruction

bit — 128 software flags, any I/O pin, controll or status bit

Notes on program addressing modes:

addr16 — Destination address for LCALL & LJMP may be anywhere within the 64-K program memory address space

Addr11 — Destination address for ACALL & AJMP will be within the same 2-K page of program memory as the first byte of the following instruction

rel — SJMP and all conditional jumps include an 8-bit offset byte, Range is +127 −128 bytes relative to first byte of the following instruction

Timer/Counters

The 8044 contains two 16-bit counters which can be used for measuring time intervals, measuring pulse widths, counting events, generating precise periodic interrupt requests, and clocking the serial communications. Internally the Timers are clocked at 1/12 of the crystal frequency, which is the instruction cycle time. Externally the counters can run up to 500 KHz.

Interrupt System

External events and the real-time driven on-chip peripherals require service by the CPU asynchronous to the execution of any particular section of code. To tie the asynchronous activities of these functions to normal program execution, a sophisticated multiple-source, two priority level, nested interrupt system is provided. Interrupt response latency ranges from 3 μsec to 7 μsec when using a 12 MHz clock.

All five interrupt sources can be mapped into one of the two priority levels. Each interrupt source can be enabled or disabled individually or the entire interrupt system can be enabled or disabled. The five interrupt sources are: Serial Interface Unit, Timer 1, Timer 2, and two external interrupts. The external interrupts can be either level or edge triggered.

Serial Interface Unit (SIU)

The Serial Interface Unit is used for HDLC/SDLC communications. It handles Zero Bit Insertion/Deletion, Flags automatic access recognization, and a 16-bit cyclic redundancy check. In addition it implements in hardware a subset of the SDLC protocol certain applications it is advantageous to have the CPU control the reception or transmission of every single frame. For this reason the SIU has two modes of operation: "AUTO" and "FLEXIBLE" (or "NON-AUTO"). It is in the AUTO mode that the SIU responds to SDLC frames without CPU intervention; whereas, in the FLEXIBLE mode the reception or transmission of every single frame will be under CPU control.

There are three control registers and eight parameter registers that are used to operate the serial interface. These registers are shown in Figure 5 and Figure 6. The control register set the modes of operation and provide status information. The eight parameter registers buffer the station address, receive and transmit control bytes, and point to the on-chip transmit and receive buffers.

Data to be received or transmitted by the SIU must be buffered anywhere within the 192 bytes of on-chip RAM. Transmit and receive buffers are not allowed to "wrap around" in RAM; a "buffer end" is generated after address 191 is reached.

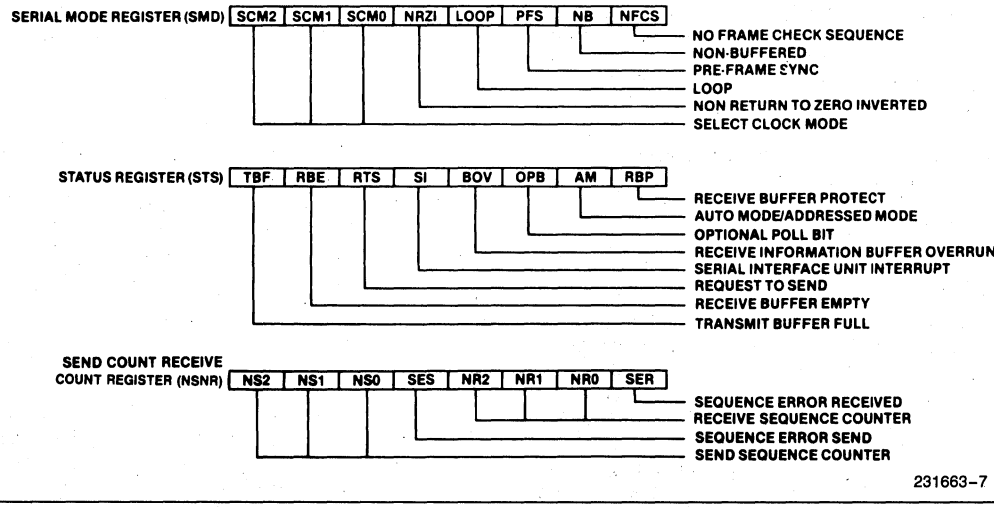
REGISTER NAMES	SYMBOLIC ADDRESS	BIT ADDRESS	BYTE ADDRESS
B REGISTER	B	247 through 240	240 (F0H)
ACCUMULATOR	ACC	231 through 224	224 (E0H)
*THREE BYTE FIFO	FIFO		223 (DFH)
	FIFO		222 (DEH)
	FIFO		221 (DDH)
TRANSMIT BUFFER START	TBS		220 (DCH)
TRANSMIT BUFFER LENGTH	TBL		219 (DBH)
TRANSMIT CONTROL BYTE	TCB		218 (DAH)
* SIU STATE COUNTER	SIUST		217 (D9H)
SEND COUNT RECEIVE COUNT	NSNR	223 through 216	216 (D8H)
PROGRAM STATUS WORD	PSW	215 through 208	208 (D0H)
*DMA COUNT	DMA CNT		207 (CFH)
STATION ADDRESS	STAD		206 (CEH)
RECEIVE FIELD LENGTH	RFL		205 (CDH)
RECEIVE BUFFER START	RBS		204 (CCH)
RECEIVE BUFFER LENGTH	RBL		203 (CBH)
RECEIVE CONTROL BYTE	RCB		202 (CAH)
SERIAL MODE	SMD		201 (C9H)
STATUS REGISTER	STS	207 through 200	200 (C8H)
INTERRUPT PRIORITY CONTROL	IP	191 through 184	184 (B8H)
PORT 3	P3	183 through 176	176 (B0H)
INTERRUPT ENABLE CONTROL	IE	175 through 168	168 (A8H)
PORT 2	P2	167 through 160	160 (A0H)
PORT 1	P1	151 through 144	144 (90H)
TIMER HIGH 1	TH1		141 (8DH)
TIMER HIGH 0	TH0		140 (8CH)
TIMER LOW 1	TL1		139 (8BH)
TIMER LOW 0	TL0		138 (8AH)
TIMER MODE	TMOD		137 (89H)
TIMER CONTROL	TCON	143 through 136	136 (88H)
DATA POINTER HIGH	DPH		131 (83H)
DATA POINTER LOW	DPL		130 (82H)
STACK POINTER	SP		129 (81H)
PORT 0	P0	135 through 128	128 (80H)

SFR's CONTAINING DIRECT ADDRESSABLE BITS

231663-6

NOTE:
*ICE Support Hardware registers. Under normal operating conditions there is no need for the CPU to access these registers.

Figure 5. Mapping of Special Function Registers



231663-7

Figure 6. Serial Interface Unit Control Registers

With the addition of only a few bytes of code, the 8044's frame size is not limited to the size of its internal RAM (192 bytes), but rather by the size of external buffer with no degradation of the RUPI's features (e.g. NRZI, zero bit insertion/deletion, address recognition, cyclic redundancy check). There is a special function register called SIUST whose contents dictates the operation of the SIU. At low data rates, one section of the SIU (the Byte Processor) performs no function during known intervals. For a given data rate, these intervals (stand-by mode) are fixed. The above characteristics make it possible to program the CPU to move data to/from external RAM and to force the SIU to perform some desired hardware tasks while transmission or reception is taking place. With these modifications, external RAM can be utilized as a transmit and received buffer instead of the internal RAM.

AUTO Mode

In the AUTO mode the SIU implements in hardware a subset of the SDLC protocol such that it responds to many SDLC frames without CPU intervention. All AUTO mode responses to the primary station will comform to IBM's SDLC definition. The advantages of the AUTO mode are that less software is required to implement a secondary station, and the hardware generated response to polls is much faster than doing it in software. However, the Auto mode can not be used at a primary station.

To transmit in the AUTO mode the CPU must load the Transmit Information Buffer, Transmit Buffer Start register, Transmit Buffer Length register, and set the Transmit Buffer Full bit. The SIU automatically responds to a poll by transmitting an information frame with the P/F bit in the control field set. When the SIU receives a positive acknowledgement from the primary station, it automatically increments the Ns field in the NSNR register and interrupts the CPU. A negative acknowledgement would cause the SIU to retransmit the frame.

To receive in the AUTO mode, the CPU loads the Receive Buffer Start register, the Receive Buffer Length register, clears the Receive Buffer Protect bit, and sets the Receive Buffer Empty bit. If the SIU is polled in this state, and the TBF bit indicates that the Transmit Buffer is empty, an automatic RR response will be generated. When a valid information frame is received the SIU will automatically increment Nr in the NSNR register and interrupt the CPU.

While in the AUTO mode the SIU can recognize and respond to the following commands without CPU intervention: I (Information), RR (Receive Ready), RNR (Receive Not Ready), REJ (Reject), and UP (Unnumbered Poll). The SIU can generate the following responses without CPU intervention: I (Information), RR (Receive Ready), and RNR (Receive Not Ready).

When the Receive Buffer Empty bit (RBE) indicates that the Receive Buffer is empty, the receiver is enabled, and when the RBE bit indicates that the Receive Buffer is full, the receiver is disabled. Assuming that the Receiver Buffer is empty, the SIU will respond to a poll with an I frame if the Transmit Buffer is full. If the Transmit Buffer is empty, the SIU will respond to a poll with a RR command if the Receive Buffer Protect bit (RBP) is cleared, or an RNR command if RBP is set.

FLEXIBLE (or NON-AUTO) Mode

In the FLEXIBLE mode all communications are under control of the CPU. It is the CPU's task to encode and decode control fields, manage acknowledgements, and adhere to the requirements of the HDLC/SDLC protocols. The 8044 can be used as a primary or a secondary station in this mode.

To receive a frame in the FLEXIBLE mode, the CPU must load the Receive Buffer Start register, the Receive Buffer Length register, clear the Receive Buffer Protect bit, and set the Receive Buffer Empty bit. If a valid opening flag is received and the address field matches the byte in the Station Address register or the address field contains a broadcast address, the 8044 loads the control field in the receive control byte register, and loads the I field in the receive buffer. If there is no CRC error, the SIU interrupts the CPU, indicating a frame has just been received. If there is a CRC error, no interrupt occurs. The Receive Field Length register provides the number of bytes that were received in the information field.

To transmit a frame, the CPU must load the transmit information buffer, the Transmit Buffer Start register, the Transmit Buffer Length register, the Transmit Control Byte, and set the TBF and the RTS bit. The SIU, unsolicited by an HDLC/SDLC frame, will transmit the entire information frame, and interrupt the CPU, indicating the completion of transmission. For supervisory frames or unnumbered frames, the transmit buffer length would be 0.

CRC

The FCS register is initially set to all 1's prior to calculating the FCS field. The SIU will not interrupt the CPU if a CRC error occurs (in both AUTO and FLEXIBLE modes). The CRC error is cleared upon receiving of an opening flag.

Frame Format Options

In addition to the standard SDLC frame format, the 8044 will support the frames displayed in Figure 7. The standard SDLC frame is shown at the top of this figure. For the remaining frames the information field will incorporate the control or address bytes and the frame check sequences; therefore these fields will be stored in the Transmit and Receive buffers. For example, in the non-buffered mode the third byte is treated as the beginning of the information field. In the non-addressed mode, the information field begins after the opening flag. The mode bits to set the frame format options are found in the Serial Mode register and the Status register.

FRAME OPTION	NFCS	NB	AM[1]	FRAME FORMAT
Standard SDLC NON-AUTO Mode	0	0	0	F A C I FCS F
Standard SDLC AUTO Mode	0	0	1	F A C I FCS F
Non-Buffered Mode NON-AUTO Mode	0	1	1	F A I FCS F
Non-Addressed Mode NON-AUTO Mode	0	1	0	F I FCS F
No FCS Field NON-AUTO Mode	1	0	0	F A C I F
No FCS Field AUTO Mode	1	0	1	F A C I F
No FCS Field Non-Buffered Mode NON-AUTO Mode	1	1	1	F A I F
No FCS Field Non-Addressed Mode NON-AUTO Mode	1	1	0	F I F

Mode Bits:
AM — "AUTO" Mode/Addressed Mode
NB — Non-Buffered Mode
NFCS — No FCS Field Mode

Key to Abbreviations:
F = Flag (01111110)
A = Address Field
C = Control Field
I = Information Field
FCS= Frame Check Sequence

Note 1:
The AM bit function is controlled by the NB bit. When NB = 0, AM becomes AUTO mode select, when NB = 1, AM becomes Address mode select.

Figure 7. Frame Format Options

Extended Addressing

To realize an extended control field or an extended address field using the HDLC protocol, the FLEXIBLE mode must be used. For an extended control field, the SIU is programmed to be in the non-buffered mode. The extended control field will be the first and second bytes in the Receive and Transmit Buffers. For extended addressing the SIU is placed in the non-addressed mode. In this mode the CPU must implement the address recognition for received frames. The addressing field will be the initial bytes in the Transmit and Receive buffers followed by the control field.

The SIU can transmit and receive only frames which are multiples of 8 bits. For frames received with other than 8-bit multiples, a CRC error will cause the SIU to reject the frame.

SDLC Loop Networks

The SIU can be used in an SDLC loop as a secondary or primary station. When the SIU is placed in the Loop mode it receives the data on pin 10 and transmits the data one bit time delayed on pin 11. It can also recognize the Go ahead signal and change it into a flag when it is ready to transmit. As a secondary station the SIU can be used in the AUTO or FLEXIBLE modes. As a primary station the FLEXIBLE mode is used; however, additional hardware is required for generating the Go Ahead bit pattern. In the Loop mode the maximum data rate is 1 Mbps clocked or 375 Kpbs self-clocked.

SDLC Multidrop Networks

The SIU can be used in a SDLC non-loop configuration as a secondary or primary station. When the SIU is placed in the non-loop mode, data is received and transmitted on pin 11, and pin 10 drives a tri-state buffer. In non-loop mode, modem interface pins, RTS and CTS, become available.

Data Clocking Options

The 8044's serial port can operate in an externally clocked or self clocked system. A clocked system provides to the 8044 a clock synchronization to the data. A self-clocked system uses the 8044's on-chip Digital Phase Locked Loop (DPLL) to recover the clock from the data, and clock this data into the Serial Receive Shift Register.

In this mode, a clock synchronized with the data is externally fed into the 8044. This clock may be generated from an External Phase Locked Loop, or possibly supplied along with the data. The 8044 can transmit and receive data in this mode at rates up to 2.4 Mbps.

This self clocked mode allows data transfer without a common system data clock. An on-chip Digital Phase Locked Loop is employed to recover the data clock which is encoded in the data stream. The DPLL will converge to the nominal bit center within eight bit transitions, worst case. The DPLL requires a reference clock of either 16 times (16x) or 32 times (32x) the data rate. This reference clock may be externally applied or internally generated. When internally generated either the 8044's internal logic clock (crystal frequency divided by two) or the timer 1 overflow is used as the reference clock. Using the internal timer 1 clock the data rates can vary from 244 to 62.5 Kbps. Using the internal logic clock at a 16x sampling rate, receive data can either be 187.5 Kbps, or 375 Kbps. When the reference clock for the DPLL is externally applied the data rates can vary from 0 to 375 Kbps at a 16x sampling rate.

To aid in a Phase Locked Loop capture, the SIU has a NRZI (Non Return to Zero Inverted) data encoding and decoding option. Additionally the SIU has a preframe sync option that transmits two bytes of alternating 1's and 0's to ensure that the receive station DPLL will be synchronized with the data by the time it receives the opening flag.

Control and Status Registers

There are three SIU Control and Status Registers:

Serial Mode Register (SMD)

Status/Command Register (STS)

Send/Receive Count Register (NSNR)

The SMD, STS, and NSNR, registers are all cleared by system reset. This assures that the SIU will power up in an idle state (neither receiving nor transmitting).

These registers and their bit assignments are described below.

SMD: Serial Mode Register (byte-addressable)

Bit 7:	6	5	4	3	2	1	0
SCM2	SCM1	SCM0	NRZI	LOOP	PFS	NB	NFCS

The Serial Mode Register (Address C9H) selects the operational modes of the SIU. The 8044 CPU can both read and write SMD. The SIU can read SMD but cannot write to it. To prevent conflict between CPU and SIU access to SMD, the CPU should write SMD only when the Request To Send (RTS) and

Receive Buffer Empty (RBE) bits (in the STS register) are both false (0). Normally, SMD is accessed only during initialization.

The individual bits of the Serial Mode Register are as follows:

Bit #	Name	Description
SMD.0	NFCS	No FCS field in the SDLC frame.
SMD.1	NB	Non-Buffered mode. No control field in the SDLC frame.
SMD.2	PFS	Pre-Frame Sync mode. In this mode, the 8044 transmits two bytes before the first flag of a frame, for DPLL synchronization. If NRZI is enabled, 00H is sent; otherwise, 55H is sent. In either case, 16 preframe transitions are guaranteed.
SMD.3	LOOP	Loop configuration.
SMD.4	NRZI	NRZI coding option. If bit = 1, NRZI coding is used. If bit = 0, then it is straight binary (NRZ).
SMD.5	SCM0	Select Clock Mode—Bit 0
SMD.6	SCM1	Select Clock Mode—Bit 1
SMD.7	SCM2	Select Clock Mode—Bit 2

The SCM bits decode as follows:

SCM				Data Rate
2	1	0	Clock Mode	(Bits/sec)*
0	0	0	Externally clocked	0-2.4M**
0	0	1	Reserved	
0	1	0	Self clocked, timer overflow	244-62.5K
0	1	1	Reserved	
1	0	0	Self clocked, external 16x	0-375K
1	0	1	Self clocked, external 32x	0-187.5K
1	1	0	Self clocked, internal fixed	375K
1	1	1	Self clocked, internal fixed	187.5K

NOTES:
*Based on a 12 Mhz crystal frequency
**0-1 M bps in loop configuration

STS: Status/Command Register (bit-addressable)

Bit:	7	6	5	4	3	2	1	0
	TBF	RBE	RTS	SI	BOV	OPB	AM	RBP

The Status/Command Register (Address C8H) provides operational control of the SIU by the 8044 CPU, and enables the SIU to post status information for the CPU's access. The SIU can read STS, and can alter certain bits, as indicated below. The CPU can both read and write STS asynchronously. However, 2-cycle instructions that access STS during both cycles ('JBC/B, REL' and 'MOV/B, C.') should not be used, since the SIU may write to STS between the two CPU accesses.

The individual bits of the Status/Command Register are as follows:

Bit #	Name	Description
STS.0	RBP	Receive Buffer Protect. Inhibits writing of data into the receive buffer. In AUTO mode, RBP forces an RNR response instead of an RR.
STS.1	AM	AUTO Mode/Addressed Mode. Selects AUTO mode where AUTO mode is allowed. If NB is true, (= 1), the AM bit selects the addressed mode. AM may be cleared by the SIU.
STS.2	OPB	Optional Poll Bit. Determines whether the SIU will generate an AUTO response to an optional poll (UP with P = 0). OPM may be set or cleared by the SIU.
STS.3	BOV	Receive Buffer Overrun. BOV may be set or cleared by the SIU.
STS.4	SI	SIU Interrupt. This is one of the five interrupt sources to the CPU. The vector location = 23H. SI may be set by the SIU. It should be cleared by the CPU before returning from an interrupt routine.
STS.5	RTS	Request To Send. Indicates that the 8044 is ready to transmit or is transmitting. RTS may be read or written by the CPU. RTS may be read by the SIU, and in AUTO mode may be written by the SIU.
STS.6	RBE	Receive Buffer Empty. RBE can be thought of as Receive Enable. RBE is set to one by the CPU when it is ready to receive a frame, or has just read the buffer, and to zero by the SIU when a frame has been received.
STS.7	TBF	Transmit Buffer Full. Written by the CPU to indicate that it has filled the transmit buffer. TBF may be cleared by the SIU.

NSNR: Send/Receive Count Register (bit-addressable)

Bit:	7	6	5	4	3	2	1	0
	NS2	NS1	NS0	SES	NR2	NR1	NR0	SER

The Send/Receive Count Register (Address D8H) contains the transmit and receive sequence numbers, plus tally error indications. The SIU can both read and write NSNR. The 8044 CPU can both read and write NSNR asynchronously. However, 2-cycle instructions that access NSNR during both cycles ('JBC /B, REL,' and 'MOV /B,C') should not be used, since the SIU may write to NSMR between the two 8044 CPU accesses.

The individual bits of the Send/Receive Count Register are as follows:

Bit #	Name	Description
NSNR.0	SER	Receive Sequence Error: NS (P) ≠ NR (S)
NSNR.1	NR0	Receive Sequence Counter—Bit 0
NSNR.2	NR1	Receive Sequence Counter—Bit 1
NSNR.3	NR2	Receive Sequence Counter—Bit 2
NSNR.4	SES	Send Sequence Error: NR (P) ≠ NS (S) and NR (P) ≠ NS (S) + 1
NSNR.5	NS0	Send Sequence Counter—Bit 0
NSNR.6	NS1	Send Sequence Counter—Bit 1
NSNR.7	NS2	Send Sequence Counter—Bit 2

Parameter Registers

There are eight parameter registers that are used in connection with SIU operation. All eight registers may be read or written by the 8044 CPU. RFL and RCB are normally loaded by the SIU.

The eight parameter registers are as follows:

STAD: Station Address Register (byte-addressable)

The Station Address register (Address CEH) contains the station address. To prevent acess conflict, the CPU should access STAD only when the SIU is idle (RTS = 0 and RBE = 0). Normally, STAD is accessed only during initialization.

TBS: Transmit Buffer Start Address Register (byte-addressable)

The Transmit Buffer Start address register (Address DCH) points to the location in on-chip RAM for the beginning of the I-field of the frame to be transmitted. The CPU should access TBS only when the SIU is not transmitting a frame (when TBF = 0).

TBL: Transmit Buffer Length Register (byte = addressable)

The Transmit Buffer Length register (Address DBH) contains the length (in bytes) of the I-field to be transmitted. A blank I-field (TBL = 0) is valid. The CPU should access TBL only when the SIU is not transmitting a frame (when TBF = 0).

NOTE:
The transmit and receive buffers are not allowed to "wrap around" in the on-chip RAM. A "buffer end" is automatically generated if address 191 (BFH) is reached.

TCB: Transmit Control Byte Register (byte-addressable)

The Transmit Control Byte register (Address DAH) contains the byte which is to be placed in the control field of the transmitted frame, during NON-AUTO mode transmission. The CPU should access TCB only when the SIU is not transmitting a frame (when TBF = 0). The N_S and N_R counters are not used in the NON-AUTO mode.

RBS: Receive Buffer Start Address Register (byte-addressable)

The Receive Buffer Start address register (Address CCH) points to the location in on-chip RAM where the beginning of the I-field of the frame being received is to be stored. The CPU should write RBS only when the SIU is not receiving a frame (when RBE = 0).

RBL: Receive Buffer Length Register (byte-addressable)

The Receive Buffer Length register (Address CBH) contains the length (in bytes) of the area in on-chip RAM allocated for the received I-field. RBL=0 is valid. The CPU should write RBL only when RBE=0.

RFL: Receive Field Length Register (byte-addressable)

The Receive Field Length register (Address CDH) contains the length (in bytes) of the received I-field that has just been loaded into on-chip RAM. RFL is loaded by the SIU. RFL = 0 is valid. RFL should be accessed by the CPU only when RBE = 0.

RCB: Receive Control Byte Register (byte-addressable)

The Received Control Byte register (Address CAH) contains the control field of the frame that has just been received. RCB is loaded by the SIU. The CPU can only read RCB, and should only access RCB when RBE = 0.

ICE Support

The 8044 In-Circuit Emulator (ICE-44) allows the user to exercise the 8044 application system and monitor the execution of instructions in real time.

The emulator operates with Intel's Intellec™ development system. The development system interfaces with the user's 8044 system through an in-cable buffer box. The cable terminates in a 8044 pin-compatible plug, which fits into the 8044 socket in the user's system. With the emulator plug in place, the user can excercise his system in real time while collecting up to 255 instruction cycles of real-time data. In addition, he can single-step the program.

Static RAM is available (in the in-cable buffer box) to emulate the 8044 internal and external program memory and external data memory. The designer can display and alter the contents of the replacement memory in the buffer box, the internal data memory, and the internal 8044 registers, including the SFR's.

SIUST: SIU State Counter (byte-addressable)

The SIU State Counter (Address D9H) reflects the state of the internal logic which is under SIU control. Therefore, care must be taken not to write into this register. This register provides a useful means for debugging 8044 receiver problem.

ABSOLUTE MAXIMUM RATINGS*

Ambient Temperature Under Bias .....0°C to 70°C
Storage Temperature.....−65°C to −150°C
Voltage on $\overline{EA}$, VPP Pin to VSS...−0.5V to −21.5V
Voltage on Any Other Pin to VSS ....−0.5V to −7V
Power Dissipation 2W

**Notice: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

D.C. CHARACTERISTICS T_A = 0°C to 70°C, VCC = 5V ± 10%, VSS = 0V

Symbol	Parameter		Min	Max	Unit	Test Conditions
VIL	Input Low Voltage (Except $\overline{EA}$ Pin of 8744H)		−0.5	0.8	V	
VIL1	Input Low Voltage to $\overline{EA}$ Pin of 8744H		0	0.8	V	
VIH	Input High Voltage (Except XTAL2, RST)		2.0	VCC + 0.5	V	
VIH1	Input High Voltage to XTAL2, RST		2.5	VCC + 0.5	V	XTAL1 = VSS
VOL	Output Low Voltage (Ports 1, 2, 3)*			0.45	V	IOL = 1.6mA
VOL1	Output Low Voltage (Port 0,ALE,$\overline{PSEN}$)*					
		8744H		0.60 0.45	V V	IOL = 3.2 mA IOL = 2.4 mA
		8044AH/8344AH		0.45	V	IOL = 3.2 mA
VOH	Output High Voltage (Ports 1, 2, 3)		2.4		V	IOH = −80 μA
VOH1	Output High Voltage (Port 0 in External Bus Mode, ALE, $\overline{PSEN}$)		2.4		V	IOH = −400 μA
IIL	Logical 0 Input Current (Ports 1, 2, 3)			−500	μA	Vin = 0.45V
IIL1	Logical 0 Input Current to $\overline{EA}$ Pin of 8744H only			−15	mA	
IIL2	Logical 0 Input Current (XTAL2)			−3.6	mA	Vin = 0.45V
ILI	Input Leakage Current (Port 0) 8744H 8044AH/8344AH			 ±100 ±10	 μA μA	 0.45 < Vin < VCC 0.45 < Vin < VCC
IIH	Logical 1 Input Current to $\overline{EA}$ Pin of 8744H			500	μA	
IIH1	Input Current to RST to Activate Reset			500	μA	Vin < (VCC − 1.5V)
ICC	Power Supply Current: 8744H 8044AH/8344AH			 285 170	 mA mA	All Outputs Disconnected: $\overline{EA}$ = VCC
CIO	Pin Capacitance			10	pF	Test Freq. = 1MHz(1)

***NOTES:**
1. Sampled not 100% tested. T_A = 25°C.
2. Capacitive loading on Ports 0 and 2 may cause spurious noise pulses to be superimposed on the VOLs of ALE and Ports 1 and 3. The noise is due to external bus capacitance discharging into the Port 0 and Port 2 pin when these pins make 1-to-0 transitions during bus operations. In the worst cases (capacitive loading > 100 pF), the noise pulse on the ALE line may exceed 0.8V. In such cases it may be desirable to qualify ALE with a Schmitt Trigger, or use an address latch with a Schmitt Trigger STROBE input.

A.C. CHARACTERISTICS

T_A = 0°C to +70°C, VCC = 5V ± 10%, VSS = 0V, Load Capacitance for Port 0, ALE, and PSEN = 100 pF, Load Capacitance for All Other Outputs = 80 pF

EXTERNAL PROGRAM MEMORY CHARACTERISTICS

Symbol	Parameter	12 MHz Osc		Variable Clock 1/TCLCL = 3.5 MHz to 12 MHz		Unit
		Min	Max	Min	Max	
TLHLL	ALE Pulse Width	127		2TCLCL-40		ns
TAVLL	Address Valid to ALE Low	43		TCLCL-40		ns
TLLAX[1]	Address Hold After ALE Low	48		TCLCL-35		ns
TLLIV	ALE Low to Valid Instr in 8744H 8044AH/8344AH		 183 233		 4TCLCL-150 4TCLCL-100	ns
TLLPL	ALE Low to $\overline{PSEN}$ Low	58		TCLCL-25		ns
TPLPH	$\overline{PSEN}$ Pulse Width 8744H 8044AH/8344AH	 190 215		 3TCLCL-60 3TCLCL-35		 ns ns
TPLIV	$\overline{PSEN}$ Low to Valid Instr in 8744H 8044AH/8344AH		 100 125		 3TCLCL-150 3TCLCL-125	 ns ns
TPXIX	Input Instr Hold After $\overline{PSEN}$	0		0		ns
TPXIZ[2]	Input Instr Float After $\overline{PSEN}$		63		TCLCL-20	ns
TPXAV[2]	$\overline{PSEN}$ to Address Valid	75		TCLCL-8		ns
TAVIV	Address to Valid Instr in 8744H 8044AH/8344AH		 267 302		 5TCLCL-150 5TCLCL-115	 ns ns
TAZPL	Address Float to $\overline{PSEN}$	−25		−25		ns

NOTES:
1. TLLAX for access to program memory is different from TLLAX for data memory.
2. Interfacing RUPI-44 devices with float times up to 75ns is permissible. This limited bus contention will not cause any damage to Port 0 drivers.

EXTERNAL DATA MEMORY CHARACTERISTICS

Symbol	Parameter	12 MHz Osc		Variable Clock 1/TCLCL = 3.5 MHz to 12 MHz		Unit
		Min	Max	Min	Max	
TRLRH	$\overline{RD}$ Pulse Width	400		6TCLCL-100		ns
TWLWH	$\overline{WR}$ Pulse Width	400		6TCLCL-100		ns
TLLAX	Address Hold after ALE	48		TCLCL-35		ns
TRLDV	$\overline{RD}$ Low to Valid Data in		252		5TCLCL-165	ns
TRHDX	Data Hold After $\overline{RD}$	0		0		ns
TRHDZ	Data Float After $\overline{RD}$		97		2TCLCL-70	ns
TLLDV	ALE Low to Valid Data In		517		8TCLCL-150	ns
TAVDV	Address to Valid Data In		585		9TCLCL-165	ns
TLLWL	ALE Low to $\overline{RD}$ or $\overline{WR}$ Low	200	300	3TCLCL-50	3TLCLCL+50	ns
TAVWL	Address to $\overline{RD}$ or $\overline{WR}$ Low	203		4TCLCL-130		ns
TQVWX	Data Valid to $\overline{WR}$ Transition 8744H 8044AH/8344AH	 13 23		 TCLCL-70 TCLCL-60		 ns ns
TQVWH	Data Setup Before $\overline{WR}$ High	433		7TCLCL-150		ns
TWHQX	Data Held After $\overline{WR}$	33		TCLCL-50		ns
TRLAZ	$\overline{RD}$ Low to Address Float		25		25	ns
TWHLH	$\overline{RD}$ or $\overline{WR}$ High to ALE High 8744H 8044AH/8344AH	 33 43	 133 123	 TCLCL-50 TCLCL-40	 TCLCL+50 TCLCL+50	 ns ns

NOTE:
1. TLLAX for access to program memory is different from TLLAX for access data memory.

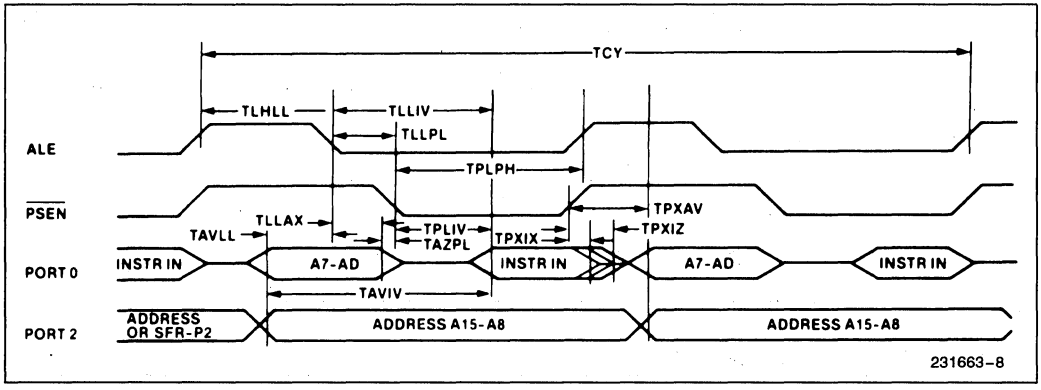
Serial Interface Characteristics

Symbol	Parameter	Min	Max	Unit
TDCY	Data Clock	420		ns
TDCL	Data Clock Low	180		ns
TDCH	Data Clock High	100		ns
tTD	Transmit Data Delay		140	ns
tDSS	Data Setup Time	40		ns
tDHS	Data Hold Time	40		ns

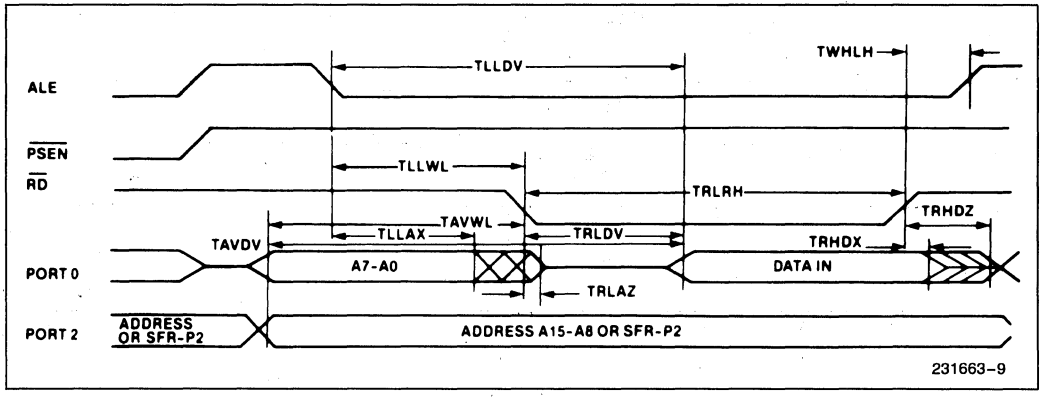
WAVEFORMS

Memory Access

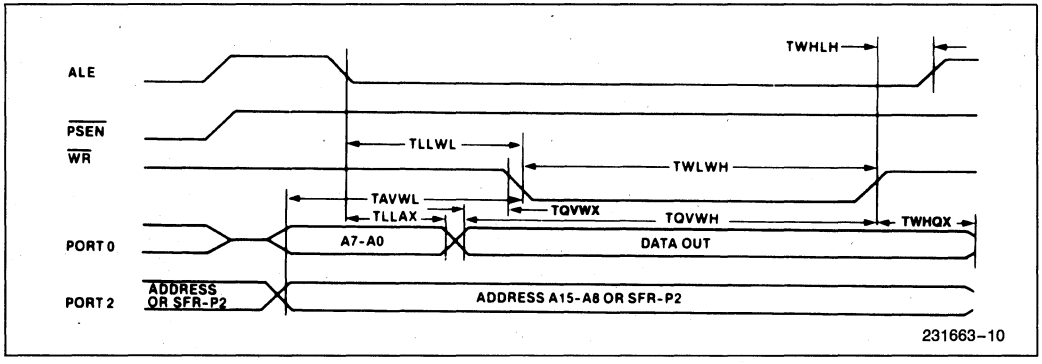
PROGRAM MEMORY READ CYCLE



DATA MEMORY READ CYCLE

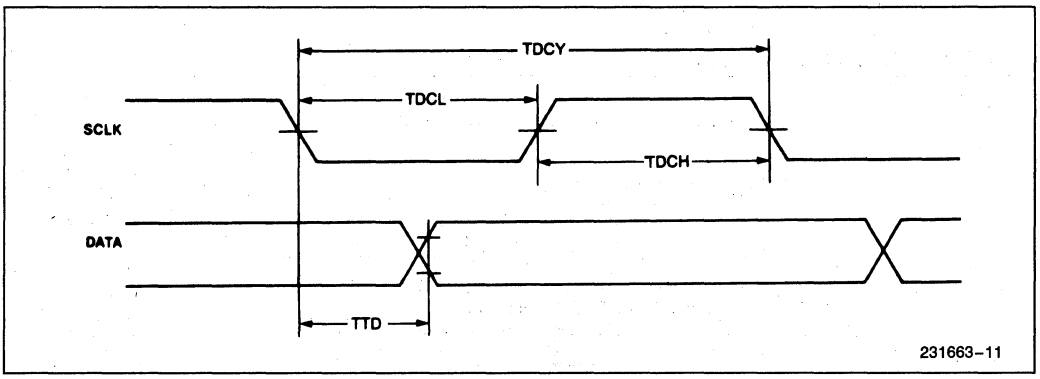


DATA MEMORY WRITE CYCLE

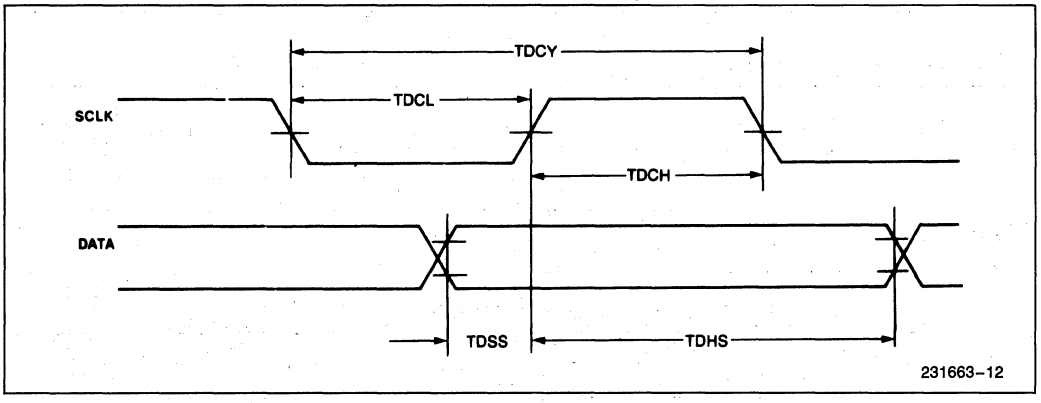


SERIAL I/O WAVEFORMS

SYNCHRONOUS DATA TRANSMISSION



SYNCHRONOUS DATA RECEPTION



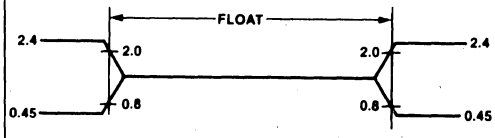
AC TESTING INPUT, OUTPUT, FLOAT WAVEFORMS

INPUT/OUTPUT

231663-13

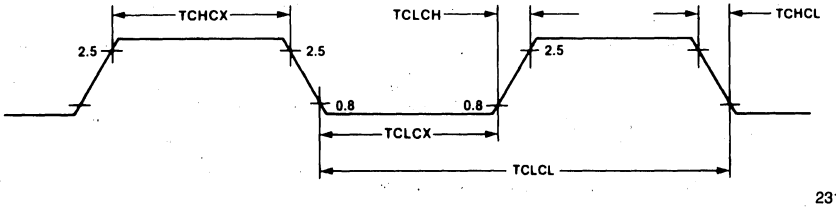
AC testing inputs are driven at 2.4V for a Logic "1" and 0.45V for a Logic "0" Timing measurements are made at 2.0V for a Logic "1" and 0.8V for a Logic "0".

FLOAT



231663-14

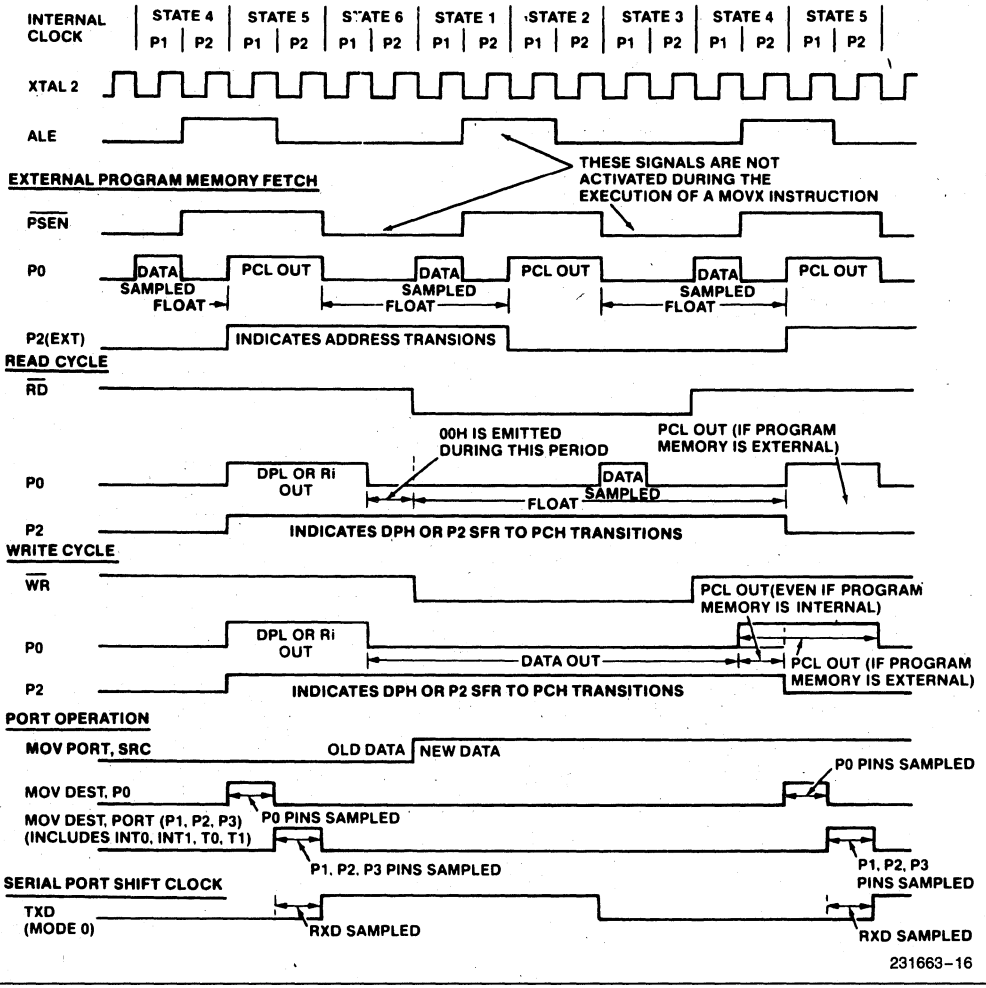
EXTERNAL CLOCK DRIVE XTAL2



231663-15

Symbol	Parameter	Variable Clock Freq = 3.5 MHz to 12 MHz		Unit
		Min	Max	
TCLCL	Oscillator Period	83.3	285.7	ns
TCHCX	High Time	20	TCLCL-TCLCX	ns
TCLCX	Low Time	20	TCLCL-TCHCX	ns
TCLCH	Rise Time		20	ns
TCHCL	Fall Time		20	ns

CLOCK WAVEFORMS



This diagram indicates when signals are clocked internally. The time it takes the signals to propagate to the pins, however, ranges from 25 to 125 ns. This propagation delay is dependent on variables such as temperature and pin loading. Propagation also varies from output to output and component to component. Typically though, (T_A = 25°C, fully loaded) RD and WR propagation delays are approximately 50 ns. The other signals are typically 85 ns. Propagation delays are incorporated in the AC specifications.

8744H EPROM CHARACTERISTICS

Erasure Characteristics

Erasure of the 8744H Program Memory begins to occur when the chip is exposed to light with wavelengths shorter than approximately 4,000 Ångstroms. Since sunlight and fluorescent lighting have wavelengths in this range, constant exposure to these light sources over an extended period of time (about 1 week in sunlight, or 3 years in room-level fluorescent lighting) could cause unintentional erasure. If an application subjects the 8744H to this type of exposure, it is suggested that an opaque label be placed over the window.

The recommended erasure procedure is exposure to ultraviolet light (at 2537 Ångstroms) to an integrated dose of at least 15 W-sec/cm^2 rating for 20 to 30 minutes, at a distance of about 1 inch, should be sufficient.

Erasure leaves the array in an all 1s state.

Programming the EPROM

To be programmed, the 8744H must be running with a 4 to 6 MHz oscillator. (The reason the oscillator needs to be running is that the internal bus is being used to transfer address and program data to appropriate registers.) The address of an EPROM location to be programmed is applied to Port 1 and pins P2.0-P2.3 of Port 2, while the data byte is applied to Port 0. Pins P2.4-P2.6 and $\overline{PSEN}$ should be held low, and P2.7 and RST high. (These are all TTL levels except RST, which requires 2.5V for high.) $\overline{EA}$/VPP is held normally high, and is pulsed to +21V. While EA/VPP is at 21V, the ALE/$\overline{PROG}$ pin, which is normally being held high, is pulsed low for 50 msec. Then EA/VPP is returned to high. This is illustrated in Figure 8. Detailed timing specifications are provided in the EPROM Programming and Verification Characteristics section of this data sheet.

Program Memory Security

The program memory security feature is developed around a "security bit" in the 8744H EPROM array. Once this "hidden bit" is programmed, electrical access to the contents of the entire program memory array becomes impossible. Activation of this feature is accomplished by programming the 8744H as described in "Programming the EPROM" with the exception that P2.6 is held at a TTL high rather than a TTL low. In addition, Port 1 and P2.0-P2.3 may be in any state. Figure 9 illustrates the security bit programming configuration. Deactivating the security feature, which again allows programmability of the EPROM, is accomplished by exposing the EPROM to ultraviolet light. This exposure, as described in "Erasure Characteristics," erases the entire EPROM array. Therefore, attempted retrieval of "protected code" results in its destruction.

Program Verification

Program Memory may be read only when the "security feature" has not been activated. Refer to Figure 10 for Program Verification setup. To read the Program Memory, the following procedure can be used. The unit must be running with a 4 to 6 MHz oscillator. The address of a Program Memory location to be read is applied to Port 1 and pins P2.0-P2.3 of Port 2. Pins P2.4-P2.6 and $\overline{PSEN}$ are held at TTL low, while the ALE/$\overline{PROG}$, RST, and $\overline{EA}$/VPP pins are held at TTL high. (These are all TTL levels except RST, which requires 2.5V for high.) Port 0 will be the data output lines. P2.7 can be used as a read strobe. While P2.7 is held high, the Port 0 pins float. When P2.7 is strobed low, the contents of the addressed location will appear at Port 0. External pullups (e.g., 10K) are required on Port 0 during program verification.

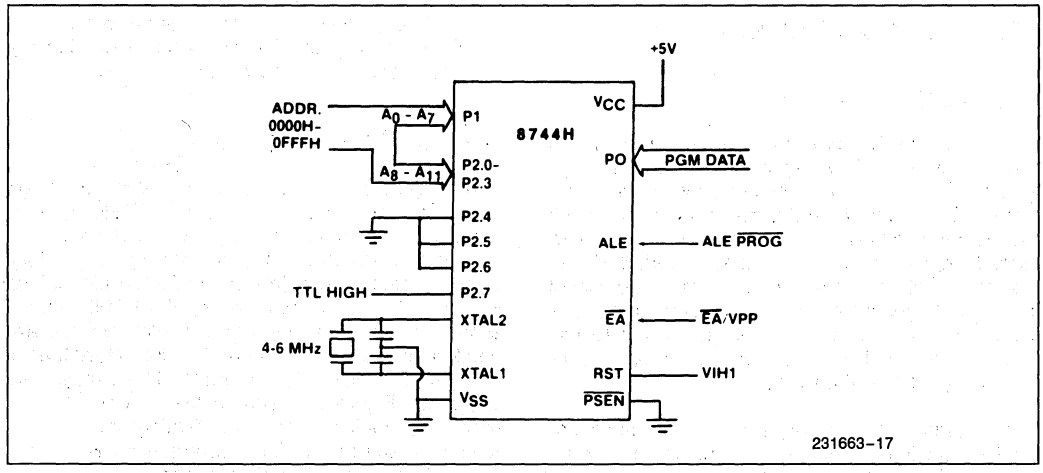


Figure 8. Programming Configuration

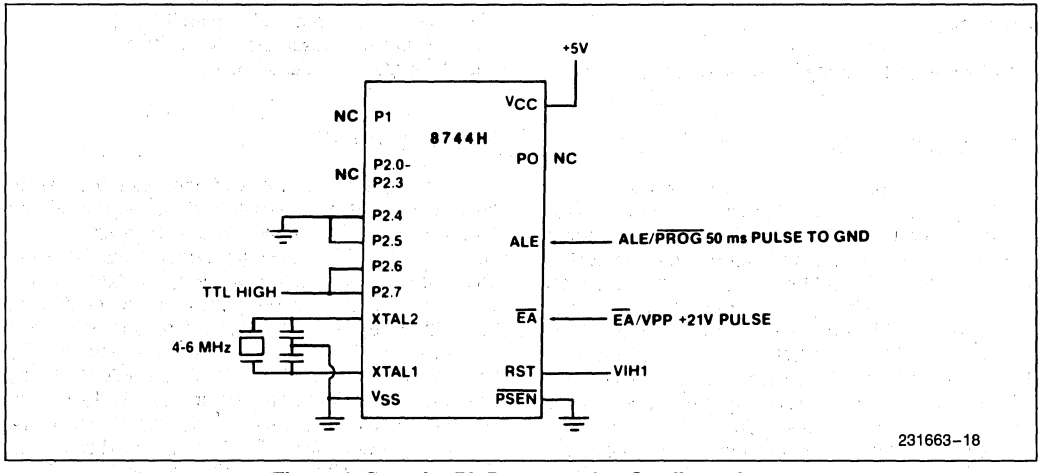


Figure 9. Security Bit Programming Configuration

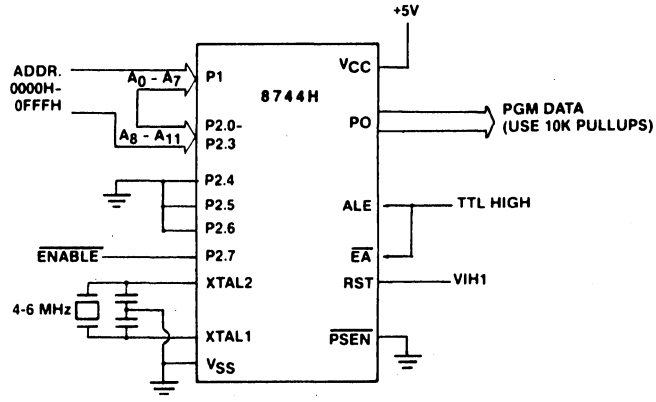


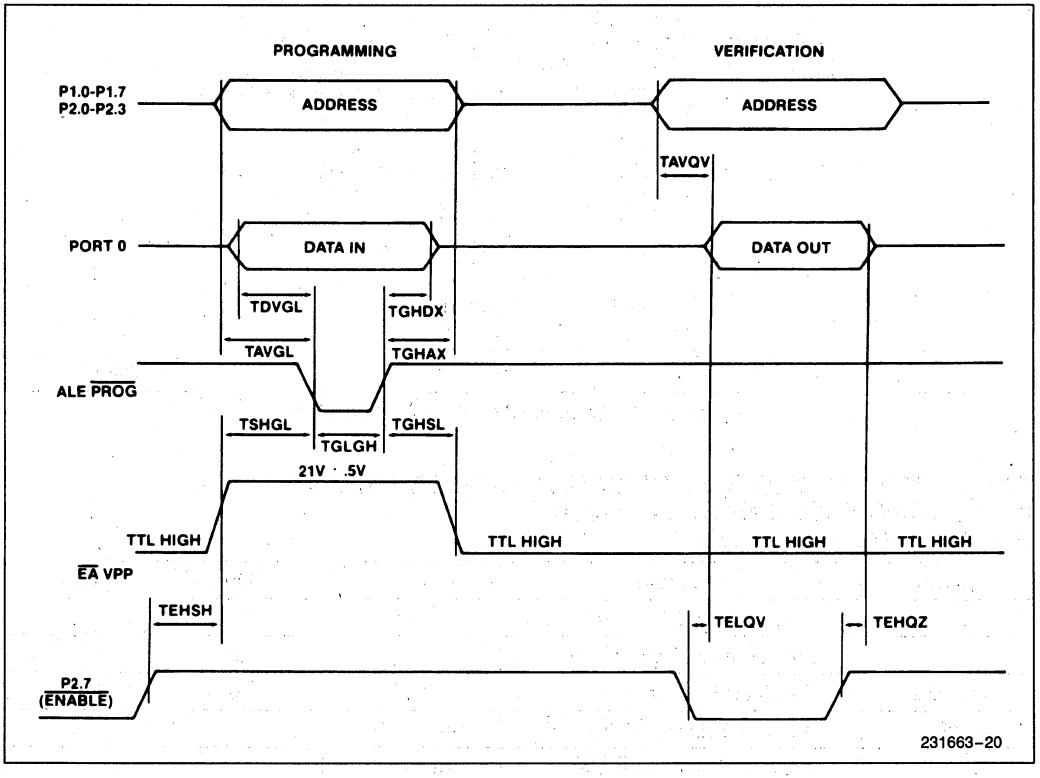
Figure 10. Program Verification Configuration

EPROM PROGRAMMING, SECURITY BIT PROGRAMMING AND VERIFICATION CHARACTERISTICS

TA = 21°C to 27°C, V_{CC} = 4.5V to 5.5V, V_{SS} = 0V

Symbol	Parameter	Min	Max	Units
V_{PP}	Programming Supply Voltage	20.5	21.5	V
IPP	Programming Current		30	mA
1/TCLCL	Oscillator Frequency	4	6	MHz
TAVGL	Address Setup to $\overline{PROG}$	48TCLCL		
TGHAX	Address Hold after $\overline{PROG}$	48TCLCL		
TDVGL	Data Setup to $\overline{PROG}$	48TCLCL		
TGHDX	Data Hold after $\overline{PROG}$	48TCLCL		
TEHSH	$\overline{ENABLE}$ High to Vpp	48TCLCL		
TSHGL	V_{PP} Setup to $\overline{PROG}$	10		µsec
TGHSL	V_{PP} Hold after $\overline{PROG}$	10		µsec
TGLGH	$\overline{PROG}$ Width	45	55	msec
TAVQV	Address to Data Valid		48TCLCL	
TELQV	$\overline{ENABLE}$ to Data Valid		48TCLCL	
TEHQZ	Data Float after $\overline{ENABLE}$	0	48TCLCL	

EPROM PROGRAMMING, SECURITY BIT PROGRAMMING AND VERIFICATION WAVEFORMS



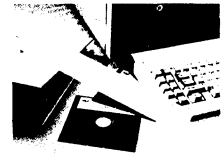
BITBUS™ SOFTWARE DEVELOPMENT ENVIRONMENT

Intel has all the software tools you'll need to implement high-performance applications using Intel BITBUS™ products. Tools include assemblers and compilers for host and BITBUS node code development, debug monitors, in-circuit emulators, and specialized BITBUS software. Intel's software tools are full-featured, easy-to-use, and help generate reliable, easily maintained code in a minimum amount of time. Intel's complete solution helps get your BITBUS-based distributed network quickly to market.

BITBUS NETWORK CONFIGURATIONS

A BITBUS network usually consists of a master (or supervisory) node and multiple remote nodes as shown on figure 1. All BITBUS host interface boards and remote control boards use the 8044 BITBUS Enhanced Microcontroller (8044BEM). The 8044BEM has built-in communications software, memory management and I/O control procedures together with a multitasking operating system. This built-in software, known as DCM44, greatly simplifies the programmer's software design task.

BITBUS networks can be configured in two ways, either as distributed I/O systems with centralized control, or as distributed control systems.



intel

June, 1987
Order Number: 280622-001

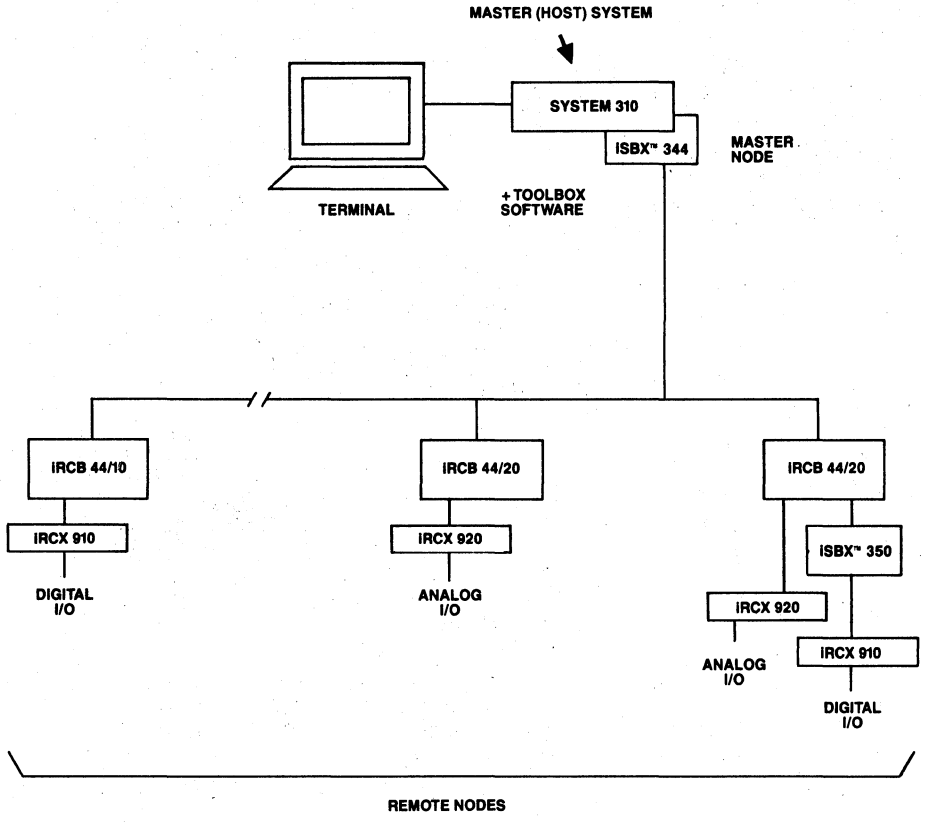


Figure 1: BITBUS™ Network

BUILT-IN RAC PROCEDURES SIMPLIFY DISTRIBUTED I/O APPLICATIONS

Distributed I/O systems are easy to design. Node code (code that runs on the remote BITBUS board) is not required because the network is controlled by the master (host) system. To simplify host code, each BITBUS board comes with a built-in set of procedures known as Remote Access and Control (RAC). The master sends out commands to the nodes and uses these RAC procedures to collect data or to turn on and off motors, valves, indicator lights, and other output devices.

DISTRIBUTED CONTROL BOOSTS PERFORMANCE AND RELIABILITY

Besides using BITBUS for distributed I/O, BITBUS can also be used to implement powerful distributed control systems. With distributed control, the system can more easily control rapidly changing, complex processes (e.g. robotics) and gain the added benefit of higher network reliability that is inherent in distributed control systems.

With distributed control, each board functions as a controller performing a set of dedicated tasks. On a periodic basis, the master can send a command to a remote board to collect process control data or request that a new task start running on a remote board. The built-in DCX 51 multitasking executive on the 8044 BITBUS microcontroller allows up to 7 user tasks to run on the node at the same time. The 12 MHz 8044 8-bit microcontroller, together with the multitasking executive, allows each BITBUS remote board to easily control multiple, complex processes.

HOST SOFTWARE TOOLS

Intel's host software development tools include the BITBUS Toolbox, a wide range of compilers and assemblers for all of Intel's microprocessors, software debug monitors, and in-circuit emulators.

BITBUS™ Toolbox—The Software Tool for All Applications

The BITBUS Toolbox is a set of six software utilities that greatly simplify development of host applications software for BITBUS systems. The utilities include: the BITBUS Monitor; two procedure libraries known as the Universal BITBUS Interface and the BITBUS Interface Handlers; PC Bridge communications software; and the OBJHEX and UDI2DOS code converters.

BITBUS™ Monitor. The BITBUS Monitor provides the designer an on-line "window" into the BITBUS network. Over 35 commands are available allowing an operator to check on the operation of various nodes, turn I/O either on or off, connect or disconnect nodes from the network, start or stop tasks running on a node, and download/upload code to/from remote boards. The Monitor is invaluable when first installing the BITBUS system, and is useful later to troubleshoot a node or the equipment connected to it.

Universal BITBUS™ Interface and BITBUS Interface Handlers. The Universal BITBUS Interface (UBI) is similar in function to the BITBUS Monitor, except that UBI calls can be made directly from the user's host application program rather than from an operator's terminal. Procedures are included that duplicate most of the BITBUS Monitor commands. The UBI is most useful for downloading code to a node, uploading data to the host, starting and stopping tasks running on the node, and writing/reading data to/from the BITBUS boards' I/O ports.

If a programmer wants to develop custom, UBI-like procedures, the Toolbox includes the BITBUS Interface Handlers, which are a set of 4 basic procedures that support communication with a BITBUS node.

PC Bridge, OBJHEX, and UDI2DOS—The Personal Computer Gateway to BITBUS™. The BITBUS Toolbox also includes the PC Bridge communications software and the OBJHEX conversion utility. Many BITBUS networks will use an Intel 310 system as the host in order to take advantage of the system's performance or multitasking capabilities. The PC Bridge and OBJHEX utilities enable the designer to use a PC to generate BITBUS node code, and then download the code through the 310 system to any node on the BITBUS network. The software also allows an operator to use a PC as a virtual terminal to the 310 system.

Some designers may choose to use their PC as the host system for the BITBUS network. To support these networks, the Toolbox includes the UDI2DOS utility, which is used to convert object code, developed using Intel tools, to a ".exe" format so that it will run on a PC.

The BITBUS Toolbox can be used on DOS, iRMX® 86/286, XENIX*, and iPDS™ based systems.

Host Code Compilers, Assemblers, and Other Tools

Intel's languages include PL/M, Fortran, PASCAL, C, and assembler for most of Intel's family of 8, 16, and 32-bit microprocessors. For debug support, PSCOPE, iSDM™, and Soft-Scope*, which are available in several versions, provide the programmer powerful software tools to rapidly isolate and correct faulty host code. These tools are supported on a variety of host systems, including DOS, iRMX 86/286, and XENIX.

For programmers who need an even fuller featured debug environment, Intel's I²ICE™ system combines the capabilities of an in-circuit emulator together with the PSCOPE 86 debug monitor and a 16-channel logic analyzer. The I²ICE system supports 8086, 8088, 80186, 80188, and 80286 code development. For programmers who are designing 80386 code, Intel provides the ICE™ 386 in-circuit emulator. The I²ICE and ICE 386 emulators are supported on DOS and Intel Series III/IV development systems.

SOFTWARE TOOLS FOR BITBUS™ CONTROLLER BOARDS

By adding node programs to BITBUS boards, the designer can take full advantage of the BITBUS boards' 8044 microcontroller's processing abilities. Programmed remote boards enable the designer to configure powerful, distributed control systems with a minimum investment in hardware.

Developing node code for remote BITBUS boards is just as easy as developing host code. Instead of using iAPX-based software, BITBUS boards run programs developed using "8051" tools. These tools include PL/M 51 and ASM 51 languages, RL51/LIB51 Linker/Locator/Librarian, and the ICE 5100/044 in-circuit emulator. BITBUS-specific software tools include DCS110 BITWARE and the DCS120 Programmer's Support Package.

PL/M 51 and ASM 51 Languages

The programmer can write node code using either PL/M 51 or the ASM 51 assembler. Many programs are written using PL/M 51 because the language's higher level statements reduce programming time and produce reliable, easy-to-maintain code. If necessary, speed-critical code is written using ASM 51.

*XENIX is a trademark of Microsoft Inc.; Soft-Scope is a registered trademark of Concurrent Sciences, inc.

Multitasking Executive and DCS120 Maximize System Performance

Included in the 8044BEM microcontroller on every BITBUS board is the DCX 51 multitasking executive, which allows up to 7 user tasks plus the RAC task to run on the board concurrently. If the programmer is writing code for a remote board that controls several interrelated tasks, he can segment the code into separate tasks and increase overall performance by using the multitasking management provided by the executive. Twelve DCX 51 calls are available providing tasks with timing services, communications to other tasks on the board, memory management services, and the ability to dynamically create and delete running tasks.

To access DCX 51 services, Intel provides the DCS120 Programmer's Support Package, which includes an interface library to DCX 51 plus DCX 51 Procedure declaration files. To use DCS120, the programmer adds the declaration files to the source code. Then, after the source modules are compiled, the interface library is linked with the object modules and any other user libraries.

ICE 5100/044 and DCS110— The Bug Chasers

To provide debug support for node code development, Intel provides the ICE 5100/044 in-circuit emulator and the DCS110 BITWARE product. ICE 5100/044 includes an 8044 probe that plugs into the BITBUS board in place of the BITBUS 8044 microcontroller. BITWARE, which is DCM44 firmware, provides the necessary software so the ICE 5100/044 can emulate a BITBUS environment. DCS110 also includes the DCX 51 interface library and declaration files that are provided in the DCS120 product.

INTEL SOFTWARE DEVELOPMENT TOOLS—COMPLETE IN EVERY WAY

Intel provides a complete set of tools for the software designer ranging from compilers and debug monitors for the host system and BITBUS nodes to specialized BITBUS software, like the BITBUS Toolbox and BITWARE. These tools are available for a wide variety of development environments, including Intel's system 310 and the PC as shown in Table 1.

	BITBUS™ TOOLS — TOOLBOX —								NODE CODE			ICE™			EPROM PROG.	
	BBM	UBI	BIH	PC Bridge	OBJHEX	UDI2DOS	BITWARE	Prog. Spt. Pkg.	ASM 51	PL/M 51	RL 51, LIB 51	ICE 5100/044	ICE 44	EMV 44	iUP200A/201A with iUPF87/44A module and iPPS sw	iPDS with iUPF87/44A module and iPPS sw
Series II									C	C	C		E		X	
III			X				X	X	X	X	X	X	E		X	
IV							X	X	X	X	X	X	E		X	
iPDS	A	A	A				X	X	C	C	C			E		X
iRMX 5¼"	X	X	X	X	X		X	X	D	D	D					
8"	X	X	X	X	X		X	X	D	D	D					
XENIX 5¼"	X	X		B	X											
8"	X	X		B	X											
DOS	X	X	X	X	X	X	X	X	X	X	X	X			X	

Notes:
A iPDS uses Release 1 Toolbox
B Supports operation with XENIX. XENIX disks not required
C Down-revision version
D Available for iRMX® 86
E ICE 44 and EMV 44 have been replaced by the ICE™ 5100/044

Table 1

Want to Know More?

Intel publishes several databooks that provide detailed technical information on these and other software products together with application data. If you would like more information about Intel software for BITBUS applications, contact your local Intel sales office or distributor for the following literature:

- Distributed Control Modules Databook 230973
- Development Tools Handbook 210940
- Embedded Controller Handbook 210918

BITBUS Software Products Order Codes:

Product	**Order Code**
BITBUS Toolbox	iDCS100
BITWARE	iDCS110
Programmer's Support Package	iDCS120

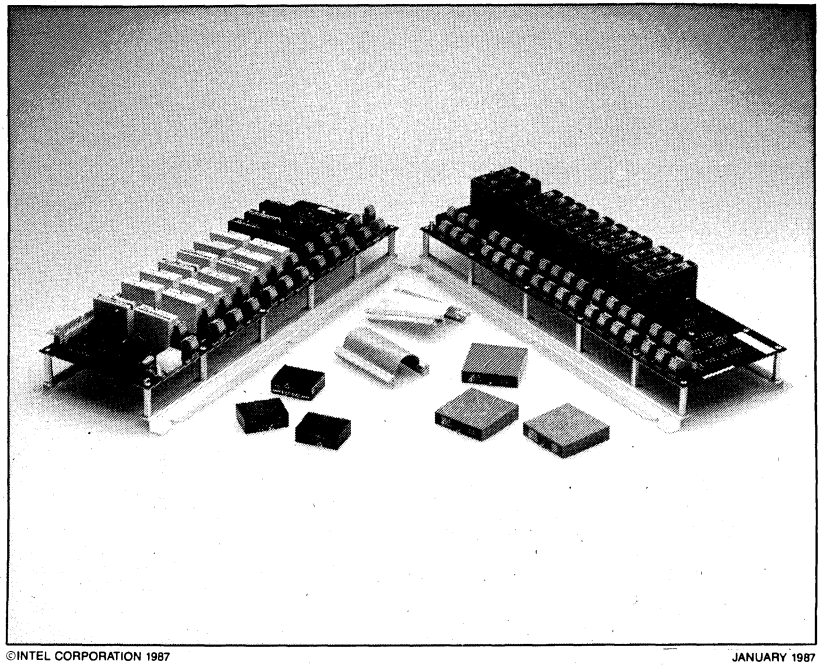
iRCX 910/920 DIGITAL/ANALOG SIGNAL CONDITIONING ISOLATION AND TERMINATION PANELS

iRCX-910

- Digital termination for BITBUS™ iRCB 44/10 digital remote controller board, iSBX™ 350 digital MULTIMODULE™ and Multibus® digital I/O single board computers (SBCs)
- Sockets for 24 industry-standard, optically coupled isolation and signal conditioning I/O modules
- LEDs indicate status of each module
- Separate connectors for BITBUS, Power, RCB and Expansion I/O
- Integral mounting site for one 24 channel digital iRCB 44/10

iRCX 920

- Analog termination for iRCB 44/20, iSBX 311, iSBX 328, and iSBC 88/40
- Sockets accepting up to 18 Analog Devices Corporation's 5B Series of isolation and signal conditioning modules
- Separate connectors for BITBUS, Power, RCB and Expansion I/O
- Integral mounting site for one 18-channel analog iRCB 44/20



JANUARY 1987
ORDER NUMBER: 280443-001

More Convenient BITBUS™ System Integration

Intel now provides one more building block for developing BITBUS™ networks: the iRCX 910/920 Digital/Analog Signal Isolation and Termination Panels. These boards provide remote node termination and isolation in a design that's easy to install and service. They work with Intel's RCB 44/10 and 44/20, which provide analog/digital control, and with Intel's BITBUS Monitor, DCX-51 Real-time Multitasking Executive and BITBUS Toolbox, which provide the software support.

Intel makes BITBUS system integration easier and more convenient than ever.

Compatible With a Wide Range of Intel MULTIBUS® Boards

The iRCX 910 and iRCX 920 not only work with the iRCB 44/10 and 44/20 controller boards but also with a wide range of MULTIBUS® boards both from Intel and MULTIBUS Manufacturing Group vendors. The 50-pin expansion connection on the iRCX panels makes iSBC and iSBX board connection easy.

Table 1 shows the Intel iSBC and iSBX boards currently compatible with the iRCX products.

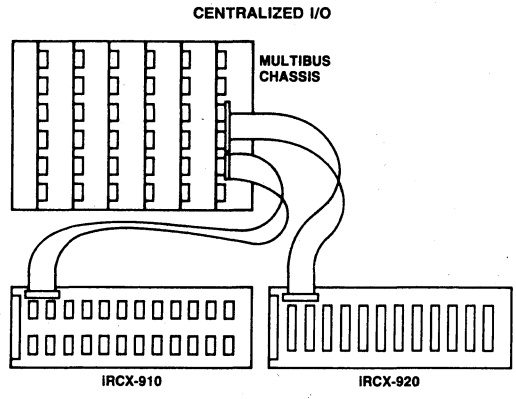
iRCX 910: Compatible With Industry-Standard I/O Modules

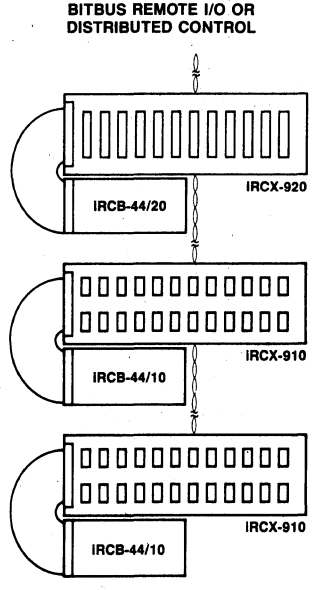
The iRCX 910 provides sockets for 24 channels of user-provided digital I/O to perform AC or DC switching and isolation. The user can configure up to 24 I/O channels, filling only the channels needed for the application. The iRCX 910 accepts a wide range of industry-standard I/O modules, including those from Gordos, Opto 22, Crydom, Potter-Brumfield and others[1]. The input modules convert high-level inputs from such sources as limit or proximity switches to TTL levels. The output modules convert TTL to high-level signals for driving motor starters, solenoids, indicating lights, and the like. Regardless of whether input or output, these modules typically provide greater than 1500 volt isolation, 2-3 KV of transient noise protection, and signal conditioning in a wide range of voltages. An LED for each channel shows on/off status, and a 5 amp fuse provides overcurrent protection.

[1]Mention of these companies in no way constitutes an endorsement by Intel of their products.

Table 1: Intel Boards Compatible with iRCX 910 and iRCX 920.

iRCX 910		iRCX 920	
Intel iSBCs	**iSBX**	**Intel iSBC**	**Intel iSBX**
80/10B	350	88/40A	311
80/20-4			328
80/24A			
80/30			
80/05A			
86/14			
86/30			
86/35			
88/25			
88/40A			
517			
519			





Examples of how iRCX 910 and 920s can be used in MULTIBUS and BITBUS systems.

iRCX 920: Uses Analog Devices Corporation Modules to Provide State-of-the-Art Signal Conditioning and Isolation

The iRCX 920 terminates 18 analog signals going to and from field wiring and provides signal conditioning and isolation using Analog Devices Corporation's 5B Series of analog isolation and signal conditioning modules (purchased separately). These modules provide 240 volt RMS field wiring protection, 1500 volt RMS common mode voltage isolation and signal conditioning in a wide range of analog voltage and currents, including thermocouple and RTD sensors, millivolt and volt inputs, and 0-20 ma and 4-20 ma process current outputs. Possible connections include temperature and pressure sensors, frequency counters and many others. The iRCB 44/20 when used in conjunction with the iRCX 920 provides up to 16 analog inputs and 2 analog outputs.

The iRCX 920 also contains an integral temperature sensor isothermal barrier strip (RTD) to provide a temperature reference for thermocouple modules doing cold junction compensation. Because this compensation is implemented in hardware rather than software, it simplifies the controller software's task, allowing superior software performance.

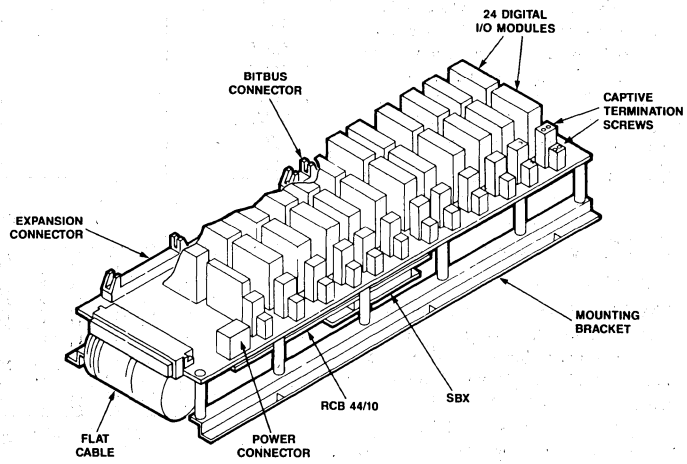
Easy to Install, Easy to Use

The iRCX panels provide a quick and easy, plug-in solution to remote node BITBUS interconnection. They can be mounted to an industrial panel or in a standard RETMA 19″ rack when used with a customer provided 19″L × 7″W pan. Quick access to the RCB 44/10 and 44/20 boards is accomplished by loosening six screws and shifting the iRCX slightly. Field wiring connections are made using captive screw terminals, positioned to allow easy wire routing. Installation is quick, service is easy.

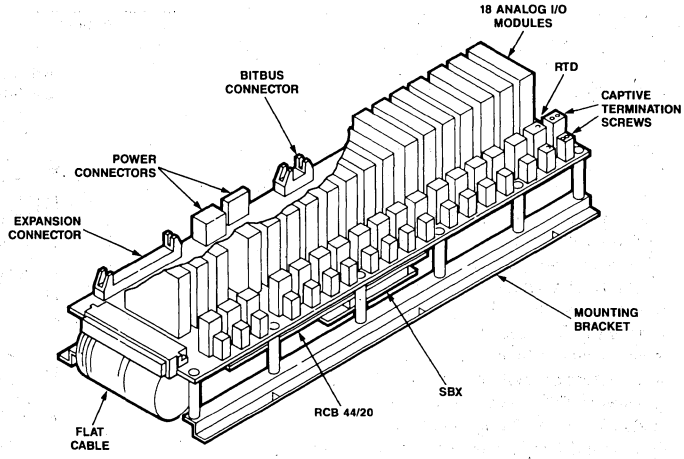
The I/O modules on the iRCX 910 are color-coded for easy identification. LEDs provide on/off status, allowing the operator a quick verification of I/O operation, and are also useful for start-up testing, debugging and trouble-shooting a process or machine breakdown.

Increased Reliability

The iRCX 910 and 920 feature improved noise immunity through judicious component placement and the inclusion of a ground terminal. Also, they're mounted in front of the iRCB 44/10 and 44/20 boards, protecting the heart of the remote node from accidental damage.



iRCX 910: The Complete Remote Node Solution for Distributed I/O and Control.



iRCX 920: The Complete Remote Node Solution for Distributed I/O and Control.

Specifications

POWER REQUIREMENTS (TYPICAL)

RCX 910

V_{CC} = +5 VDC ±5%
I_{CC} = 0.03 a/module installed
+1.00 a (if RCB 44/10 installed)
\+ current requirements of any installed SBX

RCX 920

V_{CC} = + 5 VDC ±5%
I_{CC} = 0.03 a/input module
+0.17 a/output module
+1.00 a (if RCB 44/20 is installed)
\+ current requirements of any installed SBX

Additional Power Requirements when used with RCB 44/20
100 ma @ +12 VDC ±4%
100 ma @ −12 VDC ±4%

DIMENSIONS

RCX 910
Width: 17.00″ (43.18 cm)
Height: 6.20″ (15.75 cm)
Depth: 3.25″ (8.26 cm) with user-provided modules installed

RCX 920
Width: 17.00″ (43.18 cm)
Height: 6.20″ (15.75 cm)
Depth: 4.25″ (10.80 cm) with user-provided modules installed

ENVIRONMENTAL REQUIREMENTS

RCX 910/RCX 920 Standalone
Operating Temperature: 0° to 70° C (32° to 158° F)
Operating Humidity: 0–90% R.H. (non-condensing)

RCX 910/RCX 920 with mounted RCB
In still air:
0° to 55° C (32° to 131° F)
With 200 linear feet/minute forced air:
0° to 60° C (32° to 140° F)

Ordering Information

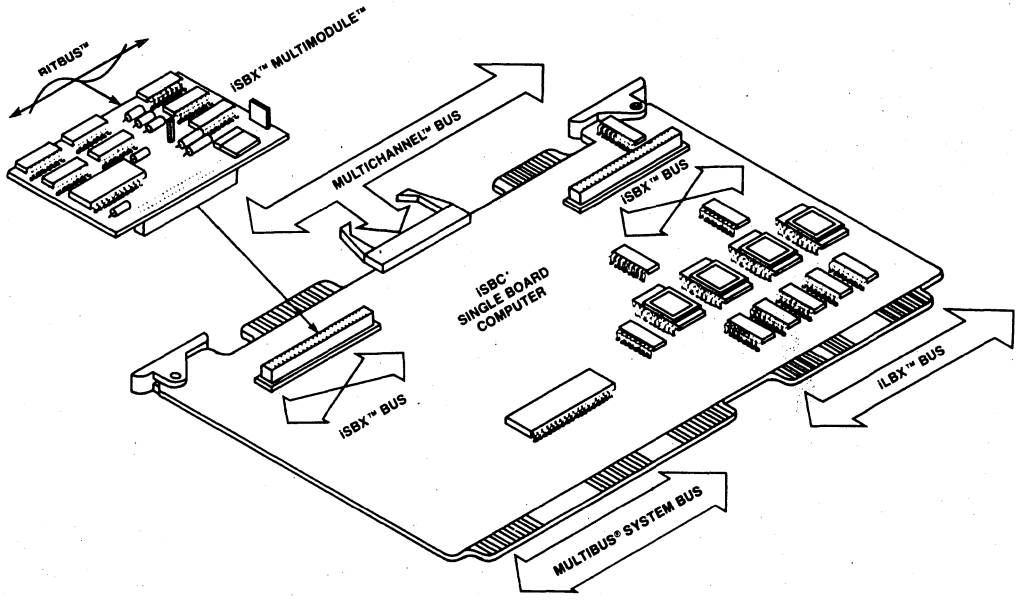
Part Name	Description
iRCX 910	BITBUS Digital Signal Conditioning, Isolation, and Termination Panel
iRCX 920	BITBUS Analog Signal Conditioning, Isolation, and Termination Panel
Analog I/O Modules	Analog Devices 5B Series To order contact: Analog Devices Corporation One Technology Way Norwood, MA 02062 (617) 329-4700

MULTIBUS® I Architecture 18

MULTIBUS® SYSTEM BUS

- **IEEE 796 Industry Standard System Bus**
- **Supports Multiple Processor Systems with Multi-Master Bus Structure**
- **8-Bit, 16-Bit, and 32-Bit Devices Share the Same MULTIBUS® System Resources**
- **Foundation of Intel's Total System Architecture: MULTIBUS®, iLBX™, MULTICHANNEL™, BITBUS™ and iSBX™ Buses**
- **16 Mbyte Addressing Capability**
- **Bus Bandwidth of Up to 10 Megabytes Per Second**
- **Supported by a Complete Family of Single Board Computers, Memory, Digital and Analog I/O, Peripheral Controllers, Graphics and Speech Recognition, Packaging and Software**
- **Supported by Over 200 Vendors Providing Over 2000 Compatible Products**

The MULTIBUS® System bus is one of a family of standard bus structures resident within Intel's total system architecture. The MULTIBUS interface is a general purpose system bus structure containing all the necessary signal lines to allow various system components to interact with one another. This device interaction is built upon the master-slave concept. The "handshaking" between master and slave devices allows modules of different speeds to use the MULTIBUS interface and allows data rates of up to 5 million transfers per second. The MULTIBUS system bus can support multiple master devices (16) on a 18 inch backplane and can directly address up to 16 megabytes of memory. As a non-proprietary, standard system bus, the MULTIBUS interface has become the most prominent 8/16-bit microcomputer system bus in the industry with over 200 vendors supplying over 2000 MULTIBUS compatible products. Its success as the industry standard has been reinforced by adoption of the MULTIBUS specification by the Institute of Electrical and Electronic Engineers—(IEEE 796 System Backplane Bus). MULTIBUS-based systems have been designed into applications, such as, industrial automation and control, office systems and word processing, graphics systems and CAD/CAM, telecommunications systems and distributed processing.



280294-1

October 1986
Order Number: 280294-001

FUNCTIONAL DESCRIPTION

Architectural Overview

The MULTIBUS® system bus is the physical framework and the conceptual foundation of Intel's total system architecture. It is a general purpose system bus used in conjunction with the single board computer concept to provide a flexible mechanism for inter-module processing, control and communication. The MULTIBUS interface supports modular CPU, memory and I/O expansion in flexible, cost effective microcomputer system configurations. These configurations implement single board computers and expansion modules in a multiple processor approach to enhance system performance. This enhanced performance is achieved through partitioning of overall system functions into tasks that each of several processors can handle individually. When new system functions are added (peripherals) more processing power can be applied to handle them without impacting existing processor tasks.

Structural Features

The MULTIBUS interface is an asynchronous, multiprocessing system bus designed to perform 8-bit and 16-bit transfers between single board computers, memory and I/O expansion boards. Its interface structure consists of 24 address lines, 16 data lines, 12 control lines, 9 interrupt lines, and 6 bus exchange lines. These signal lines are implemented on single board computers and a mating backplane in the form of two edge connectors resident on 6.75″ × 12.00″ form factor PC boards. The primary 86-pin P1 connector contains all MULTIBUS signal lines except the four address extension lines. The auxiliary 60-pin P2 connector contains the four MULTIBUS address extension lines, and reserves the remaining 56 pins for implementing the iLBX Execution Bus into the MULTIBUS system architecture.

Bus Elements

The MULTIBUS system bus supports three device categories: 1) Master, 2) Slave, 3) Intelligent Slave.

A bus master device is any module which has the ability to control the bus. This ability is not limited to only one master device. The MULTIBUS interface is capable of supporting multiple masters on the same system through bus exchange logic. Once access has been acquired by a master device, it has a period of exclusive control to affect data transfers through a generation of command signals, address signals and memory or I/O addresses.

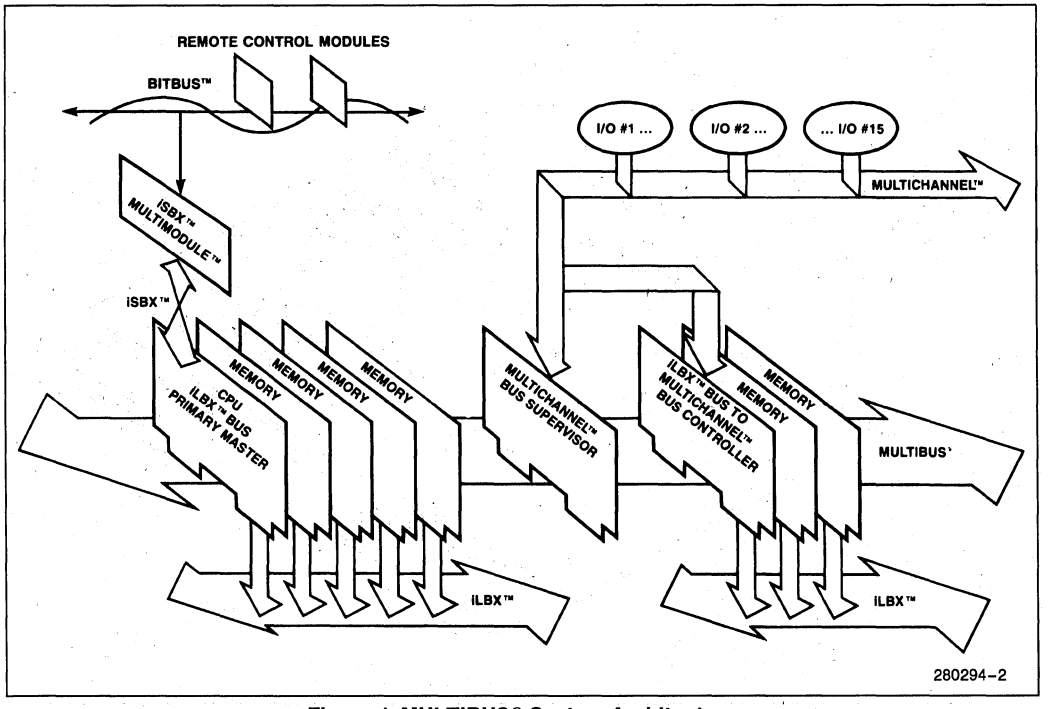


Figure 1. MULTIBUS® System Architecture

A bus slave device is a module that decodes the address lines on the MULTIBUS and acts upon the command signals from the bus masters. Slave devices are not capable of controlling the MULTIBUS interface.

The intelligent slave has the same bus interface attributes as the slave device but also incorporates an on-board microprocessor to control on-board memory and I/O tasks. This combination of on-board processor, memory and I/O allow the intelligent slave to complete on-board operations without MULTIBUS access.

Bus Interface/Signal Line Descriptions

The MULTIBUS system bus signal lines are grouped into five classes based on the functions they perform: 1) control lines, 2) address and inhibit lines, 3) data lines, 4) interrupt lines, 5) bus exchange lines. Figure 2 shows the implementation of these signal lines.

The MULTIBUS control lines are broken down into five sub-groups: clock signals (2), commands (4), acknowledge (1), initialize (1), and lock (1). The two clock signals provide for the generation of a master

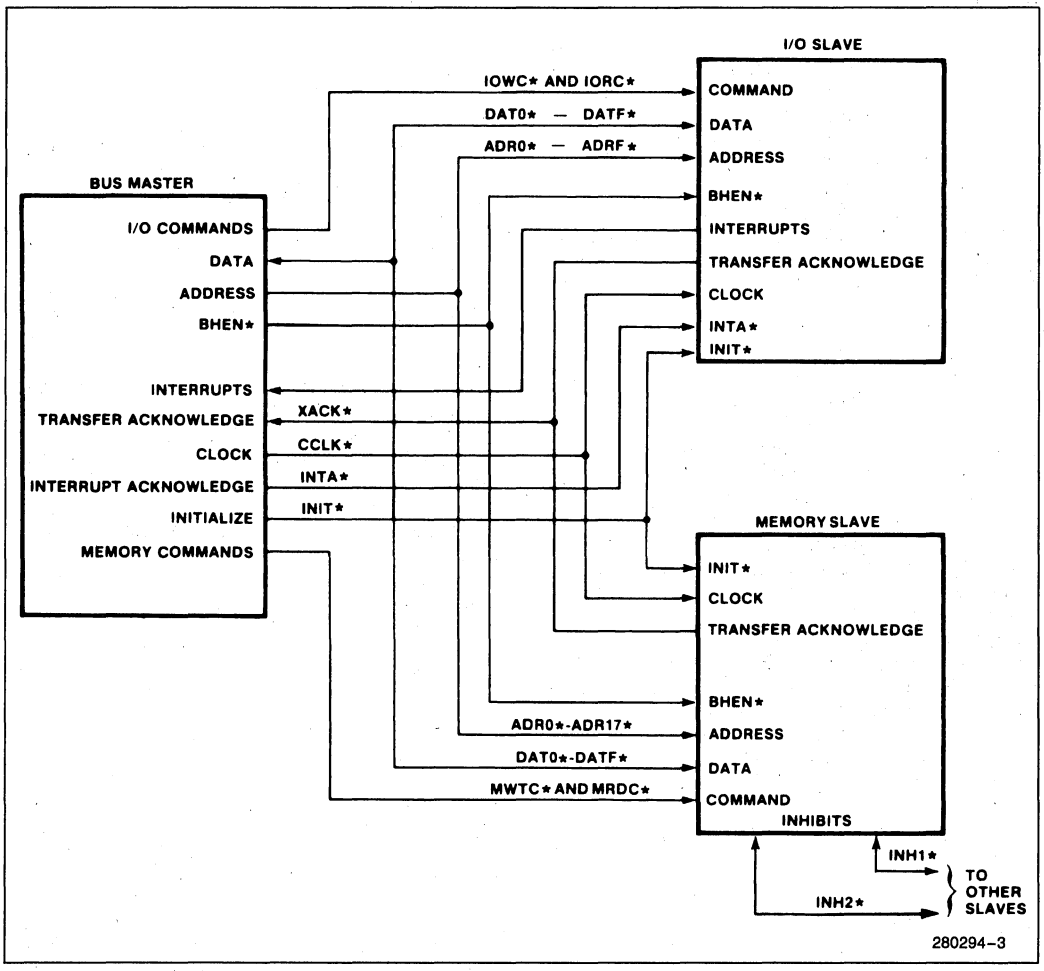


Figure 2. MULTIBUS® Interface Signal Lines

clock for the system and the synchronization of bus arbitration logic. The four command lines are the communication links between the bus masters and bus slaves, specifying types of operations to be performed such as reads or writes from memory or I/O. The transfer acknowledge line is the slave's acknowledgement that a requested action of the master is complete. The initialize signal is generated to reset the entire system to a known state. The lock signal is used by an active bus master to lock dual-ported for mutual exclusion.

The address and inhibit lines are made up of 24 address lines, two inhibit lines, and one byte control line. The 24 address lines are signal lines used to carry the address of the memory location or the I/O device that is being referenced. These 24 lines allow a maximum of 16 million bytes of memory to be accessed. When addressing an I/O device, sixteen address lines are used to address a maximum of 64 thousand devices. The two inhibit lines are used to allow different types of memory (RAM, ROM, etc.) having the same memory address to be accessed in a preferred priority arrangement. The byte control line is used to select the upper byte of a 16-bit word in systems incorporating 16-bit memory and I/O modules.

The MULTIBUS interface supports sixteen bi-directional data lines to transmit or receive information to or from a memory location or an I/O port.

The MULTIBUS interrupt lines consist of eight interrupt request lines and one interrupt acknowledge line. Interrupts are requested by activating one of the eight interrupt request lines. The interrupt acknowledge signal is generated by the bus master when an interrupt request is received. It effectively freezes interrupt status and requests the placement of the interrupt vector address onto the data lines. There are six bus exchange lines that support two bus arbitration schemes on the MULTIBUS system bus. A bus master gains control of the bus through the manipulation of these signals. The bus request, bus priority, bus busy, and bus clock signals provide for a slot dependent priority scheme to resolve bus master contention on the MULTIBUS interface. Use of the common bus request signal line can save arbitration time by providing for a higher priority path to gain control of the system bus.

Bus Operation Protocol

DATA TRANSFER OPERATION

The data transfer operation of the MULTIBUS system bus is a straight-forward implementation of an asynchronous master-slave handshaking protocol. Figures 3 and 4 show the basic timing for a read and write data transfer operation. A MULTIBUS data transfer begins by having the bus master place the memory or I/O port address on the address bus. If the operation is a write, the data is also placed on the data lines at this time. The bus master then generates a command (I/O read or write, or memory read or write) which activates the appropriate bus slave. The slave accepts the data if it is a write operation, or places data on the data bus if it is a read. A transfer acknowledge is then sent to the bus master by the bus slave, allowing the bus master to complete its cycle, removing the command from the command line, and then removing the address and data from the MULTIBUS interface.

INTERRUPT OPERATIONS

The MULTIBUS interface supports two types of interrupt implementation schemes, Non-Bus Vectored and Bus Vectored. Non-Bus vectored interrupts are interrupts handled on the bus master which do not require the MULTIBUS interface for transfer of the interrupt vector address. The interrupt vector address is generated by the interrupt controller on the master and transferred to the processor over the local bus when an interrupt request line is activated by a slave module over the MULTIBUS interface. Bus vectored interrupts are interrupts which transfer the interrupt vector address along the MULTIBUS data lines from the slave to the bus master using the interrupt acknowledge command signal for synchronization. When an interrupt request occurs, the interrupt control logic on the bus master interrupts the processor, generating an interrupt acknowledge command that freezes the interrupt logic on the bus for priority resolution and locks the MULTIBUS system bus. After the bus master selects the highest priority active interrupt request lines, a set of interrupt sequences allow the bus slave to put its interrupt vector address on the data lines. This address is used as a pointer to interrupt the service routine.

BUS EXCHANGE TECHNIQUES

The MULTIBUS system bus can accommodate several bus masters on the same system, each one taking control of the bus as it needs to affect data transfers. The bus masters request bus control through a bus exchange sequence.

The MULTIBUS interface provides for two bus exchange priority techniques: a serial technique and a parallel technique. In a serially arbitrated MULTIBUS system, requests for system bus access are ordered by priority on the basis of bus slot location. Each master on the bus notifies the next lower priority master when it needs to use the bus, and it monitors the bus request status of the next higher priori-

ty-master. Thus, the masters pass bus requests along from one to the next in a daisy chain fashion. The parallel bus arbitration technique resolves system bus master priorities using external hardware in the form of a priority resolution circuit. This parallel arbitration logic is included in many commercially available cardcages.

Mechanical Implementation

BUS PIN ASSIGNMENTS

Printed circuit boards (6.75" x 12.00") designed to interface to the MULTIBUS system bus have two connectors which plug into the bus backplane. These connectors, the 86-pin P1 (Primary) and the 60-pin P2 (Auxiliary), have specific pin/signal assignments. Because of this, the designer must insure that the MULTIBUS backplane being designed is compatible (pin-for-pin) with these two connectors. Tables 1 and 2 show the pin/signal assignments for the P1 and P2 edge connectors. The MULTIBUS interface connection is accomplished via a rigid backplane that has connectors that mate to the P1 (43/86-pin) board edge connector and allows for connectors that mate to the P2(30/60-pin) board edge connector. Figure 5 shows a typical MULTIBUS backplane. Figure 6 displays the connector and pin numbering convention. Figure 7 shows the standard MULTIBUS form-factor printed wiring board outline.

Please refer to Intel's MULTIBUS specification and iLBX bus specification for more detailed information.

Table 1. MULTIBUS® Pin/Signal Assignment—(P1)

	Pin	(Component Side)		Pin	(Circuit Side)	
		Mnemonic	Description		Mnemonic	Description
Power Supplies	1	GND	Signal GND	2	GND	Signal GND
	3	+5V	+5Vdc	4	+5V	+5 Vdc
	5	+5V	+5Vdc	6	+5V	+5 Vdc
	7	+12V	+12Vdc	8	+12V	+12 Vdc
	9		Reserved, bussed	10		Reserved, bussed
	11	GND	Signal GND	12	GND	Signal GND
Bus Controls	13	BCLK*	Bus Clock	14	INIT*	Initialize
	15	BPRN*	Bus Pri. In	16	BPRO*	Bus Pri. Out
	17	BUSY*	Bus Busy	18	BREQ*	Bus Request
	19	MRDC*	Mem Read Cmd	20	MWTC*	Mem Write Cmd
	21	IORC*	I/O Read Cmd	22	IOWC*	I/O Write Cmd
	23	XACK*	XFER Acknowledge	24	INH1*	Inhibit 1 (disable RAM)
Bus Controls and Address	25	LOCK*	Lock	26	INH2*	Inhibit 2 (disable PROM
	27	BHEN*	Byte High Enable	28	AD10*	or ROM)
	29	CBRQ*	Common Bus Request	30	AD11*	Address
	31	CCLK*	Constant Clk	32	AD12*	Bus
	33	INTA*	Intr Acknowledge	34	AD13*	
Interrupts	35	INT6*	Parallel	36	INT7*	Parallel
	37	INT4*	Interrupt	38	INT5*	Interrupt
	39	INT2*	Requests	40	INT3*	Requests
	41	INT0*		42	INT1*	
Address	43	ADRE*		44	ADRF*	
	45	ADRC*		46	ADRD*	
	47	ADRA*	Address	48	ADRB*	Address
	49	ADR8*	Bus	50	ADR9*	Bus
	51	ADR6*		52	ADR7*	
	53	ADR4*		54	ADR5*	
	55	ADR2*		56	ADR3*	
	57	ADR0*		58	ADR1*	

Table 1. MULTIBUS® Pin/Signal Assignment—(P1) (Continued)

	Pin	(Component Side)		Pin	(Circuit Side)	
		Mnemonic	Description		Mnemonic	Description
Data	59	DATE*		60	DATF*	
	61	DATC*		62	DATD*	
	63	DATA*	Data	64	DATB*	Data
	65	DAT8*	Bus	66	DAT9*	Bus
	67	DAT6*		68	DAT7*	
	69	DAT4*		70	DAT5*	
	71	DAT2*		72	DAT3*	
	73	DAT0*		74	DAT1*	
Power	75	GND	Signal GND	76	GND	Signal GND
Supplies	77		Reserved, bussed	78		Reserved, bussed
	79	−12V	−12 Vdc	80	−12V	−12 Vdc
	81	+5V	+5 Vdc	82	+5V	+5 Vdc
	83	+5V	+5 Vdc	84	+5V	+5 Vdc
	85	GND	Signal GND	86	GND	Signal GND

NOTES:
All Reserved pins are reserved for future use and should not be used if upwards compatibility is desired.
*The Reserved MULTIBUS P2 connector pin/signal assignments are contained in Intel's iLBX Bus Specification.

Table 2. MULTIBUS® Pin/Signal Assignment—(P2)

	Pin	(Component Side)		Pin	(Circuit Side)	
		Mnemonic	Description		Mnemonic	Description
	1		Reserved	2		Reserved
	3		Reserved	4		Reserved
	5		Reserved	6		Reserved
	7		Reserved	8		Reserved
	9		Reserved	10		Reserved
	11		Reserved	12		Reserved
	13		Reserved	14		Reserved
	15		Reserved	16		Reserved
	17		Reserved	18		Reserved
	19		Reserved	20		Reserved
	21		Reserved	22		Reserved
	23		Reserved	24		Reserved
	25		Reserved	26		Reserved
	27		Reserved	28		Reserved
	29		Reserved	30		Reserved
	31		Reserved	32		Reserved
	33		Reserved	34		Reserved
	35		Reserved	36		Reserved
	37		Reserved	38		Reserved
	39		Reserved	40		Reserved

Table 2. MULTIBUS® Pin/Signal Assignment—(P2) (Continued)

	Pin	(Component Side)		Pin	(Circuit Side)	
		Mnemonic	Description		Mnemonic	Description
	41		Reserved	42		Reserved
	43		Reserved	44		Reserved
	45		Reserved	46		Reserved
	47		Reserved	48		Reserved
	49		Reserved	50		Reserved
	51		Reserved	52		Reserved
	53		Reserved	54		Reserved
Address	55	ADR16*	Address Bus	56	ADR17*	Address Bus
	57	ADR14*		58	ADR15*	
	59		Reserved, Bussed	60		Reserved, Bussed

NOTES:
All Reserved Pins are reserved for future use and should not be used if upwards compatibility is desired.
*The Reserved MULTIBUS P2 connector pin/signal assignments are contained in Intel's iLBX Bus Specification.

SPECIFICATION

Word Size

Data: 8- and 16-bit

Memory Addressing

24-bits: 16 megabyte-direct access

I/O Addressing

16-bit: 64 Kbytes

Maximum Bus Backplane Length

18 inches

Electrical Characteristics

BUS POWER SUPPLY SPECIFICATIONS

Table 3

Standard(1)				
Parameter	Ground	+5	+12	−12
Mnemonic	GND	+5V	+12V	−12V
Bus Pins	P1-1,2,11,12, 75,76,85,86	P1-3,4,5,6, 81,82,83, 84	P1-7,8,	P1-79,80
Tolerance	Ref.	±1%	±1%	±1%
Combined Line & Load Reg	Ref.	0.1%	0.1%	0.1%
Ripple (Peak to Peak)	Ref.	50 mV	50 mV	50 mV
Transient Response (50% Load Change)		100 μs	100 μs	100 μs

NOTE:
1. Point of measurement is at connection point between motherboard and power supply. At any card edge connector a degradation of 2% maximum (e.g. voltage tolerance ±2%) is allowed.

Bus Devices Supported

16 total devices—(Master, Slave, Intelligent Slave)

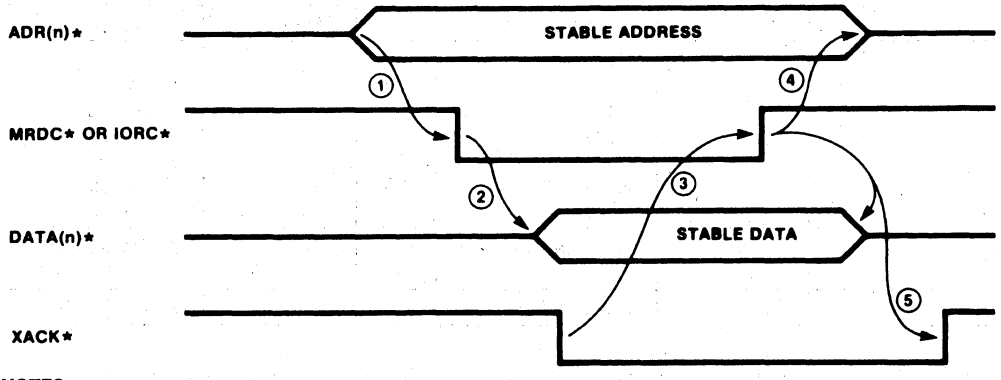
Bus Bandwidth

10 megabytes/sec: 16-bit
5 megabytes/sec: 8-bit

Bus Exchange Cycle

200 ns—Best Case; 300 ns—Worst Case (assuming no bus master is currently active on the bus.)

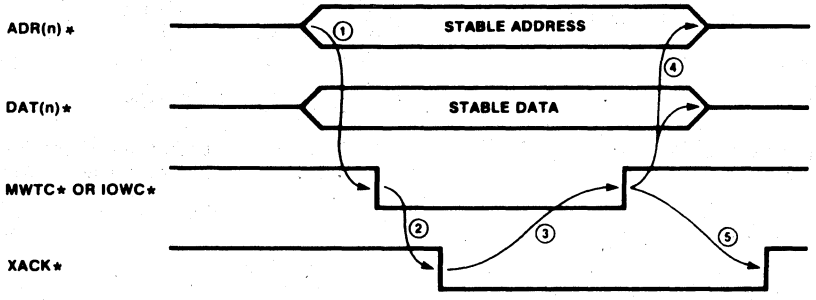
BUS TIMING



280294-4

NOTES:
1. Address Setup Time: 50 Nanoseconds Minimum.
2. Time Required for Slave to Get Data Onto Bus in Accordance with Setup Time Requirement. XACK* can be Asserted as soon as Data is on Bus.
3. Time Required for Master to Remove Command.
4. Address and Data Hold Time; 50 Nanoseconds Minimum.
5. XACK* and Data Must be Removed from the Bus a Maximum of 65 Nanoseconds after the Command is Removed.

Figure 3. Memory or I/O Read Timing

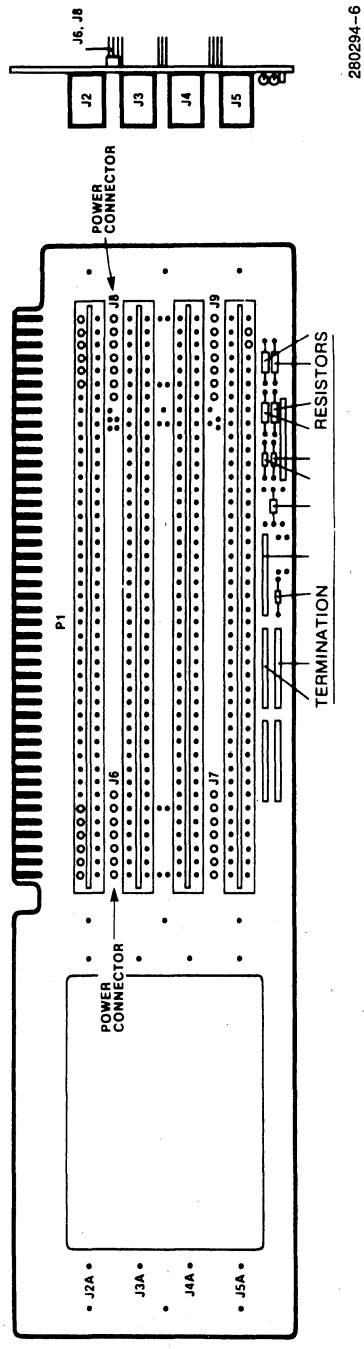


280294-5

NOTES:
1. Address and Data Setup; 50 Nanoseconds Minimum.
2. Time Required for Slave to Accept Data.
3. Time Required for Master to Remove Command from Bus.
4. Address and Data Hold Time; 50 Nanoseconds Minimum.
5. XACK* Must be off the Bus 65 Nanoseconds after Command.

Figure 4. Memory or I/O Write Timing

PHYSICAL CHARACTERISTICS



Parts List
1 PWB Termination Backplane
2 7 Post Wafer Connectors (0.156" Pin Centers) (J6 and J8)
4 Edge Board Connectors, 43/86 Pins on 0.156" Centers (J2–J5)
12 Wire Wrap Posts
4 10 Pin, 2.2K, 9 RES, 1.5W Resistor Packs (RP1–RP4)
1 10 Pin, 1K, 9 RES, 1.5W Resistor Pack (RP5)
1 10 Pin, 1.1K, 9 RES, 1.5W Resistor Pack (RP6)
1 1K Resistor, ⅛W, ±5% (R1)
1 2.2K Resistor, ⅛W, ±5% (R5)
2 220Ω Resistors, ¼W, ±5% (R9, R11)
2 330Ω Resistors, ¼W, ±5% (R10, R12)
2 510Ω Resistors, ⅛W, ±5% (R7, R8)

Figure 5. MULTIBUS® System Backplane Example

Physical Characteristics (Continued)

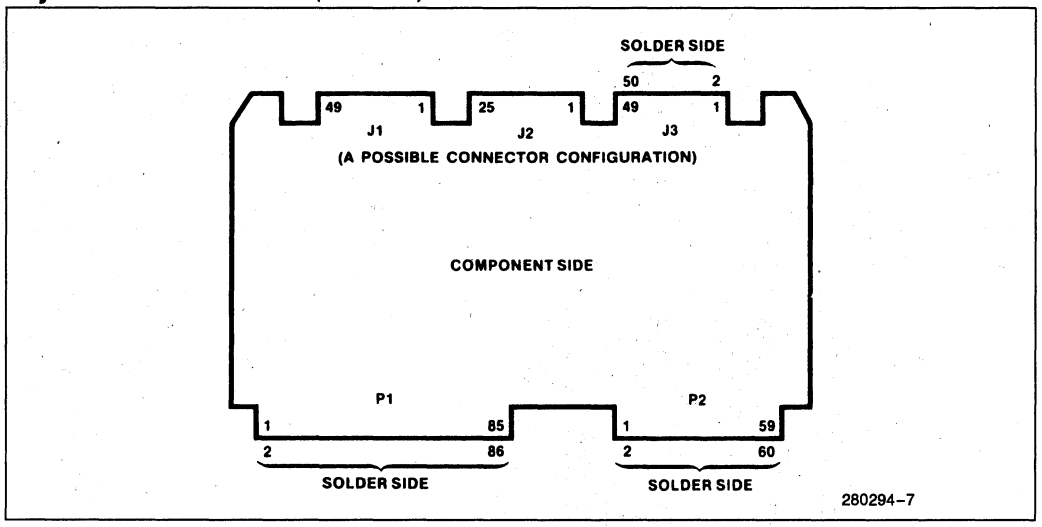


Figure 6. Connector and Pin Numbering

PHYSICAL CHARACTERISTICS (Continued)

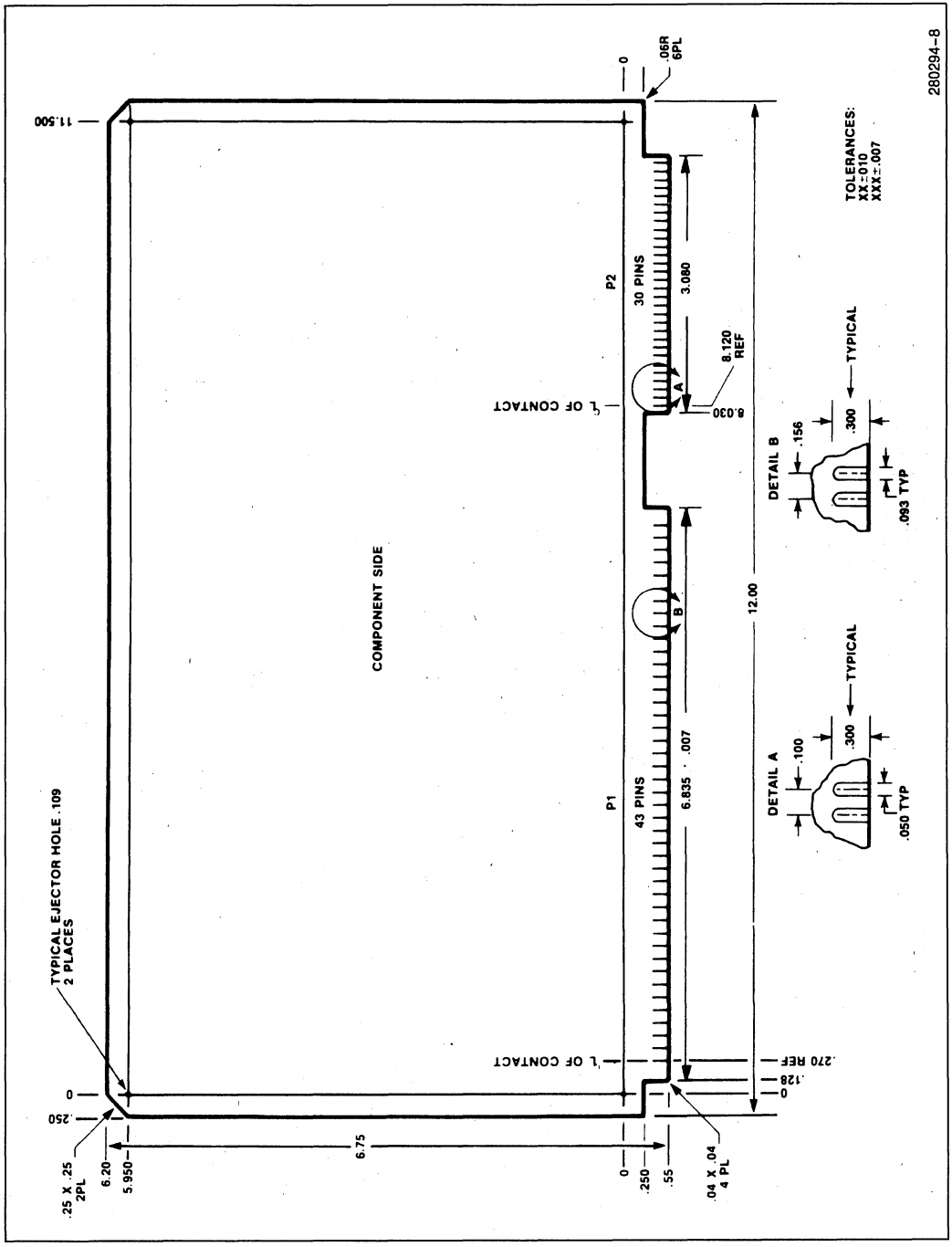


Figure 7. Standard Printed Wiring Board Outline

Backplane Connectors

Table 4. Connector Vendors

Function	# Of Pins	Centers Inches	Connector Type	Vendor	Vendor #	Intel #
Multibus Connector (P1)	43/86	0.156	Soldered(1)	VIKING ELFAB	2KH43/9AMK12 BS1562D43PBB	102247-001
Multibus Connector (P1)	43/86	0.156	Wire wrap(1, 2)	ELFAB ELDAC	BW1562D43PBB 3370860540201	102248-001
				ELFAB EDAC	BW1562A43PBB 337086540202	102273-001(3)
Auxiliary Connector (P2)	30/60	0.1	Soldered(1)	ELFAB EDAC	BS1020A30PBB 345060524802	102238-001
Auxiliary Connector (P2)	30/60	0.1	Wire wrap(1, 2)	TI VIKING	H421121-30 3KH30/9JNK	N/A(3)
				EDAC ELFAB	345060540201 BW1020D30PBB	102241-001

NOTES:
1. Connector heights are not guaranteed to conform to Intel packaging equipment.
2. Wirewrap pin lengths are not guaranteed to conform to Intel packaging equipment.
3. With mounting ears with 0.128 mounting holes.

Environmental Characteristics

Operating Temperature: 0°C to 60°C; free moving air across modules and bus

Humidity: 90% maximum (no condensation)

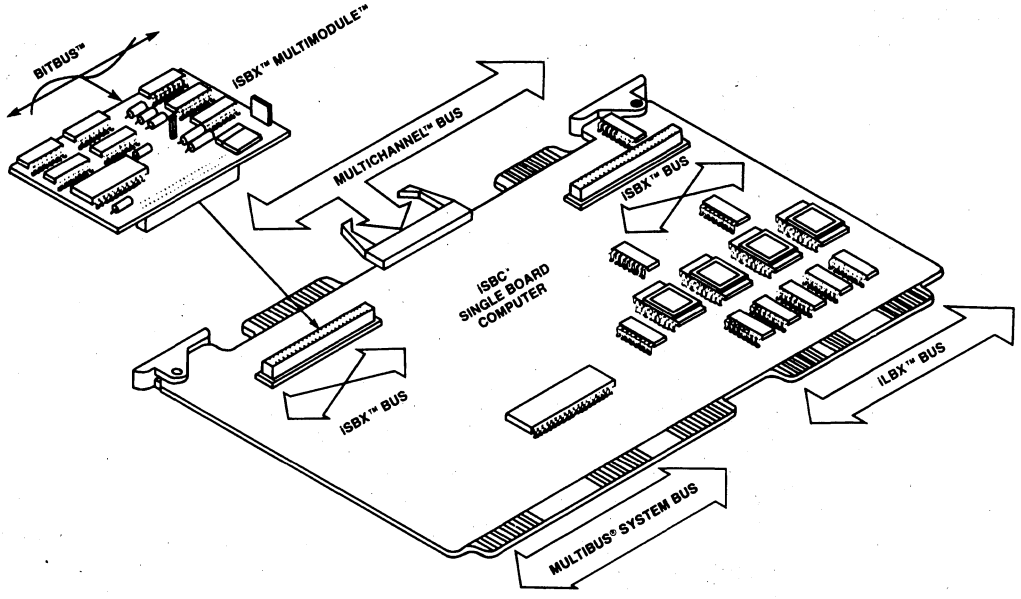
Reference Manuals

210883-002— MULTIBUS Architecture Reference Book

iLBX™ EXECUTION BUS

- **High Bus Bandwidth**
  - **— 9.5 Mbytes/sec. for 8-Bit Transfers**
  - **— 19 Mbytes/sec. for 16-Bit Transfers**
- **16 Mbyte Addressing Range**
- **8 and 16-Bit Data Transfers**
- **Supports up to 5 iLBX™ Compatible Devices Per Bus**
- **Primary and Secondary Master Bus Exchange Capabilities**
- **Standard 60-Pin MULTIBUS® P2 Connector**

The iLBX™ Execution Bus is one of a family of standard bus structures resident within Intel's total system architecture. The Local Bus Extension (iLBX) Bus is a dedicated execution bus capable of significantly increasing system performance by extending the processor board's on-board local bus to off-board resources. This extension provides for arbitration-free, direct access to high-performance memory. Acting as a "virtual" iSBC®, up to 16 megabytes of processor addressable memory can be accessed over the iLBX bus and appear as though it were resident on the processor board. The iLBX Bus preserves advantages in performance and architecture of on-board memory, while allowing memory configurations larger than possible on a single board computer. High throughput and independence from MULTIBUS® activities make the iLBX bus an ideal solution for "working store" type program memory and data processing applications requiring large amounts of high performance memory. Such applications include graphics systems, robotics, process control, office systems, and CAD/CAM.



280215-1

October 1986
Order Number: 280215-001

FUNCTIONAL DESCRIPTION

Architectural Overview

The iLBX bus is an architectural solution for supporting large amounts of high performance memory. It is the first structure that allows the CPU board selection to be decoupled from the on-board memory requirement, and still maximizes the processor's performance potential. It eliminates the processor's need to access its off-board memory resources solely over the MULTIBUS system bus. Architectural consistency with the single board computer approach including iLBX memory can be maintained by dual port access of memory resources between the iLBX bus and the MULTIBUS system bus. This allows for global access by other processors and I/O devices while still providing high speed local CPU operations. This sub-system created by the iLBX bus of a single board computer and a maximum of 4 memory cards can be perceived architecturally as a "virtual single board computer". The implementation of iLBX bus "virtual modules" makes it possible to create functional modules with a new level of flexibility and performance in implementing a wide range of memory capabilities. With future needs in mind, the iLBX bus has the capability of accessing a full 16 megabytes of memory.

Structural Features

The iLBX bus uses a non-multiplexed 16-bit configuration capable of 8 and 16-bit transfers. Used in conjunction with the MULTIBUS interface, the iLBX bus resides on the MULTIBUS form factor P2 connector and supercedes the MULTIBUS interface definitions for the P2 signals. The iLBX bus uses the standard 60-pin MULTIBUS P2 connector and occupies 56 of the P2 connector pins with 16 data lines, 24 address lines plus control, command access, and parity signals. The four MULTIBUS address extension lines on the MULTIBUS/iLBX P2 connector retain the standard MULTIBUS interface definition.

Bus Elements

The iLBX bus supports three distinct device categories: 1) Primary Master, 2) Secondary Master, 3) Slave. These three device types may be combined to create several iLBX local busses ranging (in size) from a minimum of two to a maximum of five devices per iLBX bus. There is only one Primary Master in any given implementation of iLBX bus, and its presence is required along with the attachment of at least one Slave device. To provide alternate access over an iLBX bus, one optional Secondary Master

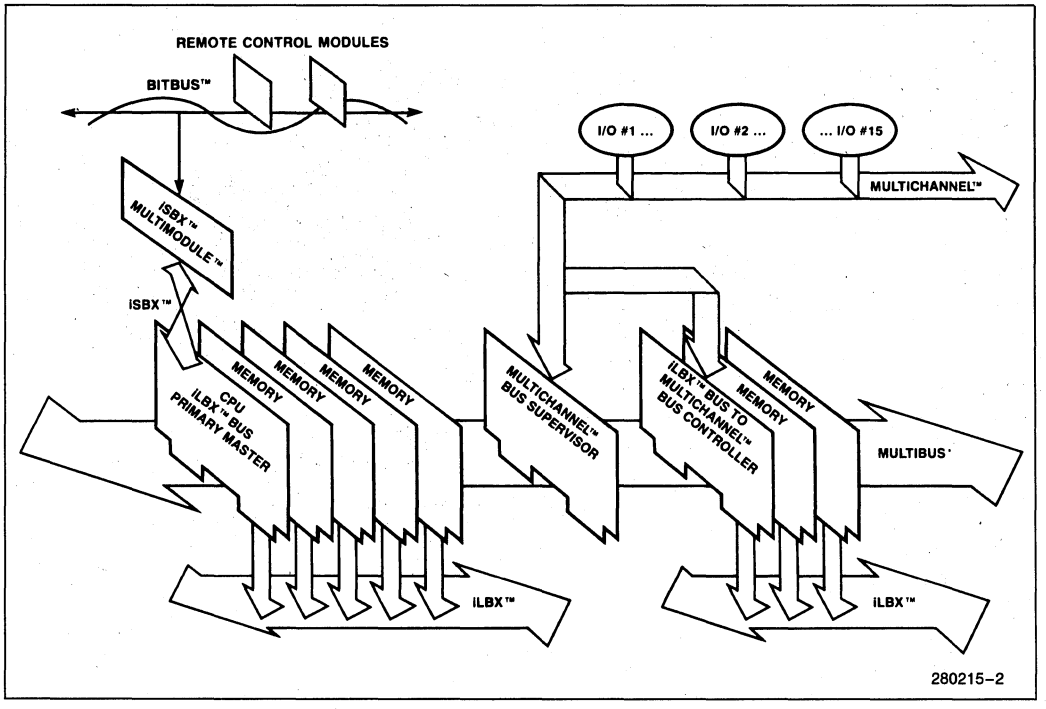


Figure 1. MULTIBUS® System Architecture

may be incorporated to create a "two-master" local bus subsystem. By limiting the iLBX bus to two masters (a Primary and a Secondary), bus arbitration is reduced to a simple request and acknowledge process, with privileged use of the bus maintained by the Primary Master, and limited access granted to the Secondary Master when needed.

The Primary Master executes the role of iLBX bus "supervisor" by controlling the general operation of the bus and managing Secondary Master accesses to the Slave memory resources.

The Secondary Master Device is an option providing alternate access to the Slave resources on the iLBX bus. Secondary master devices are typically DMA driven. This feature is provided for implementation flexibility when occasional DMA transfers in and out of iLBX memory resources can optimize the overall system performance. The Secondary Master essentially duplicates the Primary Master's data transfer capability, but must rely on the Primary Master to grant access. Once access is granted, the Secondary Master controls the bus, and drives all signal lines until the operation is complete and control is passed back to the Primary Master.

The Slave devices contain the memory resources used by the Primary Master and the optional Secondary Master. Each iLBX implementation can contain a maximum of four Slave devices. Using 64K RAM technology on four slave devices with ECC can provide for over 2 megabytes of "on-board" high performance memory. With 256K RAM chips, each iLBX bus could contain slave devices with memory totalling 8 megabytes. As memory technology increases, the iLBX bus is designed to incorporate it in rapid fashion because it is capable of directly accessing a full 16 megabytes of memory on its high-performance Slave devices.

Bus Interface/Signal Line Descriptions

The iLBX bus interface is divided into four functional classes of signal lines: address and data lines, control lines, command lines, and bus access lines. The 40 address and data lines defined by the iLBX Bus Specification consist of 16 data lines and 24 address lines.

There are 16 bi-directional data lines exclusively used to handle 8-bit and 16-bit data transfers between the active bus master and the selected slave device. The iLBX bus uses these data lines for all data transfers, and are driven by tri-state drivers.

The 24 address lines on the iLBX bus provide the ability to directly address 16 megabytes of memory. These single-direction address lines are exclusively driven by the active bus master. The iLBX bus master uses them to select a specific slave device. Three control lines specify the type of data transfer between master and slave devices, while the three command lines initiate, control, and terminate the transfer. There are also three bus access lines used to transfer bus control between master devices.

Bus Pin Assignments

The iLBX bus uses the standard 60-pin MULTIBUS P2 connector. The physical location of each pin assignment and its corresponding function is listed in Table 1. The four MULTIBUS address extension lines (pins 55–58 on the P2 connector) retain the standard MULTIBUS interface functions.

Bus Operation Protocol

The operation protocol for the iLBX bus is a straightforward set of procedures consisting of three basic operations: bus control access, write data to memory, read data from memory. These operations use asynchronous protocol with positive acknowledgment.

Bus Access

The iLBX bus is shared by at most two masters; one Primary Master and one optional Secondary Master, each providing an alternate access path to iLBX bus memory resources. The mechanism for obtaining bus access is a simple request and acknowledge process communicated between masters. Each master is a bus controller of similar capabilities, responsible for data transfer operations between devices, but the Primary Master has the added responsibility of controlling iLBX bus accesses.

The Primary Master has default control of the iLBX bus. If the Secondary Master needs access to the bus, it must initiate a request and wait for acknowledgment from the Primary Master. The choice of when to surrender control of the bus rests with the Primary Master, but if no data transfer is in progress, the Primary Master normally relinquishes control immediately to the Secondary Master.

Data Transfer Operation

The iLBX bus supports two types of data transfer operations: write data to memory and read data from memory. These data transfer operations facilitate the passing of information between the active bus master and the selected slave device. The operation of these two transfer types is very similar; the only differences being the direction of the data transfer and the device driving the data lines.

For either type of data transfer, the active bus master first initiates the transfer operation by placing the memory address on the address lines (AB23–AB0) and a control configuration on the control lines to select the slave device. Once the slave device is selected, the type of data transfer becomes the key factor. With the write operation, the active master maintains control of the data lines and provides valid data within the specified time. Upon accepting a data element, the slave sends a receipt acknowledgment signal to the master which completes the data transfer operation.

With the read operation, the slave device drives the data lines and places valid data on the data lines before sampling by the active master. The slave acknowledges the master to signal the end of the data transfer, and the master completes the operation.

The iLBX Bus Specification includes provisions for both optimized and non-optimized data transfers. Optimized operation uses pipelining and signal overlapping techniques to manage the data transfer timing relationships between the active bus master and the selected slave. The use of signal overlapping requires that every device attached to the iLBX bus provide a means of varying the timing of the slave request and acknowledge signals. The non-optimized operation uses fixed signal sequences, instead of signal overlapping, to assure a valid data transfer, and a device does not need a variable request or acknowledge to read data-valid timing on the iLBX bus. Please refer to the iLBX Bus Specification for detailed descriptions of these transfer operations.

Table 1. iLBX™ Bus Pin Assignments, P2 Edge Connector

Component Side			Solder Side		
16-Bit Pin	**Mnemonic**	**Signal Name**	**16-Bit Pin**	**Mnemonic**	**Signal Name**
1	DB0	Data Line 0	2	DB1	Data Line 1
3	DB2	Data Line 2	4	DB3	Data Line 3
5	DB4	Data Line 4	6	DB5	Data Line 5
7	DB6	Data Line 6	8	DB7	Data Line 7
9	GND	Ground	10	DB8	Data Line 8
11	DB9	Data Line 9	12	DB10	Data Line 10
13	DB11	Data Line 11	14	DB12	Data Line 12
15	DB13	Data Line 13	16	DB14	Data Line 14
17	DB15	Data Line 15	18	GND	Ground
19	AB0	Address Line 0	20	AB1	Address Line 1
21	AB2	Address Line 2	22	AB3	Address Line 3
23	AB4	Address Line 4	24	AB5	Address Line 5
25	AB6	Address Line 6	26	AB7	Address Line 7
27	GND	Ground	28	AB8	Address Line 8
29	AB9	Address Line 9	30	AB10	Address Line 10
31	AB11	Address Line 11	32	AB12	Address Line 12
33	AB13	Address Line 13	34	AB14	Address Line 14
35	AB15	Address Line 15	36	GND	Ground
37	AB16	Address Line 16	38	AB17	Address Line 17
39	AB18	Address Line 18	40	AB19	Address Line 19
41	AB20	Address Line 20	42	AB21	Address Line 21
43	AB22	Address Line 22	44	AB23	Address Line 23
45	GND	Ground	46	ACK*	Slave Acknowledge
47	BHEN	Byte High Enable	48	R/$\overline{W}$	Read Not Write
49	ASTB*	Address Strobe	50	DSTB*	Data Strobe
51	SMRQ*	Secondary Master Request	52	SMACK*	Secondary Master Acknowledge
53	LOCK*	Access Lock	54	GND	Ground
55	ADR22*	MULTIBUS® Address Extension Line 22	56	ADR23*	MULTIBUS® Address Extension Line 23
57	ADR20*	MULTIBUS® Address Extension Line 20	58	ADR21*	MULTIBUS® Address Extension Line 21
59	RES	Reserved	60	TPAR*	Transfer Parity

Mechanical Implementation

Because the iLBX bus uses the P2 connector of the MULTIBUS form factor, the iLBX bus "shares" a MULTIBUS chassis with the MULTIBUS backplane system bus in the system design. The iLBX mechanical specifications are synonymous with the MULTIBUS specifications for board-to-board spacing, board thickness, component lead length, and component height above the board. The iLBX bus interconnection can use either flexible ribbon cable or a rigid backplane. The iLBX bus interconnect maximum length is limited to 10 cm (approximately 4 inches); that is sufficient to span 5 card slots across two connected chassis. Figure 2 shows an iLBX bus cable assembly.

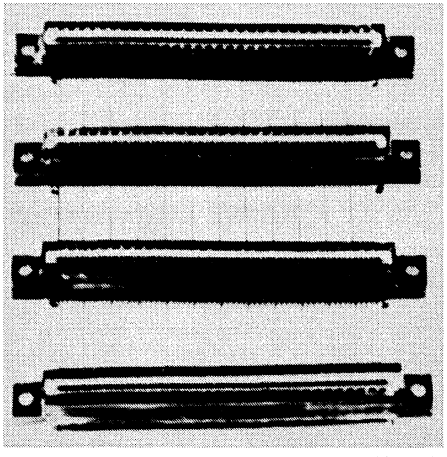


Figure 2. Typical iLBX™ Bus Interface Cable Assembly

Electrical Characteristics

DC SPECIFICATIONS

Table 2

Signal Name	Driver Type	Termination (to +5 Vdc At Master	Min Driver Requirements			Max Receiver Requirements		
			High	Low	Load Cap.	High	Low	Load Cap.
DB15–0	TRI-STATE	10 KΩ	0.6 mA	9 mA	75 pF	0.15 mA	2 mA	18 pF
TPAR*	TRI-STATE	10 KΩ	0.6 mA	9 mA	75 pF	0.15 mA	2 mA	18 pF
AB23–0	TRI-STATE	None	0.4 mA	20 mA	120 pF	0.10 mA	5 mA	30 pF
R/$\overline{W}$	TRI-STATE	None	0.2 mA	8 mA	75 pF	0.05 mA	2 mA	18 pF
BHEN	TRI-STATE	None	0.2 mA	8 mA	75 pF	0.05 mA	2 mA	18 pF
LOCK*	TRI-STATE	None	0.2 mA	8 mA	75 pF	0.05 mA	2 mA	18 pF
SMRQ*	TTL	10 KΩ	0.05 mA	2 mA	20 pF	0.05 mA	2 mA	18 pF
SMACK*	TTL	None	0.05 mA	2 mA	20 pF	0.05 mA	2 mA	18 pF
†ASTB*	TRI-STATE	10 KΩ	0.2 mA	9 mA	75 pF	0.05 mA	2 mA	18 pF
†DSTB*	TRI-STATE	10 KΩ	0.2 mA	9 mA	75 pF	0.05 mA	2 mA	18 pF
ACK*	Open Coll.	330 Ω	N.A.	20 mA	45 pF	0.05 mA	2 mA	18 pF

†At slave, additional series RC termination to GND (100 Ω, 10 pF).

SPECIFICATIONS

Word Size

Data: 8 and 16-bit

Memory Addressing

24-bits—16 megabyte—direct access

Bus Bandwidth

9.5 megabytes/sec: 8-bit
19 megabytes/sec: 16-bit

BUS TIMING

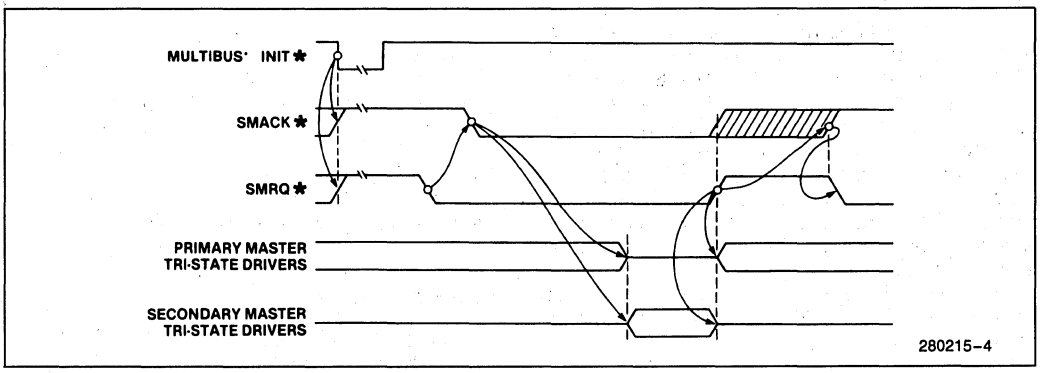


Figure 3. iLBX™ Bus Granting Timing Chart

16-Bit Transfer Timing

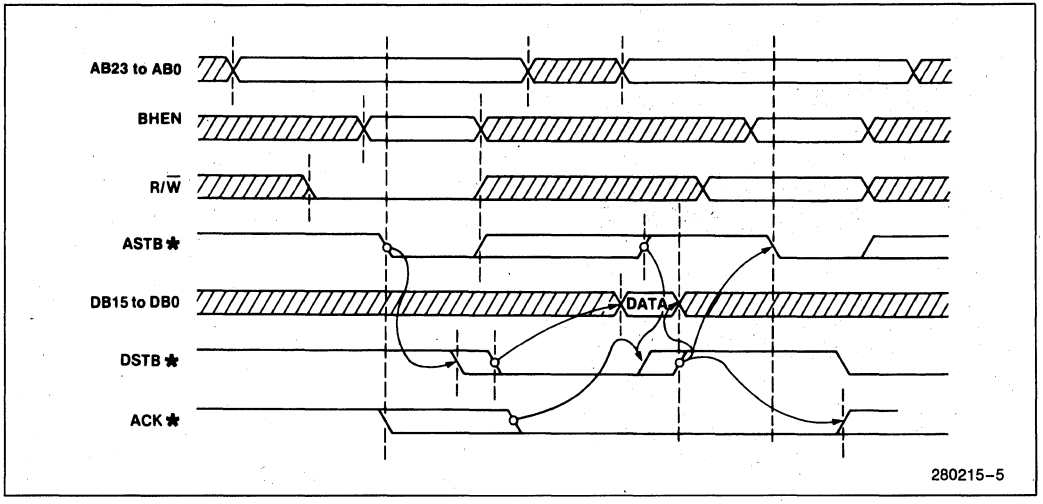


Figure 4. Write Data-to-Memory

BUS TIMING (Continued)

16-Bit Transfer Timing (Continued)

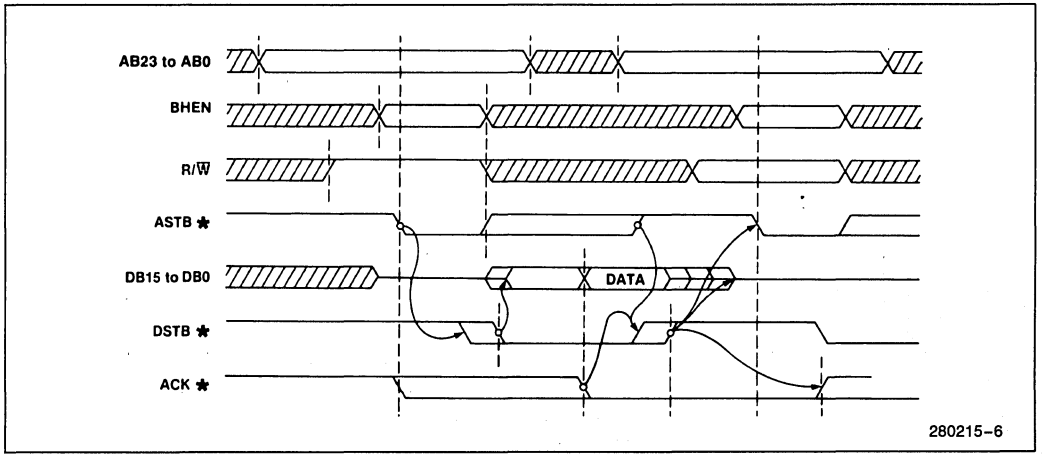


Figure 5. Read Data-From-Memory

Physical Characteristics

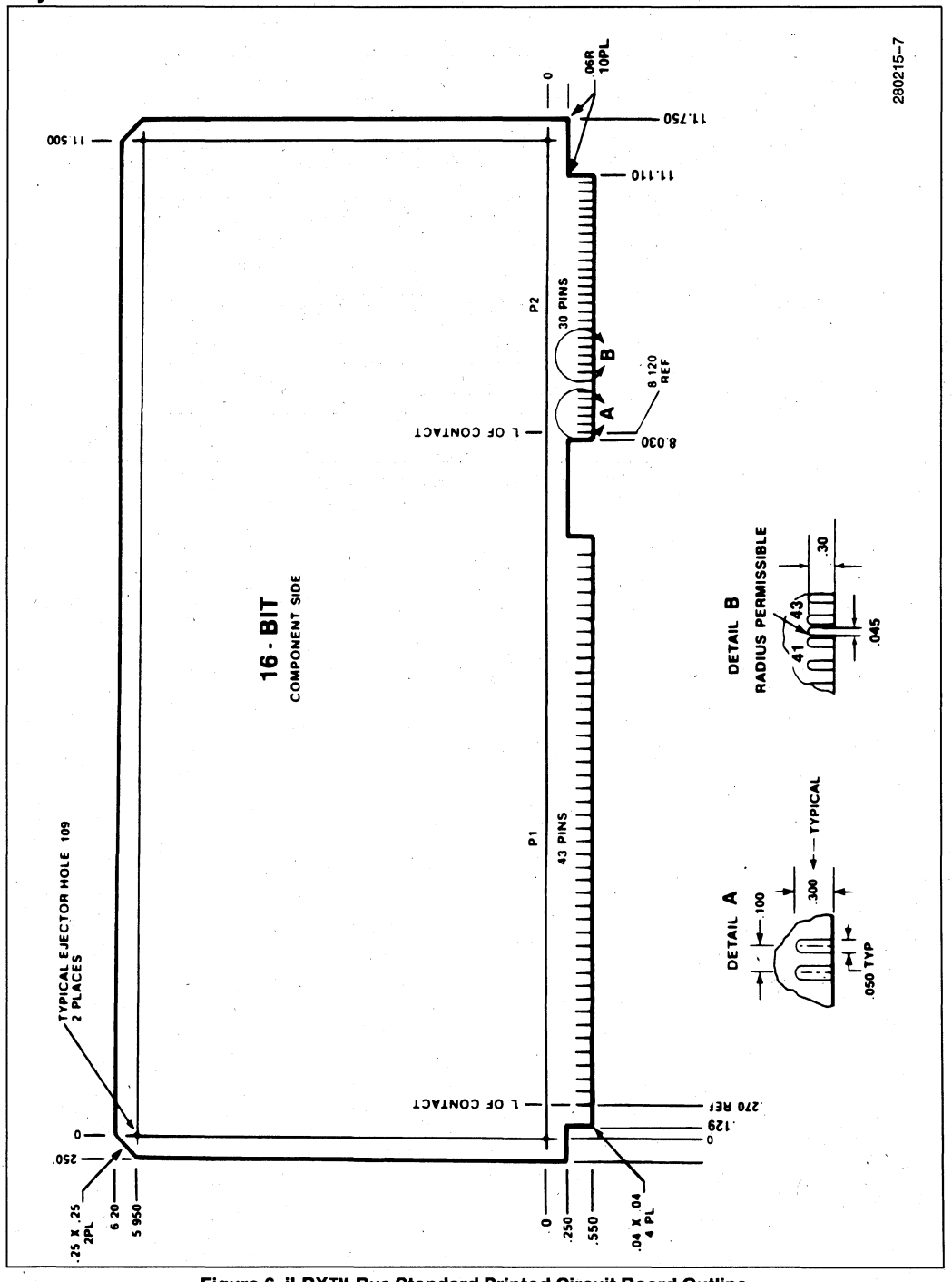


Figure 6. iLBX™ Bus Standard Printed Circuit Board Outline

Cables and Connectors

Table 3. Cable and Receptacle Vendors

iLBX™ Bus Compatible Cable		
Vendor	**Vendor Part No.**	**Conductors**
T & B Ansley	171-60	60
T & B Ansley	173-60	60
3M	3365/60	60
3M	3306/60	60
Berg	76164-060	60
Belden	9L28060	60
Spectrastrip	455-240-60	60
iLBX™ Bus Compatible Receptacles		
Vendor	**Vendor Part No.**	**Pins**
Kelam	RF30-2803-5	60
T & B Ansley	A3020 (609-6025 Modified)	60

Environmental Characteristics

OPERATING

Temperature: 0°C to 60°C

Relative Humidity: 0% to 85%; non-condensing

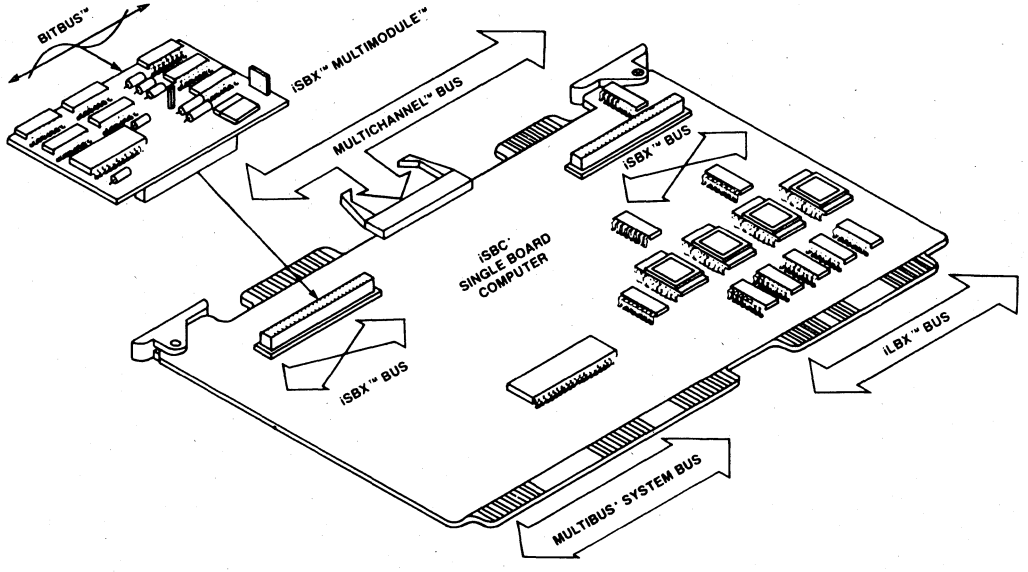
Reference Manuals

210883-002—MULTIBUS Architecture Reference Book

iSBX™ I/O EXPANSION BUS

- **IEEE P959 Industry Standard I/O Expansion Bus**
- **Provides On-Board Expansion of System Resources**
- **Small iSBX™ MULTIMODULE™ Boards Plug Directly into iSBC® Boards**
- **Supports Compatible 8- and 16-Bit Data Transfer Operations**
- **Part of Intel's Total System Architecture: MULTIBUS®, iLBX™, MULTICHANNEL™, and iSBX™**
- **Low-Cost "Vehicle" to Incorporate the Latest VLSI Technology into iSBC®-Based Systems**
- **Provides Increased Functional Capability and High Performance**
- **Supported by a Complete Line of iSBC® Base Boards and iSBX™ MULTIMODULE™ Boards, Providing Analog and Digital I/O, High-Speed Math, Serial and Parallel I/O, Video Graphics, and Peripheral Controllers**

The iSBX™ I/O Expansion Bus is one of a family of standard bus structures resident within Intel's total system architecture. The iSBX bus is a modular, I/O expansion bus capable of increasing a single board computer's functional capability and overall performance by providing a structure to attach small iSBX MULTIMODULE™ boards to iSBC® base boards. It provides for rapid incorporation of new VLSI into iSBC MULTIBUS® systems, reducing the threat of system obsolescence. The iSBX bus offers users new economics in design by allowing both system size and system cost to be kept at minimum. As a result, the system design achieves maximum on-board performance while allowing the MULTIBUS interface to be used for other system activities. The iSBX bus enables users to add-on capability to a system as the application demands it by providing off-the-shelf standard MULTIMODULE boards in the areas of graphics controllers, advanced mathematics functions, parallel and serial I/O, disk and tape peripheral controllers, and magnetic bubble memory. A full line of MULTIBUS boards and iSBX MULTIMODULE boards are available from Intel and other third party sources in the industry.



280255-1

March 1987
Order Number: 280255-001

FUNCTIONAL DESCRIPTION

Bus Elements

The iSBX™ MULTIMODULE™ system is made up of two basic elements: base boards and iSBX MULTIMODULE boards. In an iSBX system, the role of the base board is simple. It decodes I/O addresses and generates the chip selects for the iSBX MULTIMODULE boards.

The iSBX bus supports two classes of base boards, those with direct memory access (DMA) support and those without. Base boards with DMA support have DMA controllers that work in conjunction with an iSBX MULTIMODULE board (with DMA capability) to perform direct I/O to memory or memory to I/O operations. Base boards without DMA support use a subset of the iSBX bus and simply do not use the DMA feature of the iSBX MULTIMODULE board.

The iSBX MULTIMODULE boards are small, specialized, I/O mapped boards which plug into base boards. The iSBX boards connect to the iSBX bus connector and convert iSBX bus signals to a defined I/O interface.

Bus Interface/Signal Line Descriptions

The iSBX bus interface can be grouped into six functional classes: control lines, address and chip select lines, data lines, interrupt lines, option lines, and power lines. The iSBX bus provides nine control lines that define the communications protocol between base board and iSBX MULTIMODULE boards. These control lines are used to manage the general operation of the bus by specifying the type of transfer, the coordination of the transfer, and the overall state of the transfer between devices. The five address and chip select signal lines are used in conjunction with the command lines to establish the I/O port address being accessed, effectively selecting the proper iSBX MULTIMODULE. The data lines on the iSBX bus can number 8 or 16, and are used to transmit or receive information to or from the iSBX MULTIMODULE ports. Two interrupt lines are provided to make interrupt requests possible from the iSBX board to the base board. Two option lines are reserved on the bus for unique user requirements, while several power lines provide +5 and ±12 volts to the iSBX boards.

Bus Pin Assignments

The iSBX bus uses widely available, reliable connectors that are available in 18/36 pin for 8-bit devices and 22/44 pin for 16-bit devices. The male iSBX connector is attached to the iSBX MULTIMODULE board and the female iSBX connector is attached to the base board. Figure 2 shows the dimensions and pin numbering of the 18/36 pin iSBX connector, while Figure 3 does the same for the 22/44 pin iSBX connector. A unique scheme allows the 16-bit female connector to support 8 or 16-bit male MULTIMODULE boards. Table 1 lists the signal/pin assignments for the bus.

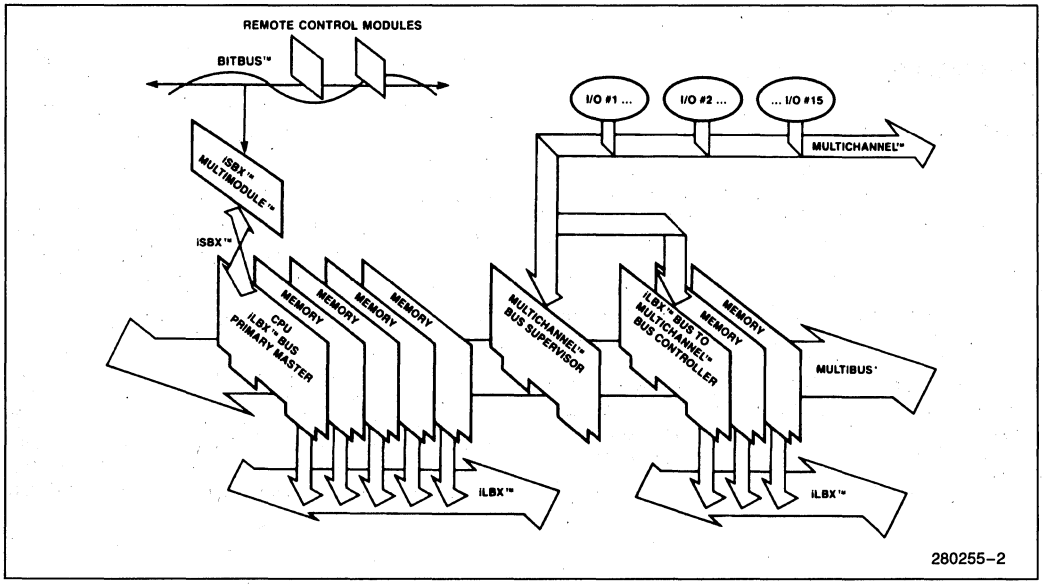


Figure 1. MULTIBUS® System Architecture

Table 1. iSBX™ Signal/Pin Assignments

Pin(1)	Mnemonic	Description	Pin(1)	Mnemonic	Description
43	MD8	MDATA Bit 8	44	MD9	MDATA Bit 9
41	MDA	MDATA Bit A	42	MDB	MDATA Bit F
39	MDC	MDATA Bit C	40	MDD	MDATA Bit D
37	MDE	MDATA Bit E	38	MDF	MDATA Bit F
35	GND	Signal Gnd	36	+5V	+5V
33	MD0	MDATA Bit 0	34	MDRQT	M DMA Request
31	MD1	MDATA Bit 1	32	MDACK/	M DMA Acknowledge
29	MD2	MDATA Bit 2	30	OPT0	Option 0
27	MD3	MDATA Bit 3	28	OPT 1	Option 1
25	MD4	MDATA Bit 4	26	TDMA	Terminate DMA
23	MD5	MDATA Bit5	24		Reserved
21	MD6	MDATA Bit 6	22	MCS0/	M Chip Select 0
19	MD7	MDATA Bit 7	20	MCS/1	M Chip Select 1
17	GND	Signal Gnd	18	+5V	+5V
15	IORD/	I/O Read Cmd	16	MWAIT/	M Wait
13	IOWRT/	I/O Write Cmd	14	MINTRO	M Interrupt 0
11	MA0	M Address 0	12	MINTR1	M Interrupt 1
9	MA1	M Address 1	10		Reserved
7	MA2	M Address 2	8	MPST/	iSBX Multimodule Board Present
5	RESET	Reset	6	MCLK	M Clock
3	GND	Signal Gnd	4	+5V	+5V
1	+12V	+12V	2	−12V	−12V

NOTES:
1. Pins 37–44 are used only on 8/16-bit systems.
2. All undefined pins are reserved for future use.

Bus Operation Protocol

COMMAND OPERATION

The iSBX bus supports two types of transfer operations between iSBX elements: I/O Read and I/O Write. An iSBX board can respond to these I/O transfers using either full speed mode or extended mode.

For a full speed I/O Read (Figure 4) the base board generates a valid I/O address and a valid chip select for the iSBX MULTIMODULE board. After setup, the base board activates the I/O Read line causing the iSBX board to generate valid data from the addressed I/O port. The base board then reads the data and removes the read command, address, and chip select. The full speed I/O Write (Figure 5) operation is similar to the I/O Read except that the base board generates valid data on the lines and keeps the write command line active for the specified hold time.

The extended Read operation (Figure 6) is used by iSBX MULTIMODULE boards that aren't configured to meet full speed specifications. It's operation is similar to full speed mode, but must use a wait signal to ensure proper data transfer. The base board begins the operation by generating a valid I/O address and chip select. After setup, the base board activates the Read line causing the iSBX board to generate a Wait signal. This causes the CPU on the base board to go into a wait state. When the iSBX board has placed valid Read data on the data lines, the MULTIMODULE board will remove the Wait signal and release the base board CPU to read the data

and deactivate the command, address, and chip select. The extended Write operation (Figure 7) is similar to the extended Read except that the Wait signal is generated after the base board places valid Write data on the data lines. The iSBX board removes the Wait signal when the write pulse width requirements are satisfied, and the base board can then remove the write command after the hold time is met.

DMA OPERATION

An iSBX MULTIMODULE system can support DMA when the base board has a DMA controller and the iSBX MULTIMODULE board can support DMA mode. Burst mode DMA is fully supported, but for clarity and simplicity, only a single DMA transfer for an 8-bit base board is discussed.

A DMA cycle (Figure 8) is initiated by the iSBX board when it activates the DMA request line going to the DMA controller on the base board. When the DMA controller gains control of the base board bus, it acknowledges back to the iSBX board and activates an I/O or Memory Read. The DMA controller then activates an I/O or Memory Write respectively. The iSBX board removes the DMA request during the cycle to allow completion of the DMA cycle. Once the write operation is complete, the DMA controller is free to deactivate the write and read command lines after a data hold time.

INTERRUPT OPERATION

The iSBX MULTIMODULE board on the iSBX bus can support interrupt operations over its interrupt lines. The iSBX board initiates an interrupt by activating one of its two interrupt lines which connect to the base board. The CPU processes the interrupt and executes the interrupt service routine. The interrupt service routine signals the iSBX MULTIMODULE board to remove the interrupt, and then returns control to the main line program when the service routine is completed.

Please refer to the Intel iSBX Bus Specification for more detailed information on its operation and implementation.

SPECIFICATIONS

Word Size

Data: 8, 16-bit

Power Supply Specifications

Table 3.

Minimum (volts)	Nominal (volts)	Maximum (volts)	Maximum (current)*
+4.75	+5.0	+5.25	3.0A
+11.4	+12	+12.6	1.0A
−12.6	−12	−11.4	1.0A
—	GND	—	3.0A

NOTE:
*Per iSBX MULTIMODULE board mounted on base board.

Port Assignments

Table 2. iSBX™ MULTIMODULE™ Base Board Port Assignments

iSBX™ Connector Number	Chip Select	8-Bit Base Board Address	16-Bit Base Board Address (8-bit mode)	16-Bit Base Board Address (16-bit mode)
iSBX1	MCS0/ MCS1/	F0–F7 F8–FF	0A0–0AF 0B0–0BF	0A0,2,4,6,8, A,C,E 0A1,3,5,7,9, B,D,F
iSBX2	MCS0/ MCS1/	C0–C7 C8–CF	080–08F 090–09F	080,2,4,6,8 A,C,E 081,3,5,7,9, B,D,F
iSBX3	MCS0/ MCS1/	B0–B7 B8–BF	060–06F 060–06F	060,2,4,6,8 A,C,E 061,3,5,7,9, B,D,F

DC Specifications

Table 4. iSBX™ MULTIMODULE™ Board I/O DC Specifications

Output[1]

Bus Signal Name	Type[2] Drive	I_{OL} Max −Min (mA)	@Volts (V_{OL} Max)	I_{OH} Max −Min (μA)	@ Volts (V_{OH} Min)	C_O (Min) (pf)
MD0–MDF	TRI	1.6	0.5	−200	2.4	130
MINTRO-1	TTL	2.0	0.5	−100	2.4	40
MDRQT	TTL	1.6	0.5	−50	2.4	40
MWAIT/	TTL	1.6	0.5	−50	2.4	40
OPT1–2	TTL	1.6	0.5	−50	2.4	40
MPST/	TTL	Note 3				

Input[1]

Bus Signal Name	Type[2] Receiver	I_{IL} Max (mA)	@V_{IN} MAX (volts) Test Cond.	I_{IH} Max (μA)	@V_{IN}MAX (volts) Test Cond.	C_IMax (pf)
MD0–MDF	TRI	−0.5	0.4	70	2.4	40
MA0–MA2	TTL	−0.5	0.4	70	2.4	40
MCS0/–MCS1/	TTL	−4.0	0.4	100	2.4	40
MRESET	TTL	−2.1	0.4	100	2.4	40
MDACK/	TTL	−1.0	0.4	100	2.4	40
IORD/ IOWRT/	TTL	−1.0	0.4	100	2.4	40
MCLK	TTL	−2.0	0.4	100	2.4	40
OPT1–OPT2	TTL	−2.0	0.4	100	2.4	40

NOTES:
1. Per iSBX MULTIMODULE I/O board.
2. TTL = standard totem pole output. TRI = Three-state.
3. iSBX MULTIMODULE board must connect this signal to ground.

All Inputs: Max V_{IL} = 0.8V
Min V_{IH} = 2.0V

Connectors

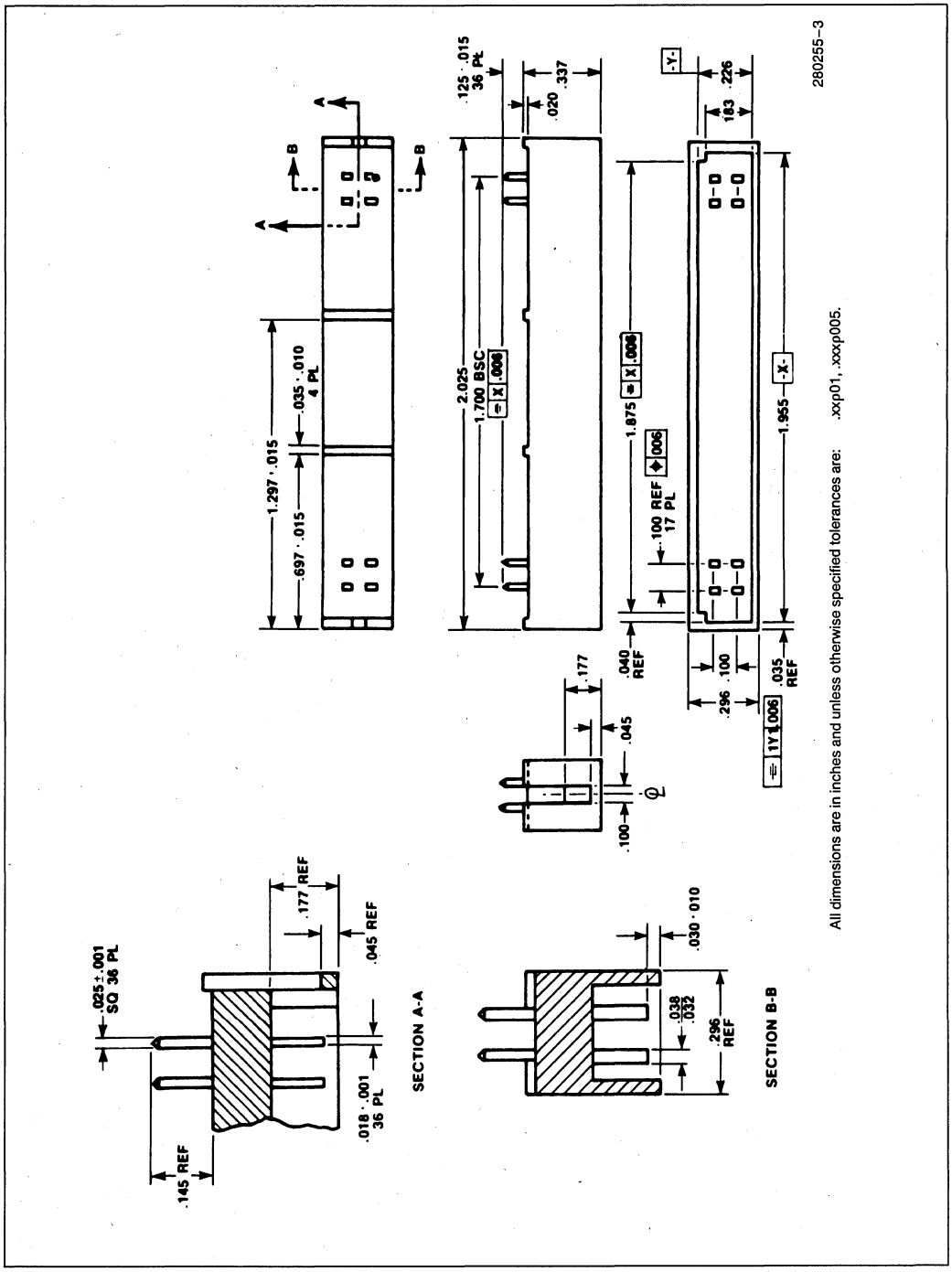


Figure 2. 18/36 Pin iSBX™ Connector

Connectors (Continued)

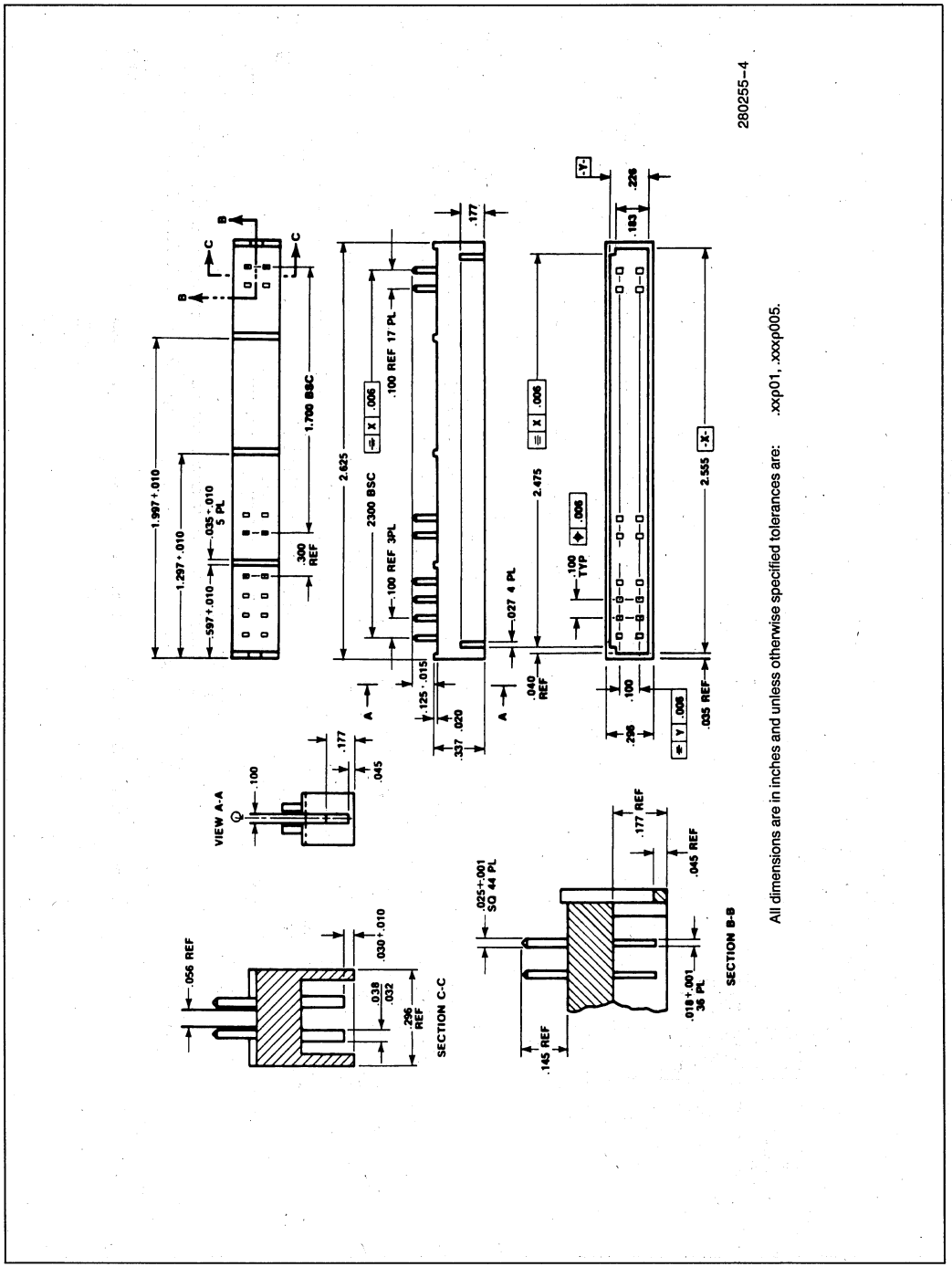


Figure 3. 22/44 Pin iSBX™ Connector

Bus Timing Diagrams

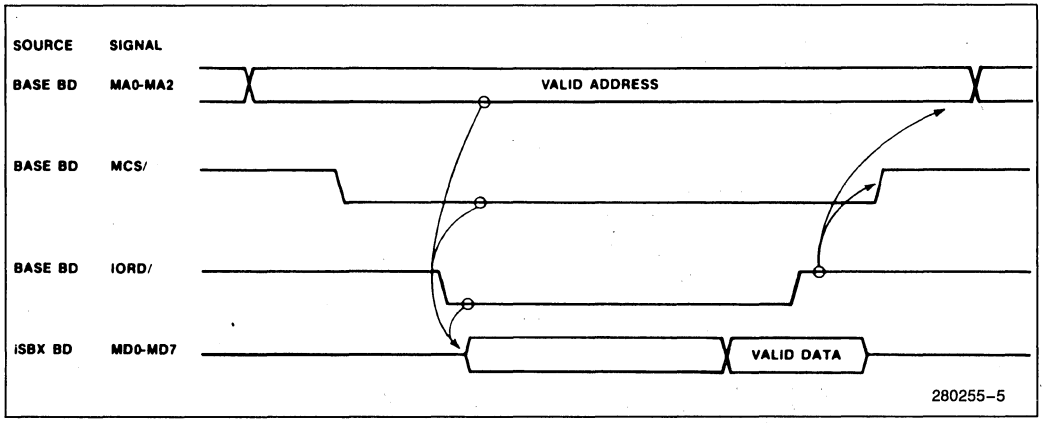


Figure 4. iSBX™ MULTIMODULE™ Read, Full Speed

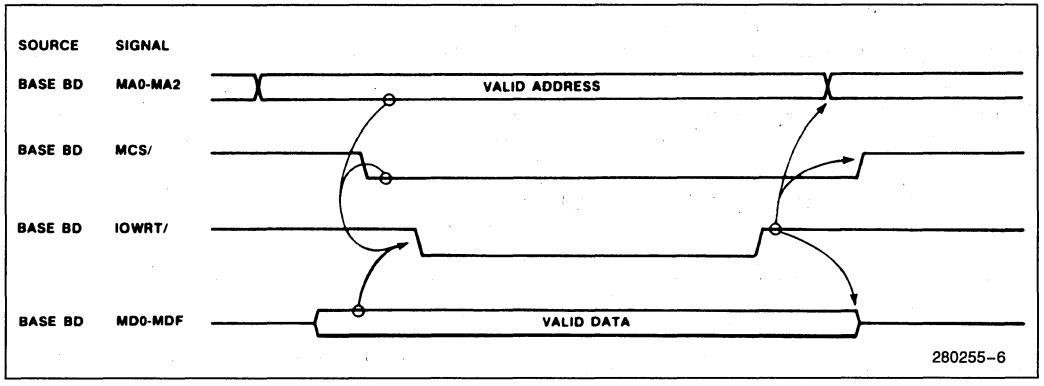


Figure 5. iSBX™ MULTIMODULE™ Board Write, Full Speed

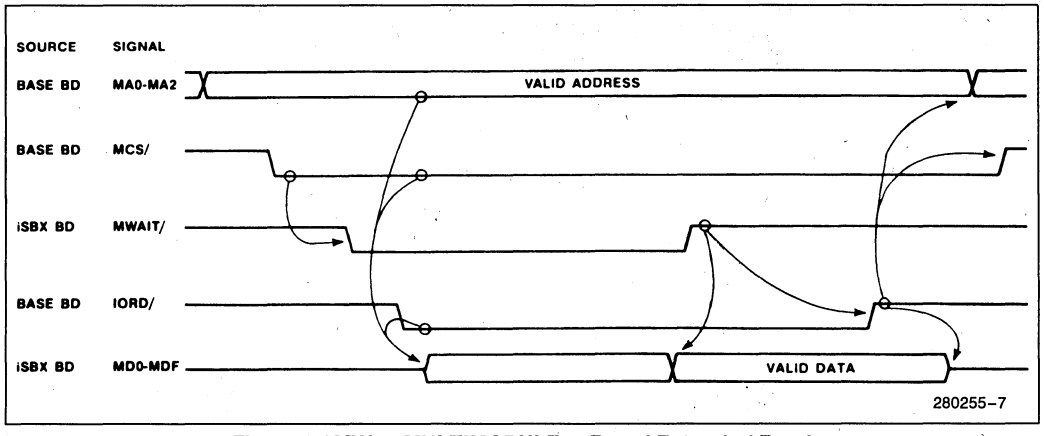


Figure 6. iSBX™ MULTIMODULE™ Board Extended Read

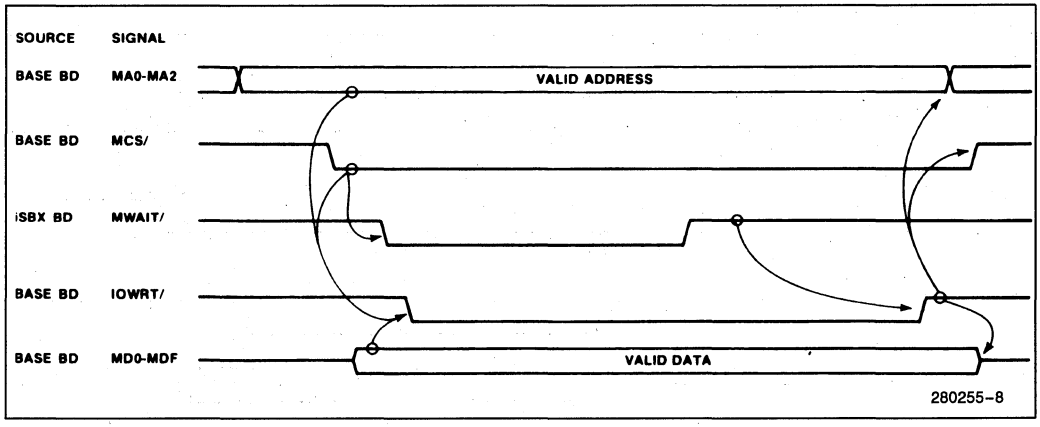


Figure 7. iSBC® MULTIMODULE™ Board Extended Write

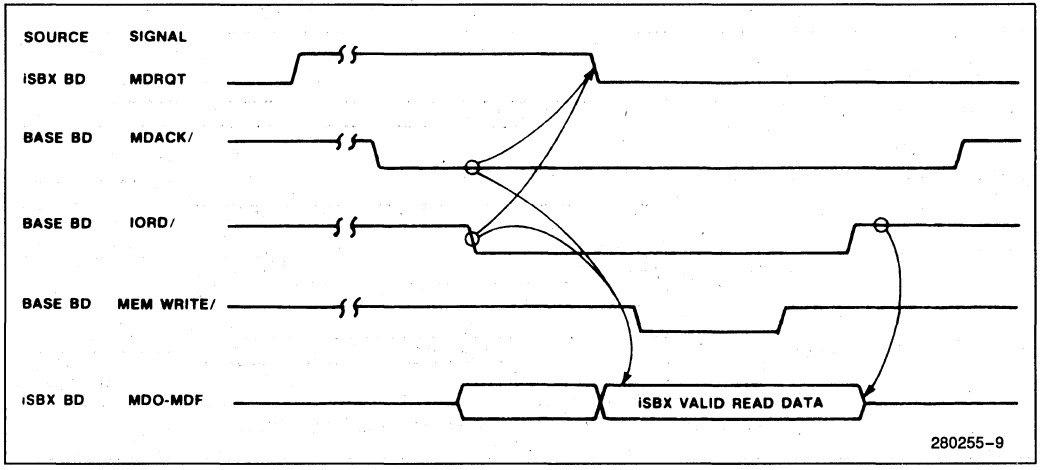


Figure 8. iSBX™ MULTIMODULE™ Board DMA Cycle (iSBX™ MULTIMODULE™ to Base Board Memory)

Board Outlines

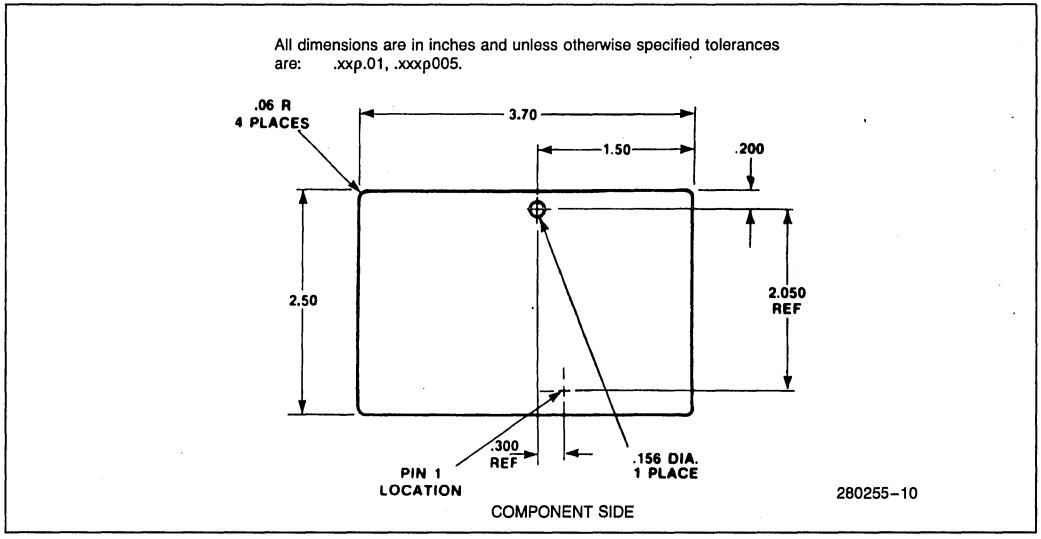


Figure 9. iSBX™ Board Outline

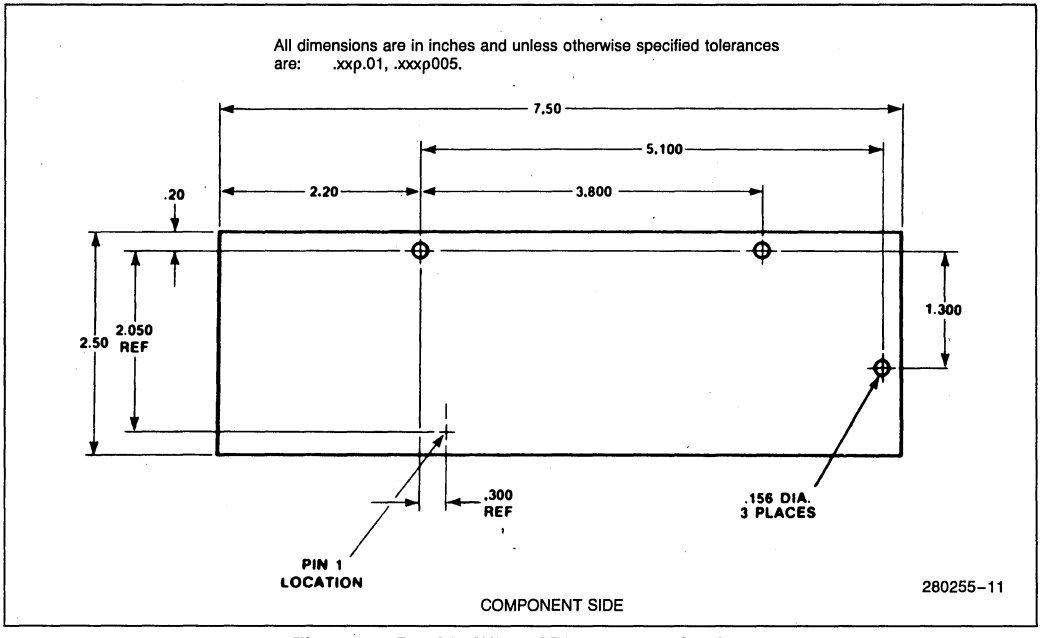


Figure 10. Double Wide iSBX™ Board Outline

Environmental Characteristics

Operating Temperature: 0°C to 55°C

Humidity: 90% maximum relative; non-condensing

Reference Manuals

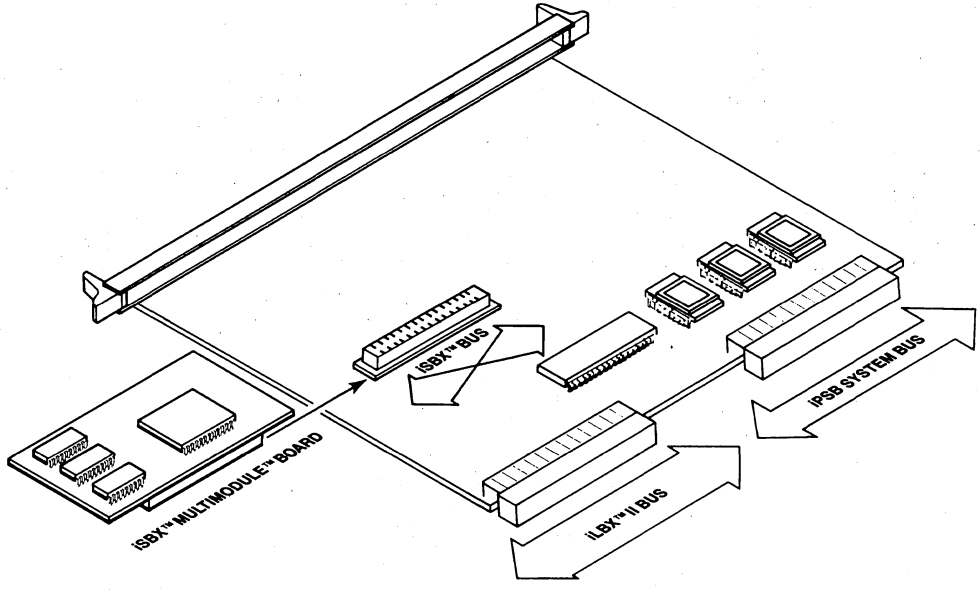
210883-002—MULTIBUS Architecture Reference Book

MULTIBUS® II Architecture 19

MULTIBUS® II
iLBX™ II LOCAL BUS EXTENSION

- **High Bus Bandwidth—**
  —48 Megabytes/sec
- **64 Megabyte (26-bit) Addressing**
- **8-, 16-, 24-, and 32-bit Data Transfers**
- **Reliable Synchronous Clocking up to 12 Megahertz**
- **Burst Transfers up to 64 Kilobytes Per Transfer**
- **Primary and Secondary Bus Master Exchange Capabilities**
- **Supports up to 6 iLBX™ II Compatible Device Per Bus**
- **Pipelined Protocol for Highest Performance**
- **Optional Parity Protection for Address and Data**

The iLBX™ II Local Bus Extension is one of the family of standard bus structures resident within Intel's MULTIBUS® II Bus Architecture. The iLBX II bus is a dedicated execution bus capable of significantly increasing system performance by removing most processor execution activity from the main iPSB™ Parallel System Bus. It extends the processor board's on-board local bus to off-board resources. Acting in conjunction with the processor board, the iLBX II resources form a multiple board "virtual single board computer". The iLBX II bus preserves advantages in performance and architecture of on-board local memory, while allowing memory configurations larger than those possible on a single board.



280376-1

MULTIBUS® II Physical Diagram

September 1987
Order Number: 280376-002

FUNCTIONAL DESCRIPTION

Architectural Overview

The iLBX II bus is an architectural solution for supporting large amounts of off-board memory with the same performance advantage enjoyed by on-board memory (see Figure 1). It allows the CPU board selection to be decoupled from the on-board memory requirement and still maximizes the processor's performance potential. It eliminates the processor's need to access its off-board memory resources solely over the iPSB system bus. In most systems, the processor is the only master on the iLBX II bus, so no time is required to arbitrate for the bus. This means the processor sees significantly lower memory latency than is possible if it were accessing memory over the multiple master system bus. Lower memory latency translates to higher individual processor performance.

In inclusion of the iLBX II bus in the architecture means not just higher single processor performance but higher system performance as well. The movement of execution traffic from the system bus to the iLBX II execution bus makes that much additional system bus bandwidth available to other system resources such as processors not using an execution bus or I/O devices.

For those applications which require a high bandwidth local path to I/O, such as an intelligent disk controller local to a particular processor, the iLBX II bus supports one additional bus master. This architectural enhancement allows a processor to "own" an intelligent I/O controller. All data transfers between these two modules (the processor and the controller) can occur over the low latency iLBX II bus path without distributing activity on the system bus.

Structural Features

OVERVIEW

The iLBX II bus uses a non-multiplexed, processor independent structure supporting 8-, 16-, and 32-bit processors. It supports 8-, 16-, 24-, and 32-bit data transfers over a 26-bit (64 megabyte) addressing range with a maximum bandwidth of 48 megabytes/sec.

All events performed on the bus are synchronous to a reference bus clock. This is not a fixed frequency clock as in the iPSB bus; the iLBX II bus clock runs at the basic processor bus frequency. In other words, a processor whose bus interface runs at 8 megahertz would drive the iLBX II bus at that frequency. This characteristic helps match the iLBX II bus timing to that of the processor transfer rate for best performance. The maximum iLBX II bus clock frequency is 12 megahertz. (Be careful not to confuse a processor's clock input frequency with its basic bus frequency. Many processors internally divide down their clock input by 2, 3, or 4 to obtain the basic bus frequency. It is this basic bus frequency which defines their transfer rate and which drives the iLBX II bus clock.)

NON-MULTIPLEXED STRUCTURED

The iLBX II bus structure is non-multiplexed in order to simplify the interface and obtain maximum performance. The separate address, data, and control paths allow overlapped operation. This overlapping, called pipelining, means that data from a previous operation can be overlapped with the address and command information of the current operation. This characteristic substantially improves bus utilization for those processor-memory subsystems which support the feature.

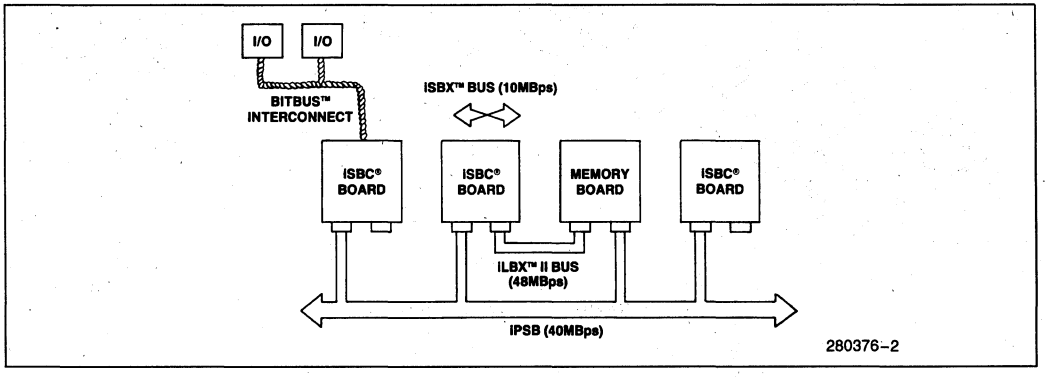


Figure 1. MULTIBUS® II Bus Architecture

INTERCONNECT ADDRESS SPACE

The iLBX II bus supports the slot-addressing concept of the interconnect address space found in the iPSB bus. Including this facility in the iLBX II bus allows the system to identify and configure iLBX II bus boards even though they may not contain a iPSB bus port. (Please refer to the iPSB bus data sheet for additional information on the interconnect address space.)

DUAL BUS MASTER

In order to support a wide range of system configurations, the iLBX II bus defines support for two bus masters. One master is called the Primary master; the other is known as the Secondary master. The Primary master normally "owns" the bus and does not have to spend any time arbitrating for access rights. The Secondary master must ask the Primary master for access rights. The Primary releases the bus at the first opportune time. This hierarchical structure ensures that the Primary master enjoys good memory latency while at the same time gives the Secondary the opportunity to access memory when it needs to.

The iLBX II bus also includes a dedicated interrupt line to facilitate signalling between the two masters for commands and status, and between the memory boards and the Primary master for things such as non-recoverable memory errors.

BUS CYCLE OVERVIEW

Like the iPSB bus, the iLBX II bus protocol consists of three types of bus cycles: arbitration, transfer, and exception.

ARBITRATION CYCLE

The arbitration cycle ensures that one and only one requesting agent is allowed access to the bus at any given time. When a requesting agent determines the need for a bus operation, it enters the arbitration cycle. For either requesting agent, this cycle lasts until it acquires the right to use the bus. In configurations with only a primary requesting agent, no time is spent for this cycle; the agent always has rights to the bus. In configurations where there are both a primary and secondary agent, the primary agent has to arbitrate for the bus only when the bus is busy under the secondary agent's control. Figure 2 illustrates the arbitration cycle.

TRANSFER CYCLE

The transfer cycle is the event where the request (address and command) and reply (data) information is exchanged between the bus agents. Like the iPSB bus, it consists of a request and a reply phase. During block transfers, the termination of the transfer cycle is controlled by the requesting agent. In non-block transfer cycles, the cycle's termination is implicitly recognized by both agents. Figure 3 shows a transfer cycle example.

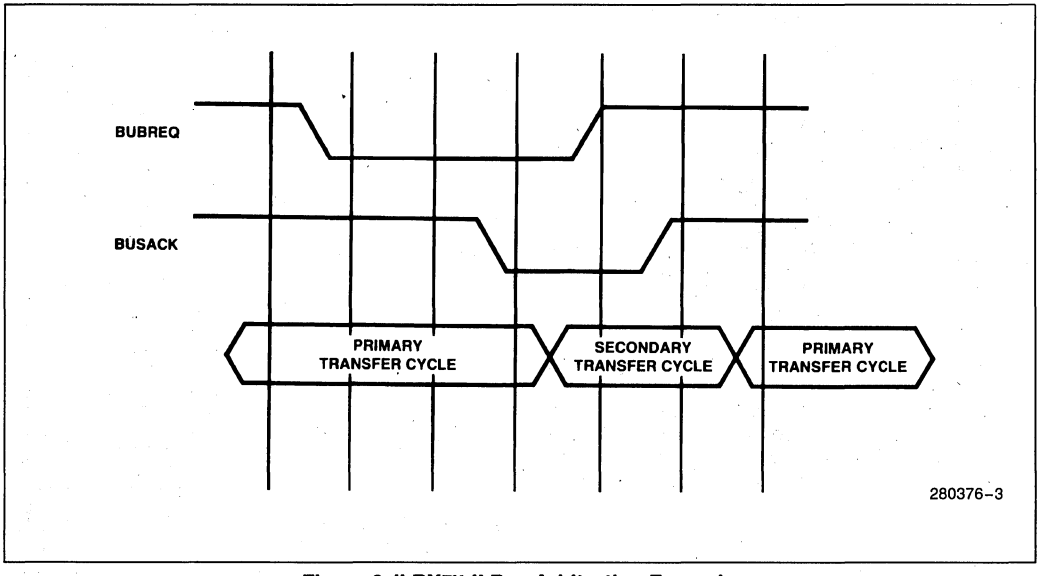


Figure 2. iLBX™ II Bus Arbitration Example

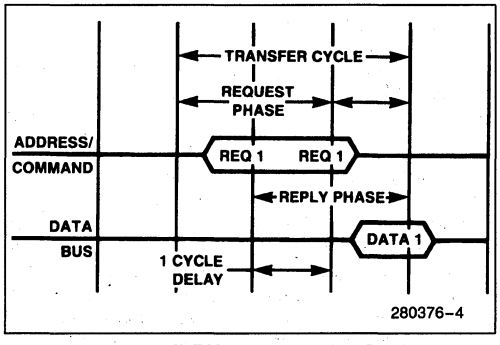


Figure 3. iLBX™ II Transfer Cycle

EXCEPTION CYCLE

Exception cycles allow the bus agents to signal any detected error or exceptional condition which might arise during a transfer cycle. Typical exceptions are uncorrectable ECC errors, parity errors, or physical boundary overflows.

Signal Groups

OVERVIEW

There are five categories of signals used in the iLBX II bus: address/command, data transfer, access control/status, bus control/status, and miscellaneous. An asterisk following the signal name or group indicates that the signal or group use their low electrical state as the active state.

ADDRESS/COMMAND

The requesting agent uses this group of signals to transfer address and command information to the potential replying agents during the request phase of a transfer cycle. This signal group consists of the non-multiplexed address lines, **XA25 through XA00** (Extension bus address), the command specification lines, **XC3 through XC0** (Extension bus command), and an associated parity line, **XAPAR** (Extension bus address/command parity).

The XA25 through XA00 lines define the starting physical byte address. The command specification lines select the address space (memory or interconnect), data width (1, 2, 3, or 4 bytes), and whether the operation is a read or write cycle. The command encodings for XC3 through XC0 are shown in Figure 4.

XC3*	XC2*	XC1*	XC0*
Address Space	**Access Type**	**Width Specification**	
Memory	Read	1 byte 2 bytes 3 bytes	
Interconnect	Write	4 bytes	

Figure 4. iLBX™ Ii Command Encoding

Parity for the address/command group is not required. The bus does allow for a single parity bit covering the address and command lines as a compliance level. The iLBX II bus environment is much different than that of the iPSB system bus. It extends only a short distance (6 card slots maximum) and employs lower switching currents. This more restrictive environment reduces the need for data integrity protection in all but the larger systems.

DATA TRANSFER GROUP

This signal category consists of the 32 bi-directional data lines and their optional parity line. **XD31 through XD0** (Extension bus data) transfer the read or write data between the requesting and replying agents. Each byte in the iLBX II bus memory is mapped to one of the four byte locations of the XD lines. This technique is commonly referred to as "byte lanes" and is illustrated in Figure 5.

Like with the address/command group, the **XDPAR** (Extension bus data parity) line is optional.

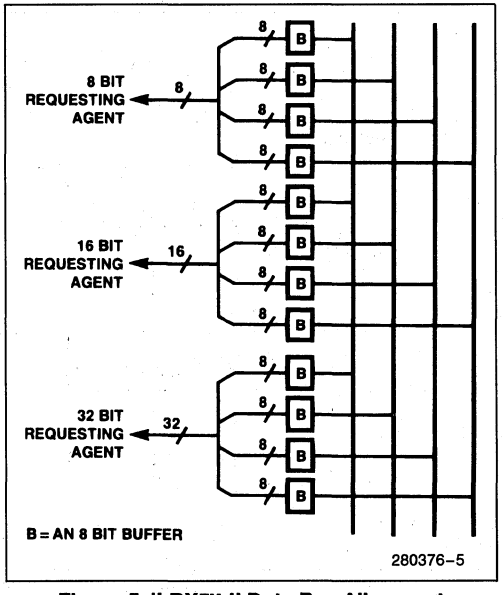


Figure 5. iLBX™ II Data Bus Alignment Interface Requirements

ACCESS CONTROL/STATUS GROUP

This signal category consists of 5 lines which determine the start of an access request, its execution, and finally, its termination.

The **XACCREQ*** (Extension bus access request) signal indicates that the address/command information is valid during the current and next bus clock cycles. It signals the presence of the request phase of the transfer cycle. Replying agents which require more time to decode the command information can extend XACCREQ* using the XWAIT* handshake line.

The **XWAIT*** (Extension bus wait) signal has a two-fold meaning in the access protocol: it can extend the duration of the request phase and it serves as a "not ready" replier indication during the reply phase. If asserted in the first clock cycle of the request phase, it extends the phase, otherwise, it will signal "not ready" during the reply phase.

In many system configurations the iLBX II bus memory boards are dual-ported to both the iLBX II and iPSB buses. This requires a mutual exclusion facility when implementing semaphores and other data structures in this shared memory. The **XLOCK*** (Extension bus lock) signal allows the iLBX II bus requesting agents to lock out the other port while performing indivisible accesses to shared structures.

To perform block transfers on the iLBX II bus, the requesting agent asserts the **XBTCTL*** (Extension bus block transfer control) signal. This line informs the replying agents that two or more data transfer periods will accompany a single request phase. XBTCTL* is de-asserted by the requesting agent to signal the end of the block transfer.

BUS CONTROL/STATUS GROUP

The signals in this group control the passing of bus ownership between the primary and secondary requesting agents. When the bus is in use, they also indicate which agent is in control.

The **XBUSREQ*** (Extension bus request) signal is driven by the secondary requesting agent to acquire the bus from the primary agent. Only the primary requesting agent receives this signal. When the primary detects that the secondary is requesting the bus, it replies with the **XBUSACK*** (Extension bus acknowledge) signal to inform the secondary that the bus is now his. This bus exchange occurs at the discretion of the primary.

The secondary owns the bus after asserting XBUSREQ* and receiving XBUSACK* active. The primary can request that the bus be returned at any time by removing XBUSACK*. The secondary must return the bus at the earliest time; typically when it completes its current transfer cycle.

MISCELLANEOUS CONTROL GROUP

The **XRESET*** (Extension bus reset) is driven by the primary requesting agent to locally initialize its iLBX II bus environment. It is typically asserted after the agent receives a reset indication on the iPSB system bus.

The **XINT*** (Extension bus interrupt) allows the secondary requesting agent and any of the replying agents to signal the primary requesting agent for inter-module communication. Since the secondary agent is usually performing tasks on behalf of the primary agent, this interrupt line removes the need for the primary to continuously poll the secondary for completion of its tasks.

The **XID2* through XID0*** (Extension bus identify) lines are hardwired lines on the backplane to allow any iLBX II bus board to determine its position on the bus. They encode the interconnect space least significant three bits of the slot ID field. (See the iPSB bus data sheet for an explanation of the interconnect address space.)

The final line is the **XBCLK*** (Extension bus clock) line. It provides the reference timing signal for the synchronous bus operations. It is driven by the primary requesting agent at its processor bus frequency.

The iLBX II bus also defines additional +5 volt and ground pins.

Bus Protocol

In the MULTIBUS II specification, both timing diagrams and state-flow diagrams describe the iLBX II bus protocol. The state-flow diagrams present the lowest level and most rigorous definition while the timing diagrams help conceptual understanding. For the purposes of this data sheet, only the timing diagram description is used. The following sections use Figure 6 as an example of the protocol.

ARBITRATION CYCLE

With only two potential requesting agents contending for access rights to the bus, the arbitration cycle is very simple. The figure illustrates the secondary requesting agent requesting the bus from the primary and then running a simple transfer cycle. The secondary requesting agent makes its request by asserting XBUSREQ*. The primary gives up the bus

by returning XBUSACK* active. In this example, the secondary uses the bus for only a single transfer cycle so it de-asserts XBUSREQ* when complete. The primary agent responds by withdrawing XBUSACK* to indicate it now owns the bus.

TRANSFER CYCLE

Like in the iPSB bus, the transfer cycle proceeds as a request phase and a reply phase. The requesting agent (either the primary or the secondary depending upon who currently owns the bus) informs the potential replying agents of the request phase by driving valid information on the address/command signal group and asserting **XACCREQ*.** The request phase normally lasts two clock cycles although the replying agents have the opportunity to extend the phase as long as necessary by asserting XWAIT* during the first clock period of the phase. The phase is extended as long as XWAIT* is active. In the example, the request phase is extended one additional clock.

The reply phase begins when XWAIT* is de-asserted. At this point, the meaning of XWAIT* changes to become a "not ready" indication from the selected replying agent. In the example, the replying agent requires one additional clock period to supply the data so XWAIT* is asserted for one clock. The reply phase terminates on the same clock that data is valid.

EXCEPTION CYCLE

If transfer integrity checking is implemented on the iLBX II bus, errors are signalled on the clock following the last valid information period. In example, errors detected on the address/command lines during the request phase are signalled on the clock following the removal of valid request information. The same applies to errors detected on the data lines during the reply phase.

Mechanical

The iLBX II bus is defined on the P2 connector of two-connector MULTIBUS II boards. Since the iLBX II bus environment is local to a particular processor board, the iLBX II bus backplane does not extend the entire length of the iPSB bus backplane. This allows for multiple iLBX II bus environments in a given system.

The pin assignment for the iLBX II bus on P2 is shown in iLBX II specification section in the MULTIBUS II Bus Architecture Specification Handbook.

Please refer to Intel's MULTIBUS II Bus Architecture Specification Handbook for more detailed information.

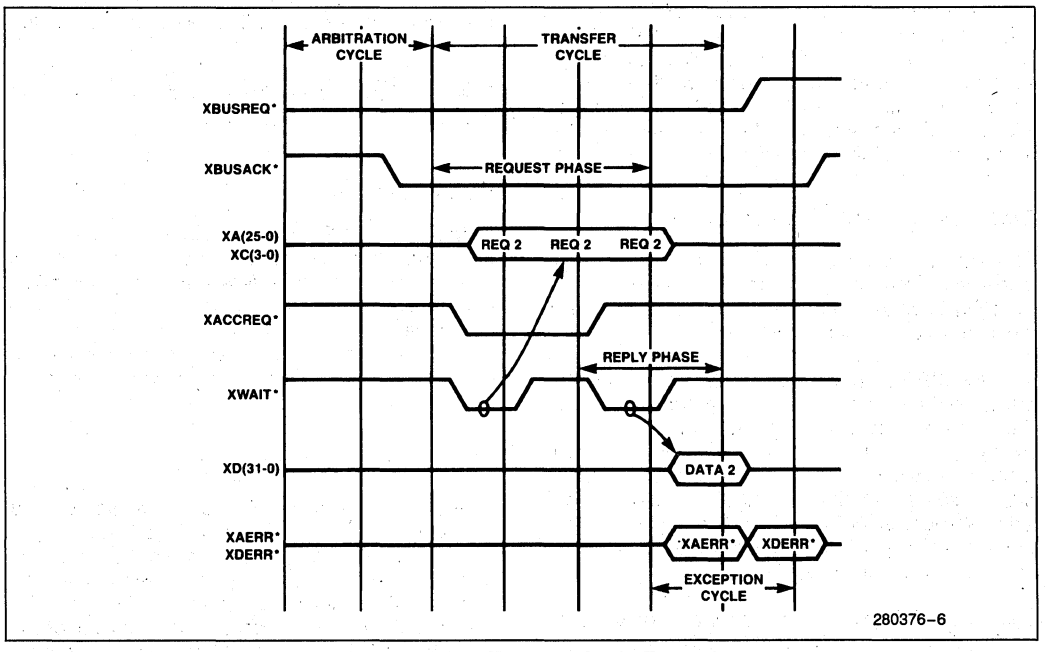
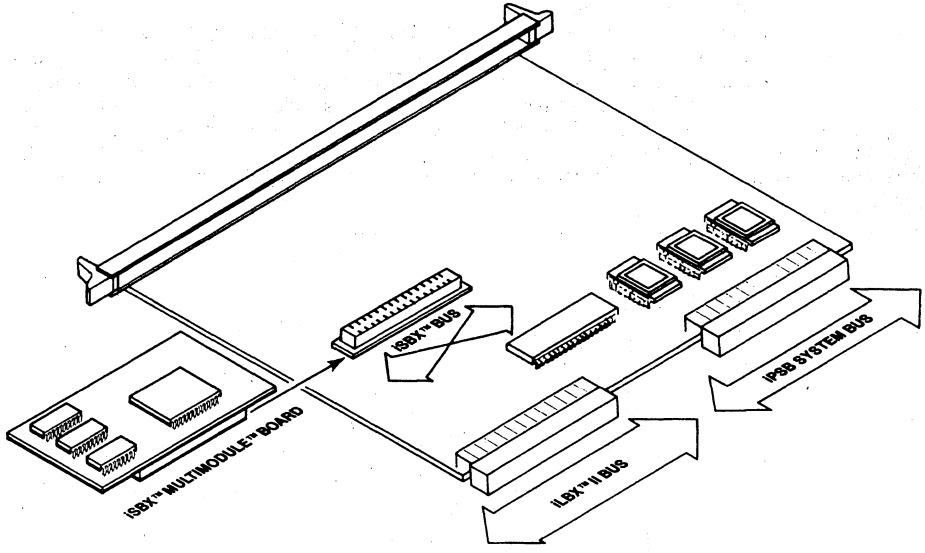


Figure 6. iLBX ™ Transfer Cycle Example

MULTIBUS® II
iPSB PARALLEL SYSTEM BUS

- **IEEE 1296 Industry Standard Bus**
- **Very High Bandwidth**
  - **— 40 Megabytes/Sec Using Burst Transfers**
  - **— 20 Megabytes/Sec with Single Cycles**
- **4 Gigabyte (32-bit) Addressing**
- **8-, 16-, 24-, and 32-bit Data Transfers over a 32-bit Path**
- **Pin-Efficient Multiplexed Structure**
- **Reliable Synchronous Clocking at 10 Megahertz with Full Handshaking for Data**
- **Distributed Arbitration with Up to 20 Bus Masters**
- **Full Parity Protection for Data Transfer Integrity**
- **Message Passing Facility for Intermodule Communication**
- **Geographic Addressing Facility for Software Indentification and Configuration of Boards**
- **Industry Standard Eurocard Form Factors—233 mm × 220 mm and 100 mm × 220 mm**

The MULTIBUS II iPSB Parallel System Bus is the foundation of the MULTIBUS II Bus Architecture. It is a general-purpose, processor independent structure which fully supports 8-, 16-, and 32-bit microprocessors. This very high bandwidth structure is defined on a single 96-pin IEC 603-2 (DIN) connector. All data movement functions required in a microcomputer system are defined including such advanced functions as an integrated message passing protocol and a geographic addressing facility which allows software to address a board by its slot position for software-based board identification and configuration.



280387-1

MULTIBUS® II Physical Diagram

September 1987
Order Number: 280387-002

FUNCTIONAL DESCRIPTION

Architectural Overview

The MULTIBUS II iPSB Parallel System Bus is the foundation of the MULTIBUS II bus architecture (see Figure 1). As a system bus, it is a very high bandwidth (40 megabytes/sec) bus optimized for intermodule communication; however, it also defines the complete set of basic bus functions required in a microcomputer system: memory accesses for execution of data, accesses to I/O for control of I/O functions, plus intermodule signalling. These basic functions are supplemented with additional functions supporting geographic (by slot) addressing and an integral message passing protocol.

Geographical addressing allows addressing of individual boards via their physical position in the backplane. Software can determine what boards are being used and configure itself appropriately. Software also can configure the hardware characteristics of the board (e.g., the starting address of a memory board). This can substantially reduce or even eliminate hardware jumper options and DIP switches for board configuration. Geographical addressing is a function of the interconnect address space.

MULTIBUS II's integral message passing protocol defines a standard and uniform way for modules to communicate over either the iPSB or iSSB buses. Integrating the protocol at the bus structure level lets the designer provide hardware support to increase system inter-module communication performance and opens the door for VLSI solutions. Standardizing the interface ensures a uniform software interface so that users can take advantage of new advances in technology without having to rewrite software.

Structural Features

OVERVIEW

The iPSB bus structure is a processor-independent general-purpose bus designed to support 8-, 16-, and 32-bit processors. It is designed to operate at a maximum bandwidth of 40 megabytes/sec while using off-the-shelf components.

Special attention has been given to how the bus structure, both electrically and mechanically, impacts system reliability. Synchronous sampling of all bus signal lines assures good immunity from crosstalk and noise. Full byte parity generation and checking protects all transfers on the bus to ensure that any bus error is detected. Signal quality on the bus is excellent due to the large number of interlaced ground lines. Mechanically, the iPSB bus is defined on a two-piece 96-pin IEC 603-2 connector to ensure good connector reliability.

MULTIPLEXING

The iPSB bus is highly multiplexed. The 32-bit address and data paths are multiplexed and the eight system control lines have different uses depending upon the phase of the transfer cycle. The six arbitration lines also serve dual purposes between system initialization and normal operation.

This multiplexed structure has several benefits. The entire 32-bit iPSB bus is defined on a single connector. This allows a full 32-bit iPSB bus interface on even the smaller, single connector, form factor board and opens the possibility of low cost 32-bit systems. Multiplexing also reduces by half the number of high current drivers required for the interface

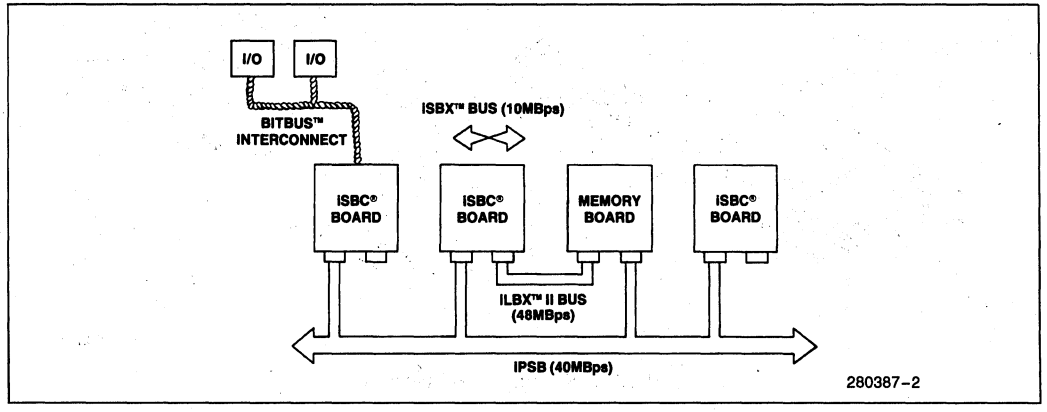


Figure 1. MULTIBUS® II Bus Architecture

which significantly reduces a board's current requirements. The routing of signal lines between the bus interface and connector is simplified.

ERRORS

The iPSB bus defines a complete set of bus error reporting mechanisms. Serious errors, such as a parity error or the failure of a module to complete the data handshake, are flagged on unique bus signal lines and are seen by all modules on the bus. These errors induce a recovery time in which the bus is allowed to stabilize before further transfer cycles may begin.

The iPSB bus also provides mechanisms for signaling less serious operational errors. Operational errors, such as attempting to perform a 32-bit access to a 8-bit device or writing to read-only memory, are signaled as agent errors. These errors may induce retry operations by an intelligent bus interface or may be passed to the on-board processor as errors.

INTERCONNECT ADDRESS SPACE

The ability to address a board by its physical position in the backplane is also supported in the iPSB bus. This facility allows board manufacturers to code such items as their vendor number, board type, board revision number, and serial number on the board. This information is available to the system software. This facility is defined in the iPSB bus interconnet address space.

Aside from this read-only information, the interconnect space allows write operations to support board configuration and diagnostics under software control. This facility can help reduce or eliminate hardware-based jumper options and DIP switches.

INTERRUPTS

The iPSB bus supports up to 255 distinct interrupt sources and 255 interrupt destinations. Rather than the user of the traditional method of dedicated interrupt signal lines on the bus, the iPSB bus defines a special bus cycle to convey interrupt information. This special bus cycle (actually part of the message passing protocol discussed below) redefines the meaning of the address; instead of a byte location in memory for example, 16 of the 32 lines encode 8 bits for the source module generating the interrupt and 8 bits for the destination module to service the interrupt.

This technique overcomes the significant problem of interrupt configuration found in traditional buses. Dedicated lines usually imply that only one particular destination can service one particular interrupt source. If an interrupt source wishes to target some interrupts to one destination and some to a different destination, separate bus interrupt lines are required for each destination. This can quickly consume all dedicated interrupt lines in even a moderate size system.

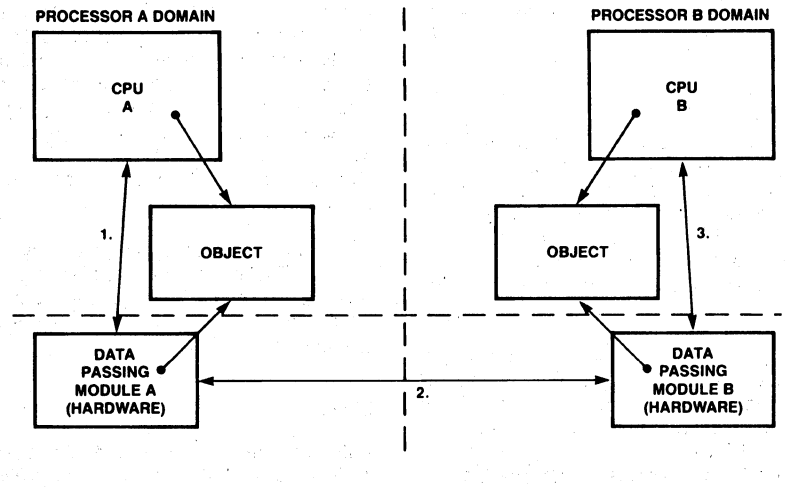
Using interrupt bus cycles with embedded source and destination module addressing removes the need for dedicated interrupt lines at the same time it allows any interrupt source to signal any interrupt destination.

MESSAGE PASSING

With the trend in microcomputer systems toward multiprocessing, it is important to provide the facilities and mechanisms to lend support for inter-module communication. The iPSB bus includes such mechanisms and defines the protocol for greatly enhanced performance in inter-module communication. This protocol is called MULTIBUS II Message Passing.

Most multiprocessor systems use either a "pass by reference" or a "pass by value" protocol for inter-module communication. In the "pass by reference" case, the two modules share a common memory resource and pass pointers or tokens to extend addressability of a desired data structure to the other module. In "pass by value", the modules exchange a copy of the desired data structure. Each of these protocols has a set of advantages and disadvantages associated with performance, data security, extendability to additional modules, and ease of use.

MULTIBUS II Message Passing takes the best of both methods and lends hardware support. Message passing uses a hardware "pass by value" interface that gives the performance of a "pass by reference" system. It replaces the software module used by the "pass by value" method with a specialized message passing interface. The processor "passes by reference" the reference to the data structure to the message passing co-processor interface. This interface communicates with the destination module's message passing interface to transfer the data without processor intervention. This data transfer is performed in the message address space. This is illustrated in Figure 2. (In many ways, it is helpful to think of the two communication message passing interfaces as a distributed, smart, DMA controller.)



NOTES:
1. CPU A Requests Transfer of Object (Pass by Reference).
2. Data Movement is Negotiated; Data Movement is Independent of Either Processor.
3. Processor B Assigns Memory for Object and is Signaled of Object Availability.

Figure 2. MULTIBUS® II Message Passing

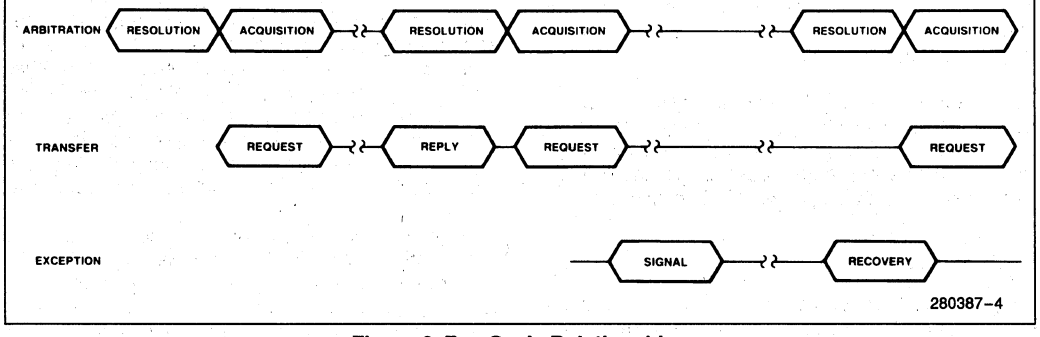


Figure 3. Bus Cycle Relationships

There are several significant benefits to this approach. First of all, the message passing interfaces can take advantage of the full capabilities of the bus (i.e., 32-bit data and burst transfer) independent of the type or nature of the controlling processor. Even 8-bit processor or I/O boards can take full advantage of the bus. This means significantly higher intermodule communication performance over a completely software-base method. Another benefit is the elimination of any shared memory. Dual-ported memory structures are no longer needed nor are global memory boards. The other primary benefit is that MULTIBUS II message passing presents a uniform software interface for all modules. Modules can be replaced with new modules containing newer technology (e.g., moving from a single density to a double density disk controller) without any software changes required in the controlling module. This makes it easy for users to integrate new technology without the problem of completely rewriting the driver software.

CENTRAL SERVICES MODULE

The iPSB bus specification defines the central system functions as the Central Services Module (CSM). The minimal set of functions are: clock generation, power-down and reset, time-out, and assignment of slot IDs. Collecting these functions in a single module improves overall board area utilization, since the functions are not duplicated on every board and then only used on one. The system designer is free to implement the CSM on a separate board or to include the functions as just one of several modules on another board.

Bus Cycle Overview

The iPSB bus defines three types of bus cycles: arbitration, transfer, and exception cycles. Each cycle is made up of one or more phases. Figure 3 illustrates the relationship among these cycles and phases.

ARBITRATION CYCLE

The arbitration cycle is made up of a resolution phase and an acquisition phase. The resolution phase is the time-period in which all requesting agents collectively arbitrate for access rights to the bus. Depending on the arbitration algorithm, the agents decide among themselves which of them is going to control the bus after the current bus owner is done. This arbitration method is referred to as self-selecting since the agents decide ownership among themselves.

The agent that wins the arbitration and obtains access rights to the bus begins the acquisition phase; that agent becomes the bus owner. This agent begins its transfer cycle and holds the arbitration logic in the resolution phase (resolving for the next access rights) until the transfer cycle is completed.

TRANSFER CYCLE

Starting the transfer cycle is the request phase. In this phase, the bus owner (requesting agent) places address and command information on the bus. This information defines the replying agent(s), the type of operation, and the type of address space. The request phase lasts one bus clock cycle.

The reply phase starts immediately after the request phase, during this phase, the requesting and replying agents engage in a handshake that synchronizes the data transfer sequence. The reply phase can contain one or more data cycles. The final data transfer is signaled by the requesting agent. During this final transfer, the requesting agent releases ownership of the bus allowing the new bus owner to use the bus immediately. Note how the transfer cycle overlaps the resolution phase of the arbitration cycle to minimize bus dead time.

EXCEPTION CYCLE

If an agent detects an error during a transfer cycle, it immediately begins an exception cycle. The exception cycle terminates any arbitration cycles and transfer cycles in progress. The exception cycle starts with the signal phase in which the detecting agent activates one of the exception lines. This notifies all agents of the problem causing them to terminate any arbitration or transfer cycles. Next the recovery phase begins. During this phase, all agents idle; this allows the bus a fixed amount of idle-time to stabilize before resuming normal operation.

Signal Groups

OVERVIEW

The iPSB bus contains five groups of signals, Figure 4, over which the requesting and replying agents can enact the protocol. An asterisk following the signal name indicates that the particular signal or group of signals are active when at their electrical low.

ARBITRATION GROUP

The arbitration signals on the iPSB bus determine which agent gains exclusive access to the bus (which agent is the bus owner). All requesting agents that require access to the bus resources must arbitrate for use of the bus. On being granted bus ownership, an agent begins using the address/data lines to perform a transfer cycle. There are seven signals in the arbitration group: BREQ* and ARB5* through ARB0*.

BREQ* (Bus Request) is an OR-tied signal which is bused on the backplane. All agents that require access to the bus assert the BREQ* signal.

A particular agent's arbitration ID number is coded on lines **ARB4* through ARB0*** (Arbitration). An agent requiring use of the iPSB bus asserts BREQ* and drives its arbitration ID onto the OR-tied ARB lines. The ARB5* line selects one of two arbitration algorithms: fairness or high priority.

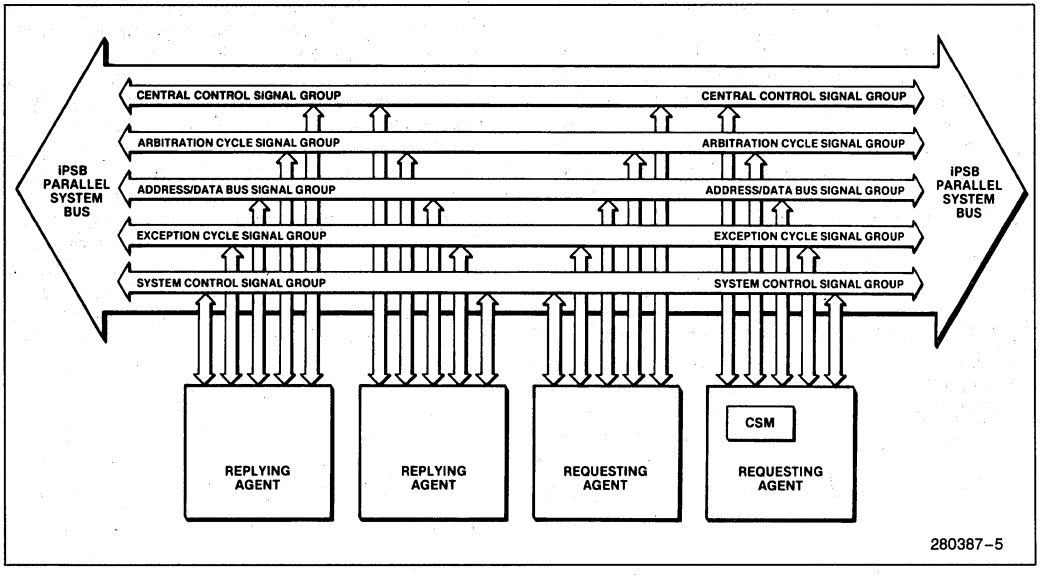


Figure 4. iPSB Bus Signal Groups

Table 1. System Control Definition

Signal	Function	
	Request Phase	Reply Phase
SC0	Request Phase	Request Phase
SC1	Lock	Lock
SC2	Data Width 0	End-of-Cycle
SC3	Data Width 1	Requesting Agent Ready
SC4	Address Space 0	Replying Agent Ready
SC5	Address Space 1	Agent Error 0
SC6	Read/Write	Agent Error 1
SC7	Reserved	Agent Error 2
SC8	Parity (SC7–4)	Parity (SC7–4)
SC9	Parity (SC3–0)	Parity (SC3–0)

ADDRESS/DATA BUS GROUP

This signal group contains the lines used to transfer the address and data information plus their respective byte parity lines. The **AD31* through AD0*** (Address/Data) lines are multiplexed and serve a dual purpose depending upon the phase of the transfer cycle.

During the request phase, they contain the address for the ensuing transfer. This address refers to the byte location for memory and I/O spaces, a processing agent module in message space, and a board slot location in interconnect space. The requesting agent drives these lines during the request phase.

During the reply phase, they contain either eight, sixteen, twenty-four, or thirty-two bits of data. They are driven by the requesting agent for write transfers and by the replying agent for read transfers.

The **PAR3* through PAR0*** (Parity) lines are the byte parity lines associated with the respective bytes of the AD lines. They form even parity with their respective address/data byte.

SYSTEM CONTROL SIGNAL

The transfer signal group consists of ten signals, SC9* through SC0((System Control). Agents use these signals to define commands or to report status, depending on the phase of the transfer cycle.

During the request phase, the requesting agent drives SC9* through SC0*. The SC lines provide command information to the replying agent(s). During the reply phase, the requesting agent drives SC9* and SC3* through SC0* with its handshake and additional control information. The replying agent drives the remainder with its handshake and status. Table 1 lists the request and reply phase functions for this group.

EXCEPTION SIGNAL GROUP

The iPBS bus provides a group of two signals for passing indications of exception errors to all agents: **BUSERR*** (Bus Error), and **TIMOUT*** (Time-out).

An agent activates BUSERR* to indicate its detection of a data integrity problem during a transfer. Parity errors on the AD or SC lines are typical of errors signaled on BUSERR. Any agent detecting such errors must signal BUSERR* and all agents must receive BUSERR*.

TIMOUT* is signaled by the CSM whenever it detects the failure of a module to complete a handshake. TIMOUT* is received by all agents on the bus.

CENTRAL CONTROL GROUP

The system control group provides status concerning the operating state of the entire iPSB bus environment. It consists of seven signals plus the power and ground lines.

The **RST*** (Reset) signal is a system-level initialization signal sent to all agents by the CSM.

The **RSTNC*** (Reset Not Complete) signal is an OR-tied line driven by any agent whose internal initialization sequence is longer than that provided by the RST* signal itself. Due to its OR-tying, RSTNC* remains active until every agent has completed its initialization sequence. Agents cannot perform bus transfer cycles until RSTNC* is inactive.

The CSM provides a **DCLOW** (DC Power Low) signal to all agents as a warning of an imminent loss of DC power. DCLOW is typically generated from a signal supplied by the system power supply on the loss of AC power. Any agent needing to preserve state

information in battery backed-up resources should do so upon receiving an active DCLOW.

Accompanying DCLOW for power-down sequencing is the **PROT*** (Protect) signal. The CSM drives PROT* active a short time after it activates DCLOW to inform all bus interfaces to ignore any transitions on the bus as power is lost.

The **BCLK*** (Bus Clock) and **CCLK*** (Constant Clock) signals are supplied by the CSM to all agents. Agents use the BCLK to drive the arbitration and timing state machines on the iPSB bus. The active going edge of BCLK* provides all system timing references. The CCLK* is an auxiliary clock at twice the frequency of BCLK.

An agent user its **LACHn*** (ID Latch) signal to save the slot ID it receives from the CSM at reset time via the ARB4* through ARB0* lines. The ID latch signal is called LACHn* where the "n" is the card slot to which the ID is assigned. At each card slot, the LACHn* signal is connected to the AD line of the same number. As an example, card slot 7 has a LACH7* signal that is connected to AD7*.

When RST* is active, the CSM sends successive slot ID's (0 through 19) on the ARB4* through ARB0* lines while activating the corresponding AD line. Agents know when the ARB lines contain the correct slot number when they see their LACHn* line go active.

POWER

System power supplied in the iPSB connector includes +5 volts, +12 volts, −12 volts, and facilities for +5 volt battery back-up. Also defined are numerous ground lines some of which are interlaced throughout the connector.

iPSB Bus Protocol

OVERVIEW

In the MULTIBUS II specification, both timing diagrams and state-flow diagrams describe the iPSB bus protocol. The state-flow diagrams present the lowest-level and most rigorous definition while the timing diagrams help conceptual understanding. For the purposes of this data book, only the timing diagram description is used.

ARBITRATION CYCLE

An agent that wishes to transfer data on the iPSB bus must begin by performing an arbitration cycle. The cycle performs two functions: first, it gives all agents the opportunity to be granted access to the bus, and second, it eliminates the possibility of more than one agent trying to transfer data on the bus at any one instant. In the case where more than one agent requests access to the bus at the same instant, the arbitration cycle grants access to the agents based upon one of two arbitration algorithms: normal or high priority.

Normal priority mode provides "fairness" or "no starvation", which means each agent has an equal opportunity to grant access to the bus. For example, assume all agents request the bus at the same instant. In the normal priority mode, each agent is granted the bus, one by one, until all requests have been serviced. If an already serviced agent desires to use the bus again before all of the original agents are serviced, it will wait until all of original requesting agents have their request granted. This "round-robin" granting of access ensures that any agent requesting the bus will eventually get it.

The high priority mode allows an agent with high priority to force its way into the arbitration and be granted the bus before agents with lesser priority. This means that a high priority agent gets access to the bus quickly; however, it can also consume so much of the bus that agents with less priority never gain access; they will "starve".

At reset, the CSM supplies each agent with its slot ID and its arbitration ID. An agent making a normal priority request activates BREQ*, holds ARB5* inactive, and drives its arbitration ID onto ARB4* through ARB0*. If the ARB lines hold its ID after a specified time (3 bus clocks), this agent won the arbitration and can use the bus once any ongoing transfer completes. However, if the ARB lines do not match its ID (after all, other agents might be also requesting the bus and driving the ARB lines), another agent won the arbitration. The losing agent removes its ID and waits for the next resolution phase before trying again.

An agent makes a high priority request by activating BREQ*, holding ARB5* active (ARB5* selects the arbitration mode), and driving its arbitration ID onto the ARB lines. The high priority algorithm requires that when a high priority request enters during an arbitration cycle, the request immediately enters the next resolution phase rather than waiting for the next bus request cycle as do normal priority requests. ARB5* being active causes the other requesting agents to remove their requests guaranteeing the high priority agent access to the bus before any simultaneous normal priority requests. When more than one agent simultaneously makes a high priority request, the agent with the higher priority (lower numerical value) arbitration ID will go first. Figure 5 illustrates the logic required to implement the iPSB bus arbitration. With either priority mode, once an agent owns the bus, it can perform any number of transfer cycles until force off by arbitration. This characteristic of the arbitration algorithms is called "bus parking".

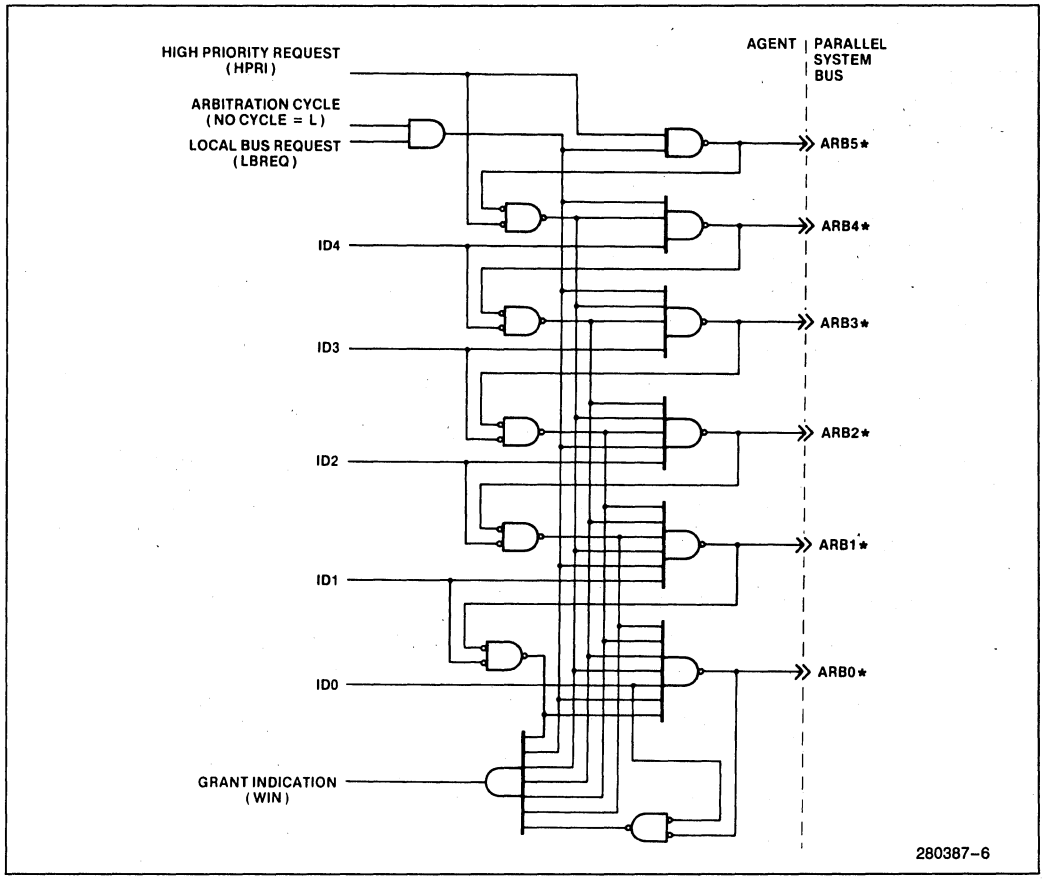


Figure 5. iPSB Bus Arbitration Cycle

TRANSFER CYCLE

Transfer cycles consist of two phases: request and reply. For illustration, an example of an access read cycle is shown in Figure 6. During the request phase, the bus owner (requesting agent) uses the transfer cycle signal group (SC lines) to notify the replying agent of the address space (memory, I/O, interconnect, or message), the data width (8-, 16-, 24- or 32-bit), and whether the cycle is read or write. The AD lines contain the desired address for the selected address space. Replying agents know the SC lines contain this request information by the requesting agent activating SC0* (Request Phase). The request phase lasts one clock cycle. All potential replying agents use the request phase to determine whether they contain the addressed resource.

The reply phase starts immediately following the request phase. During this phase the agent with the addressed resource (replying agent) and the requesting agent exchange data and status. Both the requesting and replying agent must agree that the data on the AD lines and the status on the appropriate SC lines are valid via the RQRDY (Requesting agent read—SC3*) and RPRDY (Replying agent read— SC4*) handshake lines. Either agent can

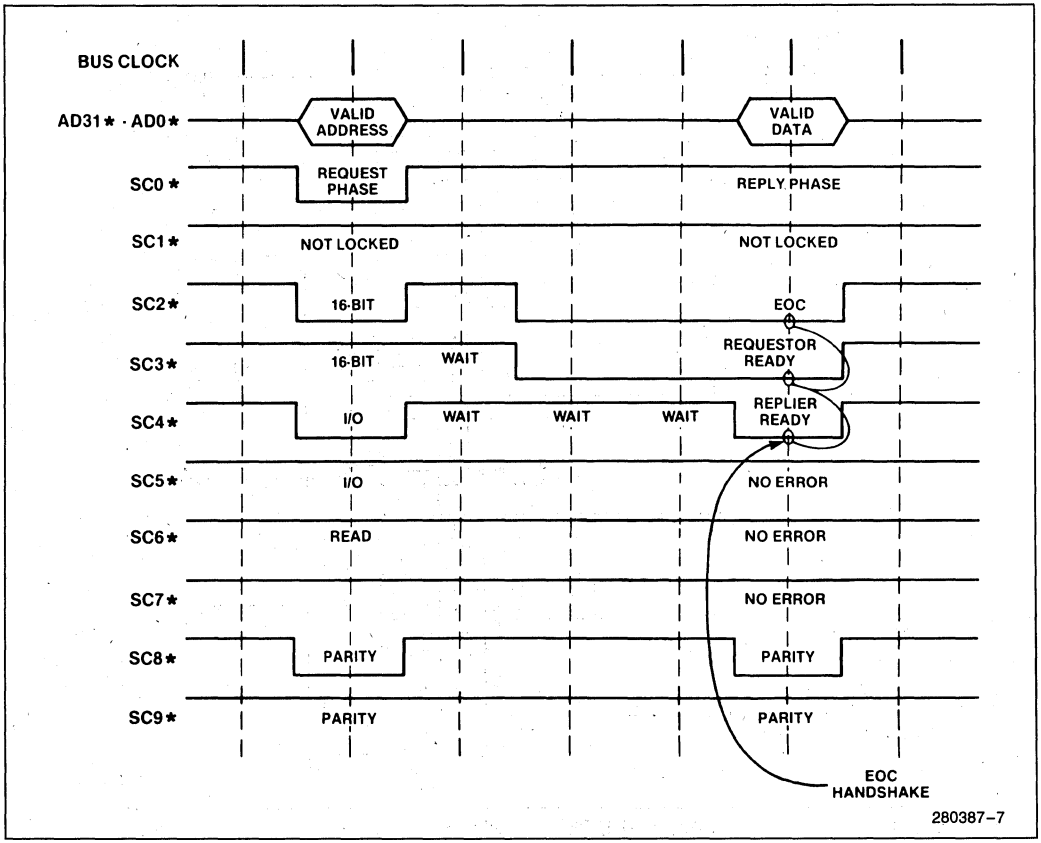


Figure 6. Transfer Cycle Example

hold off the transfer by deactivating its ready line. This handshaking supports any speed requesting or replying agent.

The transfer cycle is complete when the requesting agent signals the last data transfer via the End-Of-Cycle (EOC—SC2*). The last bus clock cycle of the transfer is when EOC, RQRDY, and RPRDY are all active simultaneously.

The replying agent has the opportunity to tell the requesting agent if it does not support the requested operation via the agent error (SC5*, SC6*, and SC7*) lines. These lines encode five types of errors: width violation, continuation error, data error, illegal operation, and negative acknowledgement of a message. Trying to extract 32-bits of data from an 8-bit peripheral is an example of a data width violation. Continuation errors occur when attempting sequential access from an agent which does not support them or running off the ending address of a memory board. Writing to a read-only memory is an example of an illegal operation. A parity or ECC error in a memory board is an example of a data error. A replying agent signals a negative acknowledgement to a message transfer cycle if its destination queue is full (the source most perform source queuing). The transfer cycle is terminated by the requesting agent when it detects that the replier is signalling an agent error. If the bus interface is intelligent, it might retry the operation with a different type that the replying agent can support. Other aspects of transfer cycle include the ability of a requesting agent to LOCK the bus via the SC1* line. SC1* is a non-multiplexed signal which inhibits alternate ports of any multi-ported resource being addressed. By locking the bus, the requesting agent can guarantee itself exclusive access to a multi-ported bus resource and retains bus ownership for more than one transfer cycle.

As noted in the figure, in addition to parity protection on the address/data lines, the SC lines are also protected by parity. The requesting agent is responsible for the SC parity bits (SC8* and SC9*) during the request phase (it drives all SC lines). The reply phase requires two parity bits: one for those lines driven by the requesting agent and one for those driven by the replier. This ensures all aspects of the transfer cycle have parity protection.

EXCEPTION CYCLE

The exception cycle is an error reporting mechanism. An agent or the CSM initiates an exception cycle as a result of sensing an exception. If no exception occurs, no exception cycles occur.

The exception cycle has two purposes in the protocol: first, it provides systematic termination of activity on the iPSB bus and second, it provides a stabilization time before allowing agents to resume operation. These two purposes correspond directly to the two phases of the exception cycle: the signal and recovery phases.

The signal phase begins when an agent or a module senses an exception and activates one of the bus error lines. One receiving a bus error, all agents terminate any transfer or arbitration cycles in progress. The net effect of the signal phase is to terminate all bus activity. The signal phase continues until the error-detecting module deactivates the bus error line.

The recovery phase begins after the bus error line becomes inactive. The recovery phase is a fixed-duration delay (in terms of bus clock cycles) that allows time for the iPSB bus signals to settle before starting more transfer cycles.

There are two types of bus exceptions supported by the iPSB bus: timeout and bus error. The CSM monitors the bus to ensure that all data handshakes complete. If for some reason the handshake hangs and exceeds a maximum time limit, the CSM activates the TIMOUT* (Time Out) bus exception line to begin the exception cycle.

An agent sends a bus error exception whenever it determines that the information on the address/data (AD) or the transfer control (SC) lines is in error. Once an error is detected, the agent activates the BUSERR* (Bus Error) signal line to begin the exception cycle.

Mechanical

The MULTIBUS II boards, board accessories, and backplanes conform to mechanical standards defined by the International Electromechanical Commission (IEC); these standards are commonly referred to as the Eurocard mechanical standards. This mechanical system offers modular board sizes as defined in standard IEC-297-3 and reliable two-piece connectors as defined in IEC-603-2.

FORM FACTOR

The MULTIBUS II specification calls out two modular board form factors: 233 × 220 mm and 100 × 200 mm (see Figure 7). The iPSB bus and iLBX II bus portions of the MULTIBUS II system architecture are always defined on the P1 and P2 connectors respectively. However, the user can optionally define the use of the P2 connector if the iLBX II bus is not supported. (The iSSB bus is additionally defined on the P1 connector.)

Connector

MULTIBUS II boards and backplanes use two-piece, 96-pin connectors for both the iPSB bus and iLBX II bus. The right-angle connectors on the printed board are IEC standard 603-2-IEC-C096-M; the receptacle connectors on the backplane are IEC standard 6-03-2-IEC-C096-F (Figure 8). This connector family is noted for its reliability, availability, and low cost.

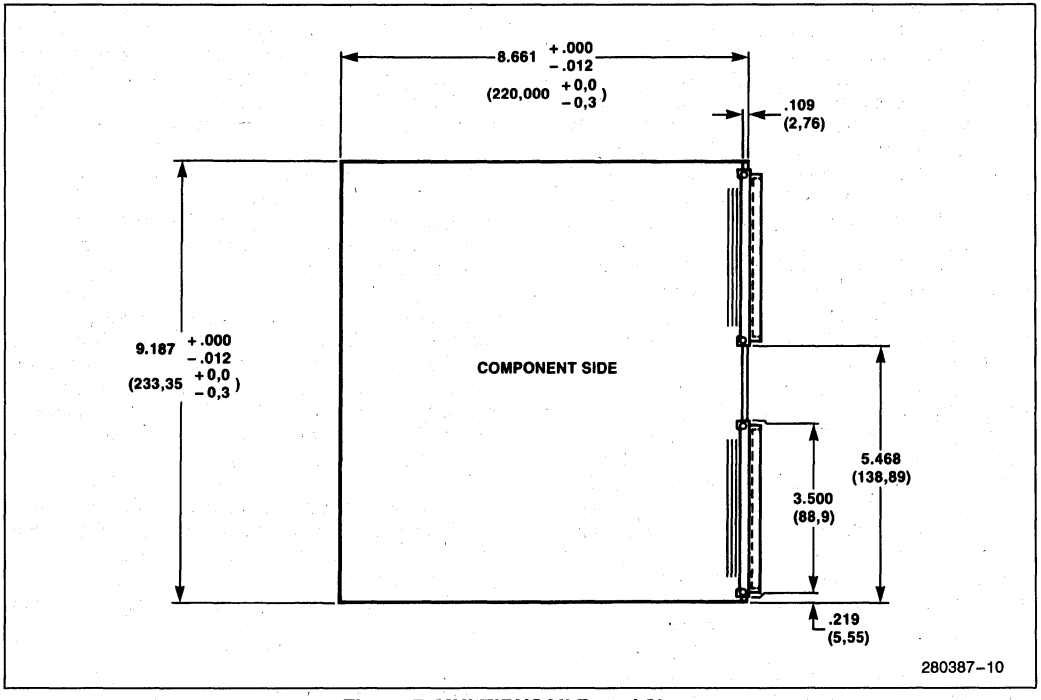


Figure 7. MULTIBUS®II Board Sizes

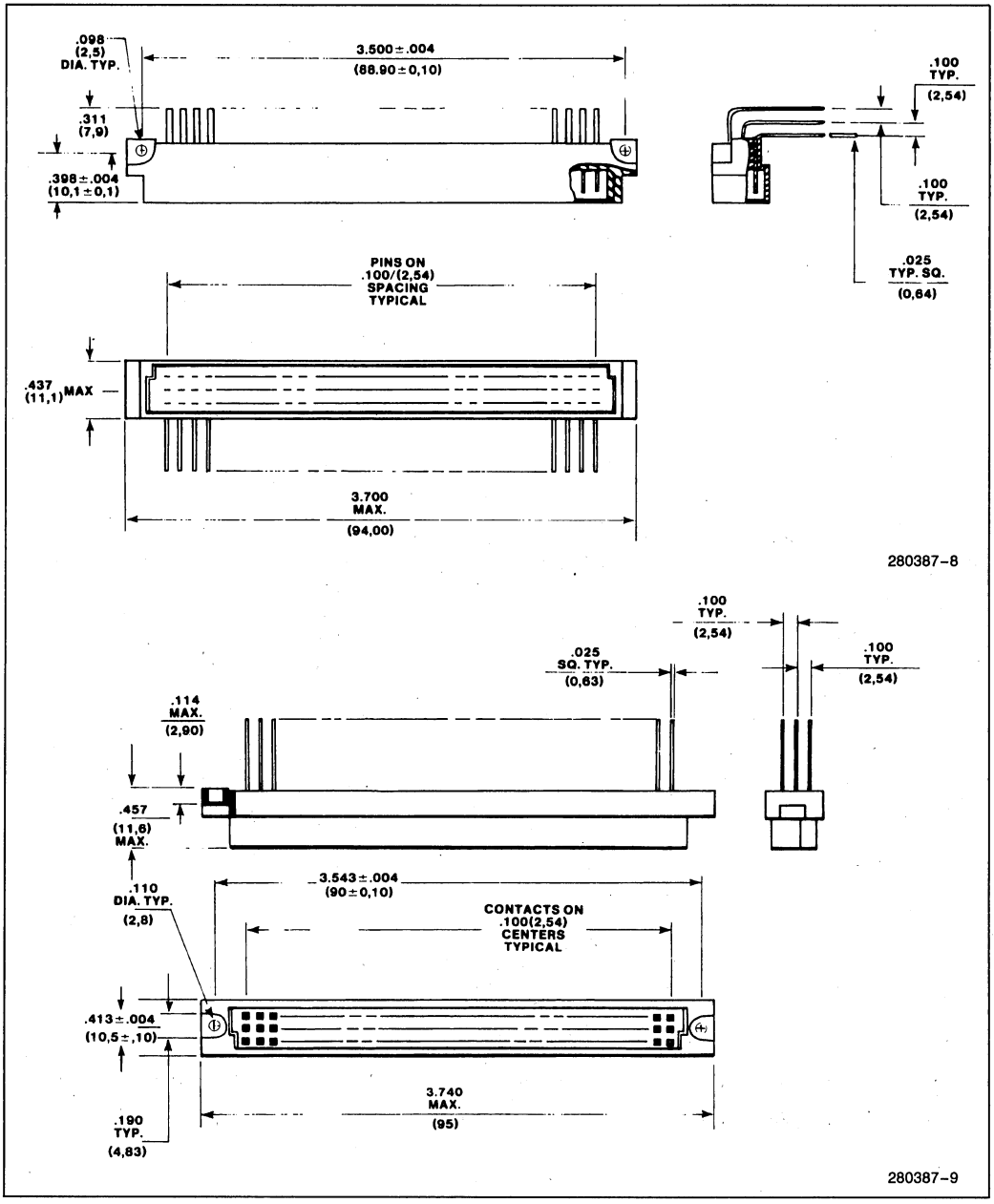


Figure 8. MULTIBUS®II Connectors

The pin assignment for the iPSB bus on P1 is shown in Table 2.

Please refer to Intel's MULTIBUS II Bus Architecture Specification Handbook for more detailed information.

Table 2. iPSB Bus Pin Assignments

Connector Pin Number	Row A	Row B	Row C
1	0 Volts	PROT*	0 Volts
2	+5 Volts	DCLOW*	+5 Volts
3	+12 Volts	+5 Battery	+12 Volts
4	(Note 2)	SDA (Note 3)	BCLK*
5	TIMOUT*	SDB (Note 3)	0 Volts
6	(Note 1) LACHn	0 Volts	CCLK*
7	AD0*	AD1*	0 Volts
8	AD2*	0 Volts	AD3*
9	AD4*	AD5*	AD6*
10	AD7*	+5 Volts	PAR0*
11	AD8*	AD9*	AD10*
12	AD11*	+5 Volts	AD12*
13	AD13*	AD14*	AD15*
14	PAR1*	0 Volts	AD16*
15	AD17*	AD18*	AD19*
16	AD20*	0 Volts	AD21*
17	AD22*	AD23*	PAR02*
18	AD24*	0 Volts	AD25*
19	AD26*	AD27*	AD28*
20	AD29*	0 Volts	AD30*
21	AD31*	Reserved	PAR3*
22	+5 Volts	+5 Volts	Reserved
23	BUSREQ*	RST*	BUSERR*
24	ARB5*	+5 Volts	ARB4*
25	ARB3*	RSTNC*	ARB2*
26	ARB1*	0 Volts	ARB0*
27	SC9*	SC8*	SC7*
28	SC6*	0 Volts	SC5*
29	SC4*	SC3*	SC2*
30	−12 Volts	+5 Battery	−12 Volts
31	+5 Volts	SC1*	+5 Volts
32	0 Volts	SC0*	0 Volts

NOTES:
1. LACHn* for all agents but the one driving CCLK*; line contains a second CCLK* signal in systems that have more than 12 cardslots.
2. 0 Volts for all agents but the one driving BCLK*; line contains a second BCLK* signal in systems that have more than 12 cardslots.
3. Signal lines SDA and SDB are reserved for the Serial System Bus.

82389
MESSAGE PASSING COPROCESSOR A MULTIBUS® II BUS INTERFACE CONTROLLER

- **Highly Integrated VLSI Device**
  - **— Single-Chip Interface for the Parallel System Bus (IEEE 1296)**
  - **— Interrupt Handling/Bus Arbitration Functions**
  - **— Dual-Buffer Input and Output DMA Capabilities**
  - **— Nine 32-Byte High Speed FIFOs**
- **Multiple Interface Support**
  - **— Complete Protocol Support of the PSB Bus (Message Passing)**
  - **— Processor Independent Interface (8, 16, or 32-Bit CPU)**
  - **— Low-Cost 8-Bit Microcontroller Interface**
  - **— Dual-Port Memory Interface**
- **High Performance Coprocessing Functions**
  - **— Offloads CPU for Communication and Bus Interfacing**
  - **— 40 Megabytes/Sec Burst Transfer Speed**
  - **— Optimized for Real-Time Response (Max. 900 ns for 32-Byte Interrupt Packet)**
- **Compatible with Bus Arbiter Controller (BAC) and Message Interrupt Controller (MIC) Interface Designs**
- **CMOS Technology**
- **149 Pin PGA Package (15 x 15 Grid)**

The MPC 82389 is a highly integrated VLSI device that maximizes the performance of a Multibus® II based multiprocessor system. It integrates the functions of bus arbitration, packetizing data for transmit, error handling and interrupt control. Because of these integrated functions the host CPU can be offloaded to utilize the maximum bus performance and subsequently increase the system throughput. The MPC 82389 also supports geographic addressing by providing access to the local interconnect registers for reference and control.

The MPC 82389 is designed to interface with an 8, 16, or 32-bit processor and the Parallel System Bus performance is not affected by the CPU buswidth or its bandwidth. The data on the Parallel System Bus is burst transferred at the maximum bus speed of 40 Megabytes/second regardless of CPU bus performance. Such performance is possible due to decoupling of the CPU from the Parallel System Bus.

MULTIPROCESSOR ARCHITECTURE

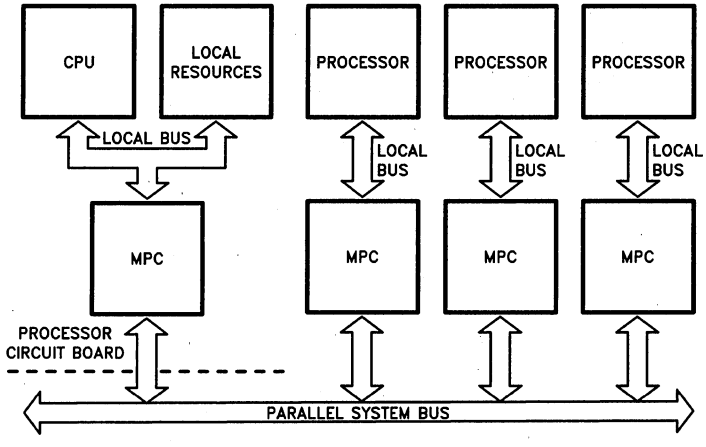


Figure 1-1

October 1987
Order Number: 290145-001

1.0 MPC 82389 INTRODUCTION

The Message Passing coprocessor 82389 is a highly integrated CMOS VLSI device to interconnect intelligent boards in a MULTIBUS II system environment. The parallel system bus of the MBII architecture definition however allows existence of intelligent and non-intelligent boards in the system.

This section of the data sheet describes the device in general including the definition of message passing protocol and the subsequent sections will contain the detailed features of the device. Please refer to the MPC User's Manual for more details.

1.1 MPC 82389 Functional Overview

The MPC 82389 is a Bus Interface Controller designed to offload the host CPU for interprocessor communication on the PSB network, and it's primary function is to support the communication protocol standard defined for the PSB bus (message passing). The device provides both the physical and data link support. By standardizing the signal interface (physical), it allows multiple vendors to offer standard add-on products for the user and at the same time it reduces costly overheads for the suppliers. The data link protocol is completely handled by the MPC 82389 including packetization after receiving data from the local interface, bus arbitration, burst transfer and error detection without the CPU intervention.

The PSB bus standard is defined for easy access and sharing of resources in a distributed processing environment. The MPC 82389 complements this standard by providing an optimized interface for the PSB bus usage at its maximum bandwidth.

The MPC 82389 also features three additional interfaces for use on a processor board.

Local Bus Interface for Host independent CPU. The CPU can be 8, 16 or 32 bits wide.

Interconnect Bus for interfacing to a low-cost microcontroller. The interconnect bus has a local address space which can be accessed by other agents on the PSB bus via the MPC.

Dual-Port Memory Interface to support an alternative communication approach which may coexist with the message passing method.

1.2 Major Operations of the MPC 82389

— Support of both unsolicited and solicited message transfers. This interprocessor communication protocol allows an intelligent agent on the PSB bus to communicate to another without any CPU intervention and at rates approaching the PSB bus bandwidth.

— Support of single cycle accesses by the host processor to memory and I/O locations resident on the PSB bus. Bus architecture, parity generation and error detection is completely handled by the MPC 82389 coprocessor.

— Support of accesses to local interconnect space by both the host processor and other agents on the PSB bus.

— Support of accesses by the host processor to interconnect location assigned to other PSB bus agents.

— Support of accesses to local, dual-port memory by other agents on the PSB bus.

1.3 Message Passing Protocol

The Multibus II architecture defines the data transfer protocol between agents on the PSB bus as Message Passing.

Message Passing allows the PSB agents to transfer variable amounts of data at rates approaching the maximum bus speed. The MPC 82389 fully supports the standardized data link protocol designed for the PSB and the entire handshaking between agents on the PSB bus is handled by the MPC 82389 without the CPU intervention.

There are two types of messages that can be transmitted from one PSB agent to another: **Unsolicited Messages** and **Solicited Messages**.

Unsolicited Messages—An unsolicited message is an intelligent interrupt also called virtual interrupt. This unsolicited message, as the name implies, is an asynchronous event to notify the receiving agent to prepare for the receipt of **Solicited Messages**. The message is in the form of a packet and it consists of information about the interrupt. By providing such intelligence the receiving agent's CPU do not have to poll for information, thus resulting in minimal latency.

Solicited Messages—The solicited messages are the actual data that are transmitted from one MPC to another. The data is once again broken into packets and these packets are transferred using the negotiation (handshaking) process which are synchronized by the MPC 82389 coprocessors.

1.4 Compatibility with BAC/MIC Interface Designs

The Bus Arbiter Controller (BAC) and Message Interrupt Contoller (MIC) were the first support components for the Parallel System Bus. The BAC implemented the full arbitration, requestor, and replier functions of the PSB. The MIC supported the transmit and receiving of minimum size unsolicited (interrupt) messages.

To ensure future compatibility with the MPC 82389 implementation, the BAC/MIC architecture was put on a module called the docket for direct incorporation onto the base-board. The PSB implementations for the MPC and the BAC/MIC docket are compatible in all respects. These implementations may coexist on the PSB bus of the same system. For the host and microcontroller interfaces, compatibility is maintained for message and interconnect space operations. It is, thus, possible to replace the BAC/MIC docket with the MPC at little impact to the board design.

Software initialization of the operating parameters for the MIC is possible through the Configuration Register to support host widths of 8, 16 or 32 bits. The MIC supports a host width of 8 bits only. Both implementations present similar software interfaces for the sending and receiving of interrupts. For details about the initialization procedures and interrupt protocols, please refer to the MPC Users's Manual, Part Number: 176526.

The MPC offers capabilities and performance far superior to the BAC/MIC implementation. Using the MPC, interrupt handling at the host interface can be improved by over an order of magnitude. Whereas the MIC can handle only minimum 4-byte interrupts, the MPC enables up to 28 bytes of data to be sent and received along with each interrupt. Further, the MPC has dedicated support for DMA based solicited message transfer.

2.0 MPC 82389 INTERFACES

The MPC 82389 features 4 interfaces: the local CPU bus for processor interface, the interconnect bus for 8-bit microcontroller interface, the Parallel System Bus interface and the dual-port memory interface.

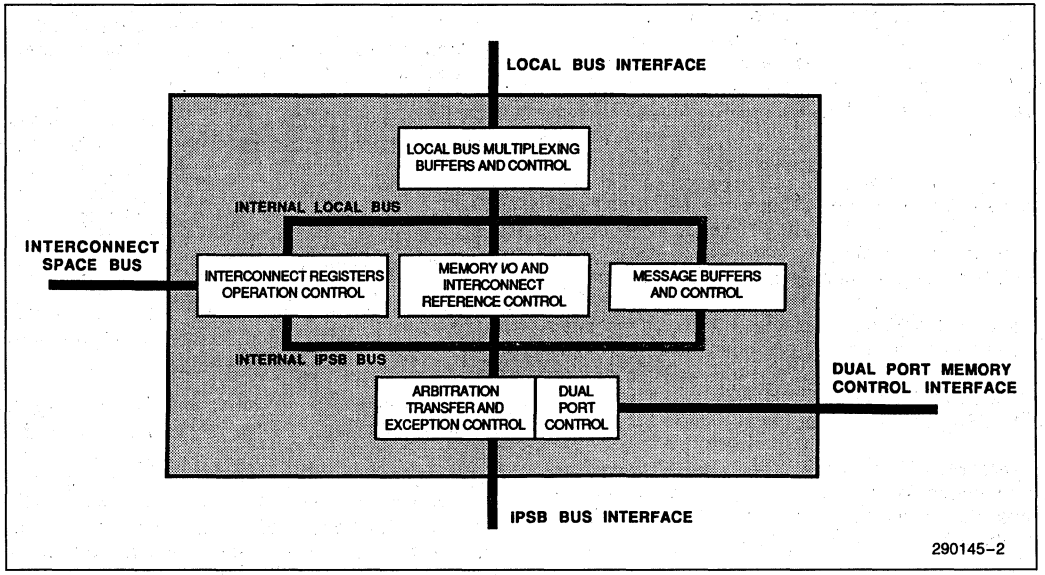


Figure 2-1. MPC Bus Interfaces

2.1 Local Bus

The local bus of the MPC 82389 is used to interface to a host processor. The CPU can be 8, 16, or 32 bits wide and the interface is processor independent.

The local bus interface supports direct references to memory, I/O and interconnect address space on the PSB bus. It also supports references to local interconnect space and the full message passing protocol. The entire local bus interface can be categorized into three sub-interfaces: register, reference and DMA.

2.1.1 REGISTER INTERFACE

The MPC 82389 local bus register interface is used for message operations and access to the interconnect space. These operations are asynchronous to the bus clock or interconnect bus operation.

2.1.2 REFERENCE INTERFACE

The MPC 82389 local bus reference interface supports direct references to memory, I/O and interconnect address space on the PSB bus. Memory and I/O references are initiated by the CPU to the MPC. The MPC responds by putting the CPU on hold while arbitrating for PSB bus access. The CPU is held in WAIT state until the operation is complete or a bus exception occurs on the PSB bus. The reference interface supports both read and write to the registers. The local interconnect address space is differentiated from the interconnect address on the PSB bus by the bit pattern stored in the slot address register of the MPC.

2.1.3 DMA INTERFACE

The DMA interface transfers data between local memory and the MPC 82389 during solicited message operations. The MPC provides both the input and output channels to the PSB bus. The number of transfers to or from the MPC is determined by the maximum size of the packet buffer (32-byte) or completion of the solicited transfer, whichever is less.

The DMA interface is designed to operate on either a read or write command to allow two-cycle operation or fly-by transfers. For two-cycle operation, the DMA uses a read operation to fetch data from the MPC and a write to put data into the MPC. Conversely, a fly-by read or write operation occurs correspondingly to memory write or read operation.

The DMA interface to the MPC performs best with aligned transfers. However, for compatibility with existing software, the MPC supports operations of arbitrary byte strings.

2.2 Parallel System Bus

The MPC 82389 provides a full 32-bit interface to the PSB bus and participates in arbitration, requestor control, replier control and error handling.

2.2.1 ARBITRATION

The MPC 82389 initials PSB bus access arbitration upon request generated inside the MPC. This request could be the result of a synchronized PSB bus reference request (memory, I/O or interconnect) or a message packet transmit request from the CPU. The PSB bus arbitration specification can be referred in the document, MPC User's Manual, Part Number: 176526.

2.2.3 REPLIER CONTROL

The MPC 82389 as a replier supports interconnect space reference and message reception. It gets into replier mode when a match is detected between the assigned slot ID and the address on the PSB bus. The interface space microcontroller is alerted of the replier mode condition. The address comparison is disabled when the MPC is the bus owner.

The MPC allows interconnect space to be locked from the PSB bus. This inhibits local bus interface access requests.

2.2.4 ERROR HANDLING

The MPC 82389 monitors errors generated during the transfer operation. It provides error checking on incoming interconnect references that match the slot ID. If an exception occurs on the PSB bus while an interconnect operation is in progress, the MPC provides for a graceful recovery.

2.3 Interconnect Bus

The Interconnect bus of the MPC 82389 has a simple 8-bit interface. A low-cost microcontroller can be interfaced to perform board configuration at startup and other tasks like local diagnostics.

The Interconnect space of an agent has a 512-byte register range. Within this space the microcontroller can store the local operating and configuration parameters associated with the agent. For example local diagnostics can be executed out of the microcontroller and the results posted in the Interconnect space. IEEE 1296 specifications require the first record in the Interconnect space to contain the board ID and Intel recommends other record types. Refer to Interconnect Interface Specification, Part Number: 149299.

The MPC 82389 provides the path to access the local Interconnect space. The references supported are:

1. CPU local bus to the local Interconnect space
2. CPU local bus to the Interconnect space of another agent on the PSB bus
3. From the PSB bus to the local Interconnect space

The local Interconnect accesses are identified as slot IDs 24–31 and the Interconnect accesses on the PSB bus are mapped as slot IDs 0–23.

The MPC participates in PSB bus handshake protocol, parity generation and checking and agent error generation for local Interconnect accesses from the PSB bus.

The Interconnect microcontroller is the master device on the bus and all other devices including the MPC are slaves.

2.4 Dual-Port Memory Interface

The MPC 82389 supports the dual-port memory interface for those designs that must coexist with the memory passing architecture.

The dual-port services supported are: Address recognition, PSB bus replier handshake, error checking, and bus parity generation and checking. A useful recovery mechanism is provided by the MPC should a bus exception error occur while a dual-port memory access is in progress. Although the MPC 82389 provides bus parity check it is the responsibility of the memory controller to generate and check data parity.

2.5 Basic Implementation with the MPC 82389

Figure 2-2 shows a basic implementation of the MPC 82389. Included in this implementation is the interconnect interface to a microcontroller, the CPU interface and the PSB bus interface.

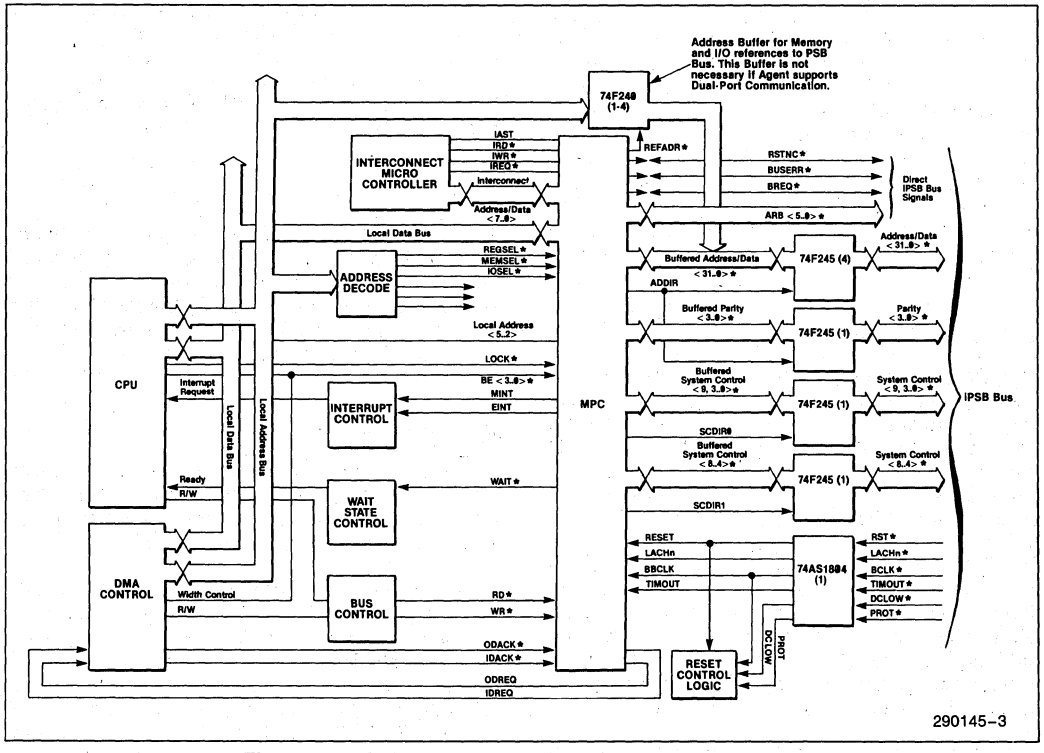


Figure 2-2. MPC Implementation to Support References

2.6 Implementation with Dual-Port Memory Interface

Figure 2-3 shows the logic required to implement dual-port operations.

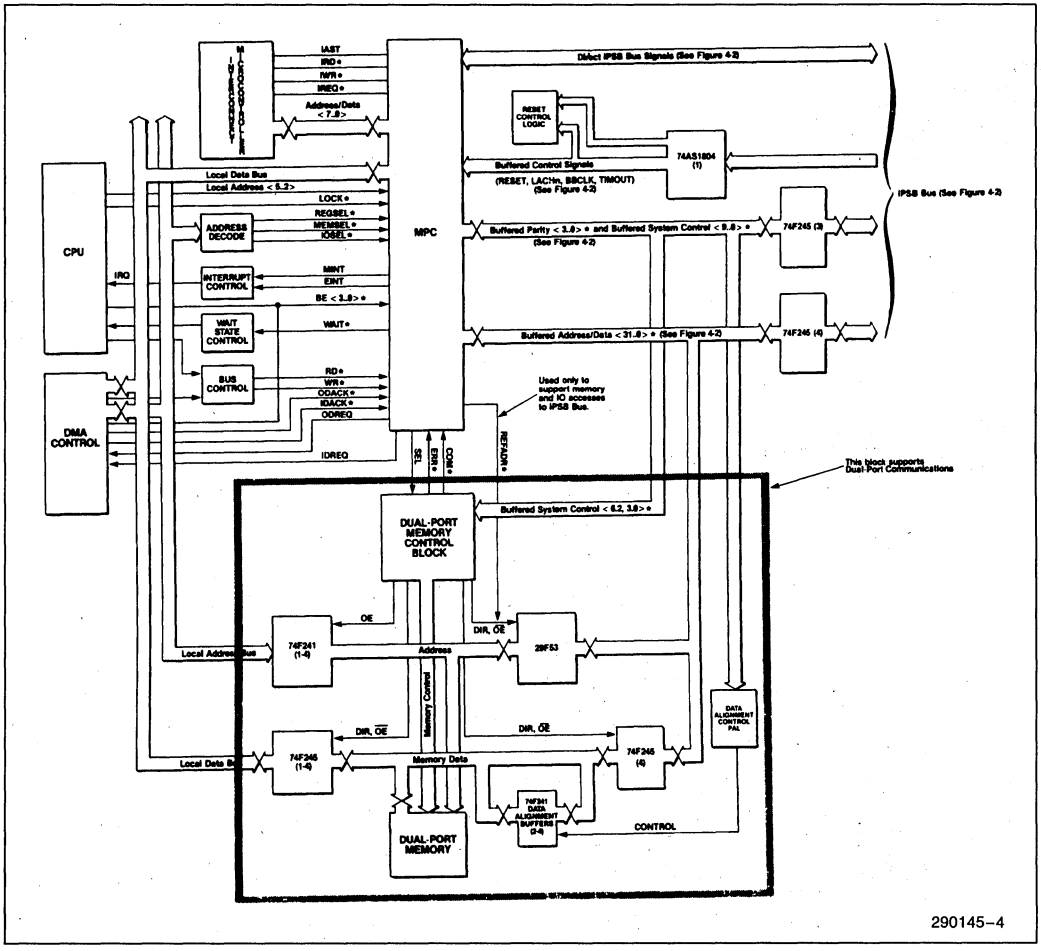


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Figure 2-3. The MPC Implemented with Dual-Port Memory

3.0 MPC 82389 INTERPROCESSOR COMMUNICATION

A MULTIBUS II system can have up to 20 boards in the slot backplane. Slot zero must have a Central Services Module (CSM) which provides bus initialization and clocking. The remaining 19 slots can have a mix of intelligent and non-intelligent boards. The intelligent boards will typically communicate over the high speed PSB bus. Any processor based board may contain an MPC 82389 for high speed communication and the MPC is designed to support the system performance and the data transfer speed of the PSB bus. The MPC has an optimized PSB bus interface.

Message Passing over the PSB bus is completely handled by the MPC 82389 coprocessor without CPU intervention. The messages (data) are packetized in blocks of 32 bytes and burst transferred over the PSB bus.

The decoupling is achieved by using very high speed FIFOs of the MPC 82389. Nine 32-byte FIFOs are used in the MPC 82389. Five of these FIFOs are used for setting up the unsolicited messages (interrupts). One is used for output set up and the other four for input set up of up to four unsolicited messages. For data transmission (solicited messages) over the PSB, the MPC 82389 has two dedicated solicited output and input channels. With each channel, dual 32-byte FIFOs are used to pipeline data during output and input operation.

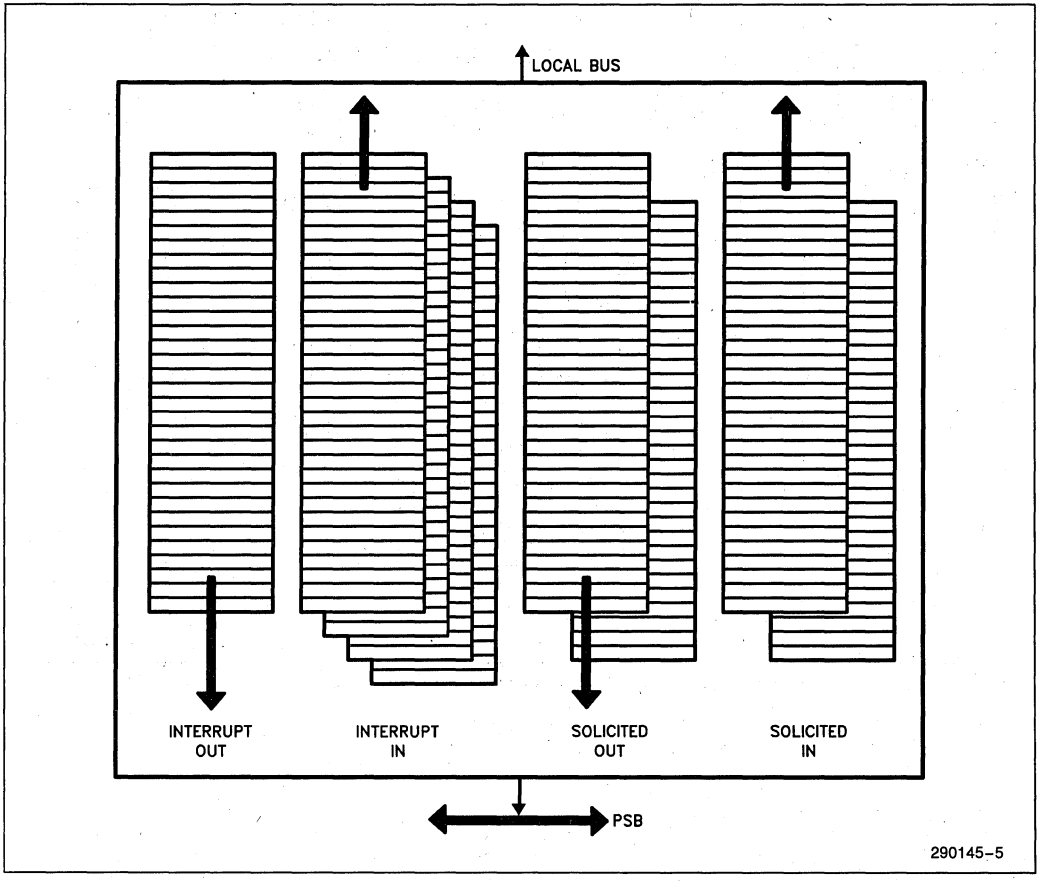

Figure 3-1. The MPC Uses Nine 32 Byte FIFOs to Couple the Local and System Buses

3.1 Communication Protocol

Any device with an interface to the PSB bus is termed as an agent. The agents communicate over the PSB bus and they completely offload the CPU for other tasks. Each agent is assigned an 8-bit address for identification.

The mechanism used for interprocessor communication over the PSB entails a standardized data link protocol, and a dedicated address space. The information which is packetized is transmitted to a dedicated address space instead of the target memory. This addressing scheme serves to decouple the CPU from the PSB bus. Packetization serves to limit the time an agent has an access over the bus, thus protecting against hogging of the bus by agents which require transmitting a large amount of data.

The data link protocol called message passing includes two kinds of messages: unsolicited and solicited.

3.1.1 UNSOLICITED MESSAGE

Unsolicited message is an intelligent interrupt. It is a virtual interrupt for the receiving agent and includes all the information required to service the interrupt. It takes only 900 ns to send an unsolicited message over the PSB bus, and since the receiving agent's processor does not have to poll for servicing the interrupt, this mechanism is fast and efficient.

The unsolicited message is sent as a packet consisting of up to 32 bytes, as shown in Figure 3-2. The address field is 8 bits long. Up to 255 agents can be addressed uniquely while one address is used for broadcast function.

The general format for unsolicited messages varies depending on the CPU bus width. There are other variations depending on whether the CPU is receiving or transmitting the message and the type of unsolicited message.

Unsolicited messages are asynchronous in nature. These unsolicited messages are used to set up solicited messages and contain Control and Command information.

An unsolicited message consisting of 32 bytes takes a maximum of 900 ns to transmit. The unsolicited message packet without the optional 28-byte data will take only 200 ns to transmit.

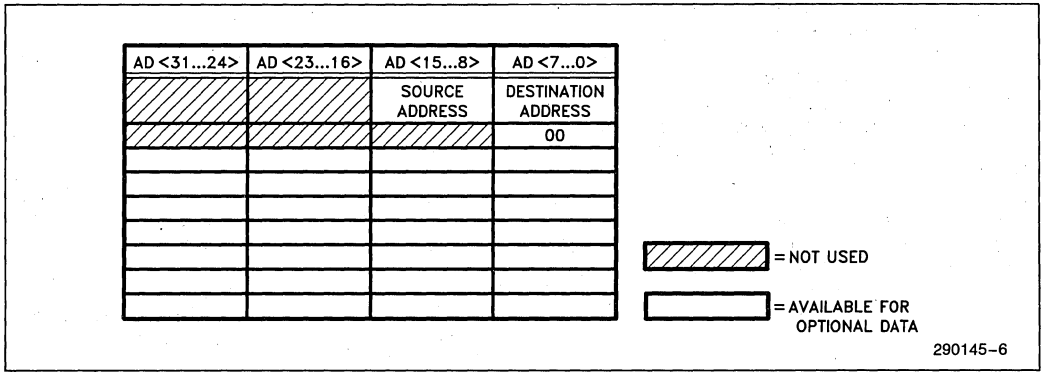

Figure 3-2. General Interrupt Message on the PSB

AD<31..24>	AD<23..16>	AD<15..8>	AD<7..0>
		Source Add. Byte 1	Dest. Add. Byte 0
		ID Byte 3	Type Byte 2
Data, Byte 7	Data, Byte 6	Data, Byte 5	Data, Byte 4
Data, Byte 11	Data, Byte 10	Data, Byte 9	Data, Byte 8
Data, Byte 15	Data, Byte 14	Data, Byte 13	Data, Byte 12
Data, Byte 19	Data, Byte 18	Data, Byte 17	Data, Byte 16
Data, Byte 23	Data, Byte 22	Data, Byte 21	Data, Byte 20
Data, Byte 27	Data, Byte 26	Data, Byte 25	Data, Byte 24
Data, Byte 31	Data, Byte 30	Data, Byte 29	Data, Byte 28
Data, Byte 35 Solic. only	Data, Byte 34 Solic. only	Data, Byte 33 Solic. only	Data, Byte 32 Solic. only

Figure 3-3. General Message Packet Format on the PSB Bus

3.1.2 SOLICITED MESSAGE

Solicited message consists of the actual data to be transferred from one agent to another over the PSB bus. The data is packetized in blocks of 32 bytes for transfer. Up to 16 Megabytes of data may be transferred in a single solicited message.

The transfer of data is negotiated between the transmitting and receiving agents via unsolicited messages. By using the acknowledge response method through the unsolicited messages, the agents complete the transfer of data.

A solicited message contains one or more data packets. The packetization of solicited messages is handled by the MPC. The padding of header information at the transmitting end and the stripping of this information out of the packet is solely the MPC responsibility. The local CPU simply fills or empties the FIFO over the local bus. The MPC also handles the last packet fillers to maintain the 32-byte data packet format. If necessary, during output the bytes are padded and during input the padded bytes are stripped by the MPC.

For programming details consult MPC User's Manual, Part Number: 176526.

3.2 Bus Bandwidth

The advantages of decoupling the buses can be summarized in Figure 3-4. The effective speed performance numbers are also listed. The first advantage is that no resource is held in wait states while arbitration for another resource is occurring. The second advantage is that each transfer can occur at the full bandwidth of the associated bus.

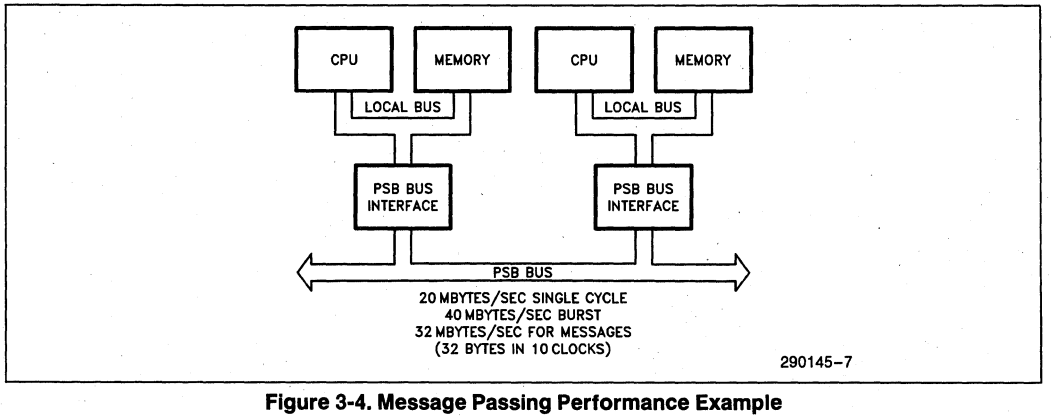

Figure 3-4. Message Passing Performance Example

4.0 MPC 82389 PIN DESCRIPTION

The MPC 82389 is packaged in a 149 pin package. The signals for the device are functionally divided by their associated interfaces as shown in Figure 4-1.

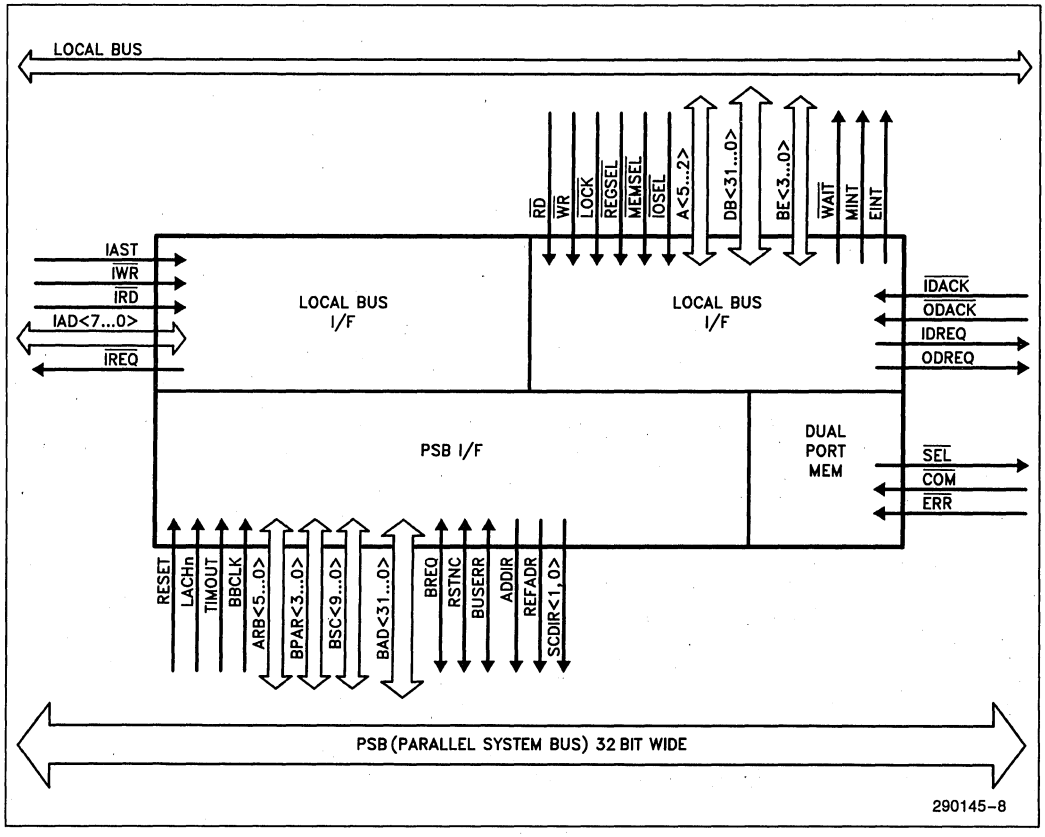

Figure 4-1. MPC Functional Blocks

4.1 PSB Bus Signals

This section describes each of the PSB bus signals that interface with the MPC. For complete descriptions of these signals, see the MULTIBUS II Architecture Specification, Part Number: 146077.

The PSB bus signals interfaced by the MPC 82389 fall into five groups, depending on function:

- Arbitration Operation Signal Group
- Address/Data Bus Signal Group
- System Control Signal Group
- Central Control Signal Group
- Exception Operation Signal Group

Unless otherwise stated, all PSB bus signals are synchronous to the bus clock.

4.1.1 ARBITRATION OPERATION SIGNAL GROUP

The MPC 82389 interfaces directly with the Arbitration Operation Signal Group of the PSB bus. These are all high-current drive, open-collector signals. Below is a description of each signal.

$\overline{\text{BREQ}}$ (Bus Request)
$\overline{\text{BREQ}}$ is a bidirectional open-collector signal that connects directly to the PSB bus. As an input to the MPC, it indicates that agents are awaiting access to the bus. In fair access mode, this inhibits the MPC from activating its own request. As an output, the MPC asserts $\overline{\text{BREQ}}$ to request access to the PSB bus.

$\overline{\text{ARB}}$<5..0> (Arbitration)
$\overline{\text{ARB}}$<5..0> are the arbitration signals for the PSB bus. At the MPC interface, these are bidirectional, open-collector signals that connect directly to the PSB bus. $\overline{\text{ARB}}$<5..0> are used during normal operation to identify the mode and arbitration priority of an agent during an arbitration cycle to facilitate the arbitration process. During system initialization (while reset is active), the Central Services Module (CSM) drives these signals to initialize slot and arbitration IDs.

4.1.2 ADDRESS/DATA BUS SIGNAL GROUP

This signal group includes a 32-bit multiplexed address/data path that interfaces to the PSB address/data bus. The MPC also includes the byte parity signals present on the PSB bus $\overline{\text{BPAR}}$<3..0>. All signals in this group interface with the PSB bus through bus tranceivers. For the MPC, this signal group also includes signals to control these bus transceivers (ADDIR and $\overline{\text{REFADR}}$). These signals are described next.

$\overline{\text{BAD}}$<31..0> (Buffered Address/Data)
$\overline{\text{BAD}}$<31..0> are the 32 buffered, multiplexed address/data signals that are bidirectional and provide the interface to the PSB address/data bus. At the MPC, these lines should be connected to the equivalent PSB bus $\overline{\text{AD}}$ signals using 74F245 or equivalent transceivers.

$\overline{\text{BPAR}}$<3..0> (Buffered Parity)
$\overline{\text{BPAR}}$ are four signals that provide parity for the 4 bytes of the $\overline{\text{BAD}}$ bus. These bidirectional lines connect to the PSB bus $\overline{\text{PAR}}$<3..0> signals through a 74F245 or equivalent transceiver. These signals are used to receive byte parity for incoming operations and to drive byte parity for outgoing operations.

ADDIR (Address/Data Direction)
ADDIR is an output that provides direction control over the transceivers driving and receiving $\overline{\text{BAD}}$<31..0> and $\overline{\text{BPAR}}$<3..0>. In the high state, this signal causes the transceivers to place address/data information along with parity onto the PSB bus. In the low state, this signal causes address/data information and parity to be received from the PSB bus.

$\overline{\text{REFADR}}$ (Reference Address Enable)
$\overline{\text{REFADR}}$ is an output used to enable external address buffers. Asserting this signal places address information from the local bus onto $\overline{\text{BAD}}$. The address path enabled by this signal is used for memory and I/O references to the PSB bus and is not used during message passing or for references to interconnect space on the PSB bus.

4.1.3 SYSTEM CONTROL SIGNAL GROUP

The MPC provides signals that are used to interface to the System Control Signal Group of the PSB bus. These signals are described next.

$\overline{\text{BSC}}$<9..0> (Buffered System Control)
$\overline{\text{BSC}}$<9..0> is a group of ten bidirectional signals that interface to the System Control Signal Group of the PSB bus through 74F245 or equivalent transceivers. Direction control of the transceivers is provided by SCDIR<1, 0> (discussed next). Agents on the PSB bus use the System Control Signal Group to define commands or report status, depending on the phase of the operation. See the MULTIBUS II Architecture Specification for more information on these signals.

SCDIR<1, 0> (System Control Direction)
SCDIR<1, 0> are output signals that provide direction control of the 74F245 transceivers driving and receiving $\overline{\text{BSC}}$<9..0>. SCDIR0 provides control for $\overline{\text{BSC}}$<9, 3..0>, while SCDIR1 provides control for

$\overline{BSC}$<8..4>. When either signal is high, the corresponding five bits of the $\overline{BSC}$ signal group are driven onto the PSB bus. When either signal is low, the corresponding five bits on the PSB bus are driven onto the $\overline{BSC}$ signal group.

4.1.4 CENTRAL CONTROL SIGNAL GROUP

The MPC provides several signals that interface directly or through transceivers to the Central Control signal group of the PSB bus. These signals are described next.

BBCLK (Buffered Bus Clock)
BBCLK is buffered from the PSB bus $\overline{BCLK}$ signal. This signal should be connected to $\overline{BCLK}$ using a 74AS1804 or equivalent inverting buffer. This clock is used for all synchronous internal MPC timing.

LACHn (Latch n)
LACHn is an input signal used during initialization of slot and arbitration IDs (where "n" is the slot number). When the RESET signal is active, LACHn asserted indicates to an agent that a slot or arbitration ID is available and should be latched. LACHn is an active high input and should be connected to the $\overline{LACHn}$ signal on the PSB bus with a 74AS1804 or equivalent inverting buffer.

RESET
RESET is an input that, when asserted, places the MPC in a known state. Only the parts of the MPC involved with initialization of slot and arbitration IDs remain unaffected. RESET is an active high input and should be connected to the $\overline{RST}$ signal on the PSB bus with a 74AS1804 or equivalent inverting buffer.

Reset Condition
Table 4-1 summarizes the states of the signals while the RESET signal is active.

Table 4-1. Signal State During Reset

Signal	Reset State
$\overline{BREQ}$, $\overline{ARB}$<5..0>	Z
$\overline{BAD}$<31..0>	Z
ADDIR	L
$\overline{REFADR}$	H
$\overline{BSC}$<9..0>	Z
SCDIR<1, 0>	L
$\overline{BUSERR}$	Z(H)
$\overline{RSTNC}$	L
$\overline{SEL}$	H
D<31..0>	Z
$\overline{WAIT}$	H
MINT, EINT	L
ODREQ, IDREQ	L

NOTES:
H — Electrical High State
L — Electrical Low State
Z — High Impedence

$\overline{RSTNC}$ (Reset Not Complete)
$\overline{RSTNC}$ is a bidirectional, open-collector signal with high-current drive. It connects directly to the PSB bus. As an input, $\overline{RSTNC}$ inhibits the MPC from initiating PSB bus operations. As an output, the MPC asserts $\overline{RSTNC}$ to prevent PSB bus operation until the agent is finished with initialization. The MPC asserts $\overline{RSTNC}$ whenever the $\overline{RST}$ signal is asserted by the Central Services Module (CSM). After the CSM deasserts $\overline{RST}$ and initialization of the local agent is complete, the interconnect microcontroller writes to a register within the MPC. The MPC then deasserts $\overline{RSTNC}$.

4.1.5 EXCEPTION OPERATION SIGNAL GROUP

The MPC interfaces with both signals of the Exception Operation Signal Group (part of the PSB bus), as described below.

$\overline{BUSERR}$ (Bus Error)
$\overline{BUSERR}$ is a bidirectional, open-collector signal with high-current drive. It connects directly to the PSB bus. As an input, the MPC uses this signal to detect bus errors signaled by other agents. As an output, the MPC uses $\overline{BUSERR}$ to indicate parity errors detected on either the $\overline{BAD}$ or $\overline{BSC}$ signals and to indicate handshake protocol violations detected on the $\overline{BSC}$ signals.

TIMOUT (Time-Out)
TIMOUT is an input from the PSB bus used to detect a time-out condition signaled by the CSM. TIMOUT is an active high input to the MPC and must be connected to the $\overline{TIMOUT}$ signal of the PSB bus through a 74AS1804 or equivalent inverter buffer.

4.2 Dual-Port Memory Control Signals

The MPC provides the following signals to support dual-port memory.

$\overline{SEL}$ (Select)
The MPC asserts $\overline{SEL}$ to indicate that a dual-port memory access is in progress. The assertion of $\overline{SEL}$ initiates the dual-port operation and during memory reads, can be used to enable the dual-port data buffers onto the $\overline{BAD}$ bus. When the MPC completes the PSB bus handshake on the PSB bus, or if the MPC detects an exception, it deasserts $\overline{SEL}$.

$\overline{COM}$ (Complete)
$\overline{COM}$ is an input to the MPC. The dual-port memory controller asserts $\overline{COM}$ to indicate it is ready to complete dual-port access. $\overline{COM}$ is assumed to be synchronous to the bus clock. The MPC asserts the Replier Ready ($\overline{SC4}$) signal on the PSB bus on the bus clock after the memory controller has asserted $\overline{COM}$. The memory controller cannot deassert $\overline{COM}$ until the end-of-transfer (EOT) handshake is complete on the PSB bus. This requires that the memory controller monitor the PSB bus for the EOT handshake.

$\overline{ERR}$ (Error)
$\overline{ERR}$ is asserted by the dual-port memory controller to signal a memory data parity error. $\overline{ERR}$ must be stable (high or low) whenever $\overline{COM}$ is asserted. The MPC responds to this signal by completing the replier handshake on the PSB bus using a "data error" agent error code. This signal may be asynchronous to the bus clock since it is qualified by the $\overline{COM}$ signal.

4.3 Local Bus Signals

The MPC provides five signal groups that together interface to the CPU's local bus. These local bus signal groups are:

- data
- address and select
- transfer control
- interrupt
- DMA control

All local bus signals are assumed to be asynchronous to the bus clock.

4.3.1 DATA BUS

The local data bus (D<31..0>) is a bidirectional group of signals that transfers data between the host CPU, DMA controller, or memory and the MPC. Although this is a 32-bit interface, the MPC provides control to allow operation with processors using 8-, 16-, or 32-bit data buses.

Not all processors use the same byte order when performing multiple data byte operations. For example, for a 16-bit write to memory, one processor may carry the least-significant byte on local bus bits D<7..0> and the most-significant byte on bits D<15..8>, while another processor may carry the least-significant byte on bits D<15..8> and the most-significant byte on bits D<7..0>. For a given agent, be sure to implement the processor interface to maintain consistent byte addressability with all other agents in the system.

4.3.2 ADDRESS AND SELECT SIGNALS

The address and status signals identify all MPC operations over the local bus.

A<5..2> (Address)
The address inputs select MPC registers for message and interconnect space operations. A1 and A0 are omitted to provide a consistent register address for all data bus width options. These signals are qualified by commands in the MPC (for example, $\overline{RD}$ or $\overline{WR}$, defined in section 4.1.3.3). To the MPC, the state of A<5..2> must be stable within the specified setup and hold window. The address values defined by A<5..2>, and required to access MPC registers, are provided in, "Programming the Host Interface" of the MPC User's Manual, Part Number: 176526.

$\overline{BE}$<3..0> (Byte Enable)
These input signals identify valid bytes for memory and I/O reference operations and also provide data path control for register and DMA operations. The assertion of a byte enable signal validates a particular byte on the data bus. Signals $\overline{BE}$<3..0> correspond to data bytes 3 through 0 on the data bus (where byte 3 is D<31..24>). Only combinations supported by the PSB bus specification are valid. Valid combinations are summarized in Table 4-2. Values not shown in the table are illegal and will result in unpredictable operation. These signals are qualified by commands (for example, $\overline{RD}$ or $\overline{WR}$) in the MPC and must be stable within the specified setup and hold window.

Operation with 32-bit local buses requires that all byte enable and data signals are used. For 16-bit local buses, $\overline{BE2}$ and $\overline{BE33}$ are deasserted, $\overline{BE1}$ and $\overline{BE2}$ are used to indicate which of the two bytes will contain valid data, and only D<15..0> are used. For 8-bit local bus operations, $\overline{BE3}$ is asserted, $\overline{BE2}$ is deasserted, and $\overline{BE1}$ and $\overline{BE0}$ are used to select which byte of the PSB bus will carry the valid data byte. This mode uses only D<7..0> (on the local bus). Note that during all read operations, the MPC drives D<31..0>.

Table 4-2. Valid Byte Enable Combinations

				Local Bus				PSB Bus†			
$\overline{BE3}$	$\overline{BE2}$	$\overline{BE1}$	$\overline{BE0}$	D31–D24	D23–D16	D15–D8	D7–D0	AD31–AD24	AD23–AD16	AD15–AD8	AD7–AD0
L	L	L	L	V3	V2	V1	V0	V3	V2	V1	V0
L	L	L	H	V3	V2	V1	x	V3	V2	V1	x
H	L	L	L	x	V2	V1	V0	x	V2	V1	V0
L	L	H	H	V3	V1	x	x	x	x	V3	V2
H	L	L	H	x	V2	V1	x	x	V2	V1	x
H	H	L	L	x	x	V1	V0	x	x	V1	V0
L	H	H	H	V3	x	x	x	x	x	V3	x
H	L	H	H	x	V2	x	x	x	x	x	V2
H	H	L	H	x	x	V1	x	x	x	V1	x
H	H	H	L	x	x	x	V0	x	x	x	V0
L	H	L	H	x	x	x	V0	x	x	V0	x
L	H	H	L	x	x	x	V0	x	x	x	V0

NOTES:
L — Electrical low state (active)
H — Electrical high state (inactive)
Vx — Valid data bytes
x — Active bytes with undefined data
† — For this PSB bus, these combinations apply to reference operations, not message space operations

$\overline{MEMSEL}$ (Memory Select)
This MPC input signal, when asserted, indicates to the MPC that the current operation is a memory reference to the PSB bus. It is qualified by the assertion of $\overline{RD}$ or $\overline{WR}$ (defined in section 4.3.3). The state of $\overline{MEMSEL}$ be must stable within the defined set-up and hold window. Additionally, for $\overline{MEMSEL}$ to be valid, the signals $\overline{IOSEL}$, $\overline{REGSEL}$, $\overline{IDACK}$, and $\overline{ODACK}$ must not be active during the same setup and hold window. ($\overline{IDACK}$ and $\overline{ODACK}$ are defined later in section 4.3.5.)

$\overline{IOSEL}$ (I/O Select)
This input signal, when asserted, indicates to the MPC that the current operation is an I/O reference to the PSB bus. It is qualified by the assertion of $\overline{RD}$ or $\overline{WR}$ (defined in section 4.3.3). The state of $\overline{IOSEL}$ must be stable within the defined setup and hold window. Additionally, for $\overline{IOSEL}$ to be valid, the signals $\overline{MEMSEL}$, $\overline{REGSEL}$, $\overline{IDACK}$, and $\overline{ODACK}$ must not be active during the same setup and hold window. ($\overline{IDACK}$ and $\overline{ODACK}$ are defined later in section 4.3.5.)

$\overline{REGSEL}$ (Register Select)

This input signal, when asserted, identifies an operation as an MPC-register access. The host CPU asserts $\overline{REGSEL}$ to set up the MPC for message or interconnect space operations and these are mapped as register operations. $\overline{REGSEL}$ is qualified by the assertion of $\overline{RD}$ or $\overline{WR}$ (defined in section 4.3.3). The state of $\overline{REGSEL}$ must be stable within the defined setup and hold window. Additionally, for $\overline{REGSEL}$ to be valid, the signals $\overline{MEMSEL}$, $\overline{IOSEL}$, $\overline{IDACK}$, and $\overline{ODACK}$ must not be active during the same setup and hold window. ($\overline{IDACK}$ and $\overline{ODACK}$ are defined later in section 4.3.5).

$\overline{LOCK}$
This input signal allows back-to-back operations to be performed on the PSB bus or to local interconnect space. When $\overline{LOCK}$ is asserted, any resource accessed by the operation (PSB bus or local interconnect space) is locked until $\overline{LOCK}$ is deasserted.

4.3.3 TRANSFER CONTROL SIGNALS

Transfer control to the MPC over the local bus is provided by two command signals (Read and Write) and a wait signal. This handshake provides fully interlocked (two-sided handshake) operation.

$\overline{RD}$ (Read)
This input signal, when asserted, generally initiates a read operation. The CPU asserts $\overline{RD}$ to initiate read operations of MPC registers. The CPU also asserts $\overline{RD}$ to initiate read operations of I/O and memory locations present on the PSB bus. The DMA controller asserts $\overline{RD}$ to qualify DMA cycles. In this last case, the MPC does not interpret $\overline{RD}$ as an indicator of the data transfer direction, but only to qualify the DMA acknowledge signal (see definitions for $\overline{ODACK}$ and $\overline{IDACK}$). $\overline{RD}$ must transition cleanly, since it is used to latch other signals that define the parameters of the operation.

$\overline{WR}$ (Write)
This input signal, when asserted, generally initiates a write operation. The CPU asserts $\overline{WR}$ to initiate write operations of MPC registers. The CPU also asserts $\overline{WR}$ to initiate write operations of I/O and memory locations present on the PSB bus. The DMA controller asserts $\overline{WR}$ to qualify DMA cycles. In this last case, the MPC does not interpret $\overline{WR}$ as an indicator of the data transfer direction, but only to qualify the DMA acknowledge signal (see definitions for $\overline{ODACK}$ and $\overline{IDACK}$). $\overline{WR}$ must transition cleanly, since it is used to qualify other signals that define the parameters of the operation.

$\overline{WAIT}$
$\overline{WAIT}$ is an MPC output signal used to delay (or suspend) a local bus operation during an access to an asynchronous resource via the MPC. The MPC asserts $\overline{WAIT}$ to the local CPU for memory, I/O, and interconnect accesses to the PSB bus; and for local interconnect accesses. $\overline{WAIT}$, when asserted, allows time for the accessed resource to become available. The MPC asserts $\overline{WAIT}$ after the CPU has asserted the command signal ($\overline{RD}$ or $\overline{WR}$). On the PSB bus, the MPC deasserts $\overline{WAIT}$ after either the PSB bus EOT handshake or an exception has occurred. For accesses to local interconnect space, the MPC deasserts $\overline{WAIT}$ after the interconnect operation is complete.

4.3.4 INTERRUPT SIGNALS

Interrupt signals are used to inform the host CPU that the MPC requires service. The MPC provides two signals: one for message operations and one for reference errors.

MINT (Message Interrupt)
The MPC asserts this output signal for all message-related signaling to the host CPU. This includes the arrival of an unsolicited message, an available transmit FIFO buffer, the completion of a solicited transfer, and an error on message transfer.

EINT (Error Interrupt)
The MPC asserts this output signal to the CPU to indicate errors related to memory, I/O, or interconnect space operations (i.e., all except message operations). Internal registers in the MPC provide details of the error via interconnect space.

4.3.5 DMA CONTROL SIGNALS

The MPC provides several DMA control signals to support an external DMA controller. A DMA controller is required to support solicited message operations.

ODREQ (Output Channel DMA Request)
ODREQ is an output signal the MPC asserts to enable DMA transfer of data to the MPC (i.e., output to the PSB bus). This signal behaves as a normal DMA request line. For a solicited message output operation, the MPC asserts ODREQ when a solicited output packet buffer is empty and as long as the MPC is in the transfer phase (the Buffer Request unsolicited message has been sent). The DMA controller responds by performing DMA transfers to the MPC for transfer to the receiving agent.

IDREQ (Input Channel DMA Request)
The MPC asserts this output signal to enable DMA transfer of data from the MPC (i.e., input from the PSB bus). This signal behaves as a normal DMA request line. For a solicited message input operation, the MPC asserts IDREQ after a solicited input packet buffer is full and as long as the MPC is in the transfer phase. The DMA controller responds by performing DMA transfer from the MPC. IDREQ remains asserted until the packet is transferred to memory.

$\overline{ODACK}$ (Output Channel DMA Acknowledge)
$\overline{ODACK}$ is an input signal asserted by the DMA controller in response to the assertion of ODREQ by the MPC. The DMA controller asserts $\overline{ODACK}$ to set up the MPC for the DMA transfer from local memory (or the controller) to the MPC. The assertion of $\overline{ODACK}$ is qualified by the assertion of $\overline{RD}$ or $\overline{WR}$ by the MPC. The direction of data transfer with respect to the MPC is controlled by the request signal (IDREQ or ODREQ) and the acknowledge signal ($\overline{IDACK}$ or $\overline{ODACK}$). The command signal ($\overline{RD}$ or $\overline{WR}$) only qualifies the acknowledge signal ($\overline{IDACK}$ or $\overline{ODACK}$). The state of $\overline{ODACK}$ must be stable within the defined setup and hold window. Additionally, for $\overline{ODACK}$ to be valid, the signals $\overline{MEMSEL}$, IOSEL, $\overline{REGSEL}$, and $\overline{IDACK}$ must not be active during the same setup and hold window.

$\overline{IDACK}$ (Input Channel DMA Acknowledge)
$\overline{IDACK}$ is an input signal asserted by the DMA controller in response to the assertion of IDREQ by the MPC. The DMA controller asserts $\overline{IDACK}$ to set up the MPC for the DMA transfer from the MPC to the DMA controller (or local memory). The assertion of $\overline{IDACK}$ is qualified by the assertion of $\overline{RD}$ or $\overline{WR}$ by the DMA controller. The direction of data transfer with respect to the MPC is controlled by the request signal (IDREQ or ODREQ) and the acknowledge signal ($\overline{IDACK}$ or $\overline{ODACK}$). The command signal ($\overline{RD}$ or $\overline{WR}$) only qualifies the acknowledge signal. The state of $\overline{IDACK}$ must be stable within the de-

fined setup and hold window. Additionally, for $\overline{IDACK}$ to be valid, the signals $\overline{MEMSEL}$, $\overline{IOSEL}$, $\overline{REGSEL}$, and $\overline{ODACK}$ must not be active during the same setup and hold window.

4.4 Interconnect Bus Signals

The interconnect bus signals provide a simple interface to a microcontroller for implementation of interconnect space. All interconnect bus signals are asynchronous to the bus clock and to the local bus signals.

IAD<7..0> (Interconnect Address/Data)
IAD<7..0> is an 8-bit, bidirectional, multiplexed address and data bus intended to interface directly to a microcontroller. In addition to the MPC, other interconnect registers can be connected to this bus.

$\overline{IREQ}$ (Interconnect Request)
The MPC asserts this output signal when an interconnect operation has been requested from either the local bus or the PSB bus. The MPC deasserts $\overline{IREQ}$ after the microcontroller has written to the Interconnect Reference Arbitration register.

IAST (Interconnect Address Strobe)
IAST is an input signal from the microcontroller and, when asserted, indicates that a valid address is on the interconnect bus. IAST may be directly connected to the ALE (Address Latch Enable or equivalent) output of most microcontrollers. IAST must provide clean transitions.

$\overline{IRD}$ (Interconnect Bus Read)
$\overline{IRD}$ is an input signal. The microcontroller asserts $\overline{IRD}$ to perform a read operation to one of the MPC interconnect interface registers. $\overline{IRD}$ must provide clean transitions. When $\overline{IRD}$ is asserted in conjunction with the $\overline{IWR}$ signal, all MPC outputs are disabled.

$\overline{IWR}$ (Interconnect Write)
$\overline{IWR}$ is an input signal. The microcontroller asserts $\overline{IWR}$ to perform a write operation to one of the MPC interconnect interface registers. $\overline{IWR}$ must provide clean transitions. When $\overline{IWR}$ is asserted in conjunction with the $\overline{IRD}$ signal, all MPC outputs are disabled.

4.5 Power and Ground Signals

The MPC requires supply voltage and ground connections at the pin numbers listed below.

V_{CC}	Ground
D4	J3
M4	N4
N8	N6
M12	N9
D12	N11
C7	N13
	K13
	F13
	C12
	D8
	C5
	C3

5.0 MPC 82389 MECHANICAL DATA

The MPC 82389 is packaged in a 149 lead pin grid array. The square package has a 15 x 15 grid layout with the outer 3 rows used along each edge.

5.1 Pin Assignment

The MPC 82389 pinout as viewed from the top side of the component is shown in Figure 5-1. When viewed from the pin side, the component pin layout is shown in Figure 5-2.

To reduce possible noise problems on the board, V_{CC} and V_{SS} must be connected to multiple supplies. The board should be laid out with V_{CC} and Ground planes for power distribution and the components V_{CC} and V_{SS} must be connected to the appropriate power plane.

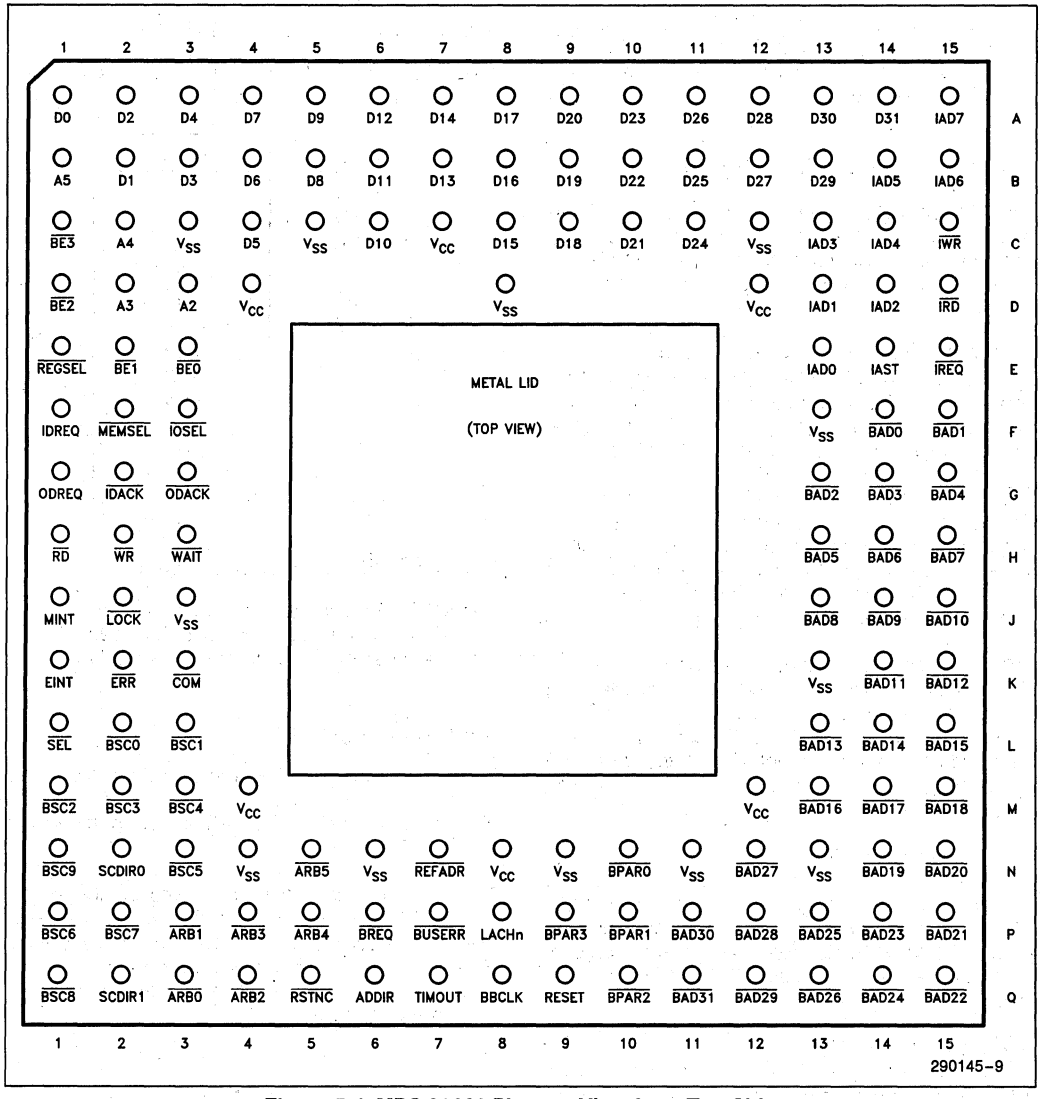

Figure 5-1. MPC 82389 Pinout—View from Top Side

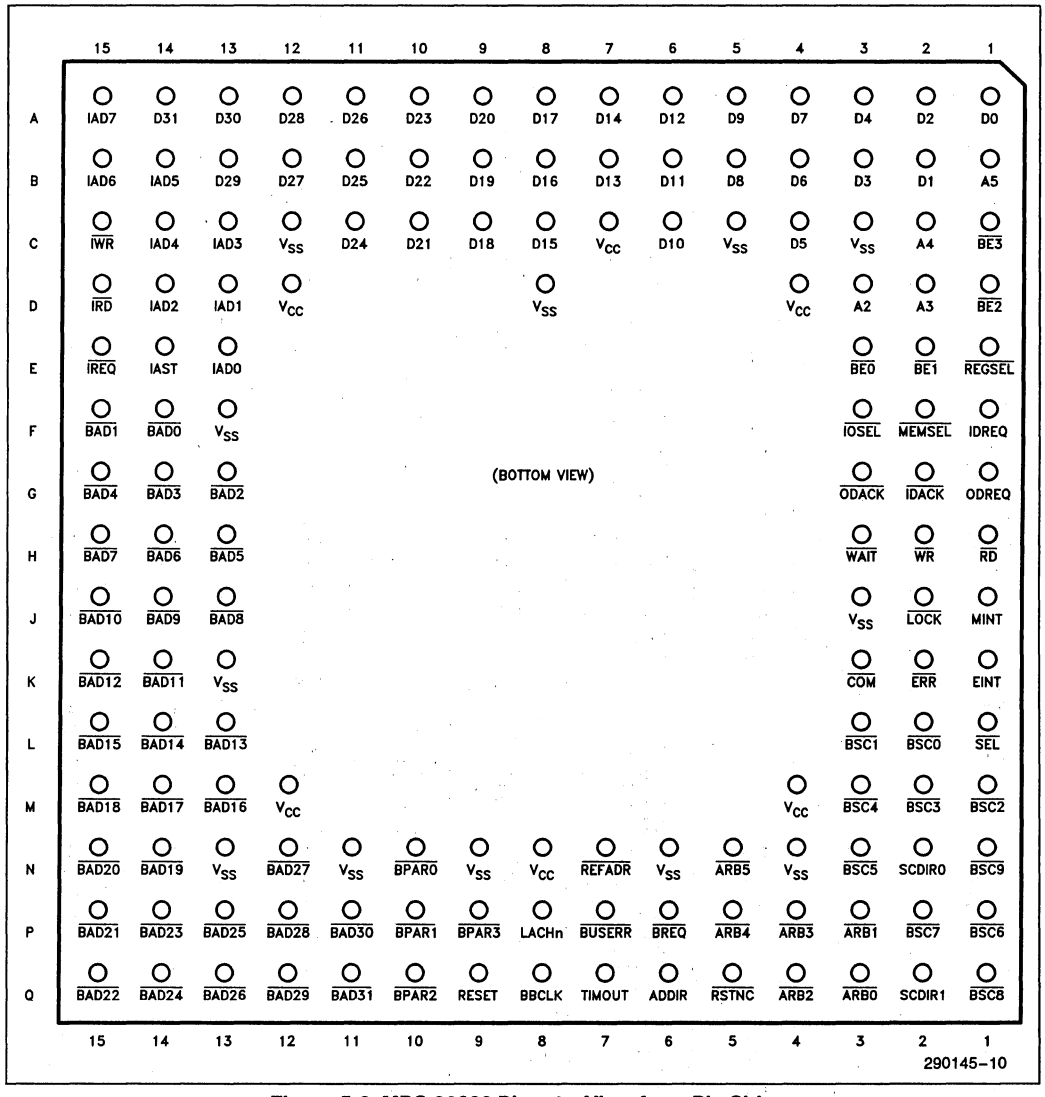

Figure 5-2. MPC 82389 Pinout—View from Pin Side

Table 5-1

Signal and Characteristic		Pin #	Signal and Characteristic		Pin #	Signal and Characteristic		Pin #
V_{CC}		D4	REFADR	O	N7	IAST	I	E14
A5	I	B1	ADDIR	O	Q6	$\overline{IRD}$	I	D15
A4	I	C2	$\overline{BPAR3}$	I/O	P9	$\overline{IWR}$	I	C15
A3	I	D2	$\overline{BAD31}$	I/O	Q11	IAD7	I/O	A15
A2	I	D3	$\overline{BAD30}$	I/O	P11	IAD6	I/O	B15
$\overline{BE3}$	I	C1	$\overline{BAD29}$	I/O	Q12	IAD5	I/O	B14
$\overline{BE2}$	I	D1	$\overline{BAD28}$	I/O	P12	IAD4	I/O	C15
$\overline{BE1}$	I	E2	$\overline{BAD27}$	I/O	N12	IAD3	I/O	C13
$\overline{BE0}$	I	E3	$\overline{BAD26}$	I/O	Q13	IAD2	I/O	D14
$\overline{IOSEL}$	I	F3	$\overline{BAD25}$	I/O	P13	IAD1	I/O	D13
$\overline{MEMSEL}$	I	F2	$\overline{BAD24}$	I/O	Q14	IAD0	I/O	E13
$\overline{REGSEL}$	I	E1	$\overline{BAD23}$	I/O	P14	V_{CC}		D12
$\overline{IDACK}$	I	G2	$\overline{BAD22}$	I/O	Q15	V_{SS}		C12
$\overline{ODACK}$	I	G3	$\overline{BAD21}$	I/O	P15	D31	I/O	A14
IDREQ	O	F1	$\overline{BAD20}$	I/O	N15	D30	I/O	A13
ODREQ	O	G1	$\overline{BAD19}$	I/O	N14	D29	I/O	B13
$\overline{WR}$	I	H2	$\overline{BAD18}$	I/O	M15	D28	I/O	A12
$\overline{RD}$	I	H1	$\overline{BAD17}$	I/O	M14	D27	I/O	B12
$\overline{WAIT}$	O	H3	$\overline{BAD16}$	I/O	M13	D26	I/O	A11
V_{SS}		J3	$\overline{BAD15}$	I/O	Q14	D25	I/O	B11
MINT	O	J1	$\overline{BAD14}$	I/O	L14	D24	I/O	C11
EINT	O	K1	$\overline{BAD13}$	I/O	L13	D23	I/O	A10
$\overline{LOCK}$	I	J2	$\overline{BAD12}$	I/O	K15	D22	I/O	B10
$\overline{ERR}$	O	K2	$\overline{BAD11}$	I/O	K14	D21	I/O	C10
$\overline{SEL}$	O	L1	$\overline{BAD10}$	I/O	J15	D20	I/O	A9
$\overline{COM}$	I	K3	$\overline{BAD9}$	I/O	J14	D19	I/O	B9
$\overline{BSC9}$	I/O	N1	$\overline{BAD8}$	I/O	J13	D18	I/O	C9
$\overline{BSC8}$	I/O	Q1	$\overline{BAD7}$	I/O	H15	D17	I/O	A8
$\overline{BSC7}$	I/O	P2	$\overline{BAD6}$	I/O	H14	D16	I/O	B8
$\overline{BSC6}$	I/O	P1	$\overline{BAD5}$	I/O	H13	D15	I/O	C8
$\overline{BSC5}$	I/O	N3	$\overline{BAD4}$	I/O	G15	D14	I/O	A7
$\overline{BSC4}$	I/O	M3	$\overline{BAD3}$	I/O	G14	D13	I/O	B7
$\overline{BSC3}$	I/O	M2	$\overline{BAD2}$	I/O	G13	D12	I/O	A6
$\overline{BSC2}$	I/O	M1	$\overline{BAD1}$	I/O	F15	D11	I/O	B6
$\overline{BSC1}$	I/O	L3	$\overline{BAD0}$	I/O	F14	D10	I/O	C6
$\overline{BSC0}$	I/O	L2	$\overline{BPAR2}$	I/O	Q10	D9	I/O	A5
SCDIR1	O	Q2	$\overline{BPAR1}$	I/O	P10	D8	I/O	B5
SCDIR0	O	N2	$\overline{BPAR0}$	I/O	N10	D7	I/O	A5
V_{CC}		M4	V_{CC}		N8	D6	I/O	B4
V_{SS}		N4	V_{SS}		N9	D5	I/O	C4
$\overline{ARB5}$	I/O, OC	A15	V_{SS}		N11	D4	I/O	A3
$\overline{ARB4}$	I/O, OC	P5	V_{CC}		M12	D3	I/O	B3
$\overline{ARB3}$	I/O, OC	P4	V_{SS}		N13	D2	I/O	A2
$\overline{ARB2}$	I/O, OC	Q4	V_{SS}		F13	D1	I/O	B2
$\overline{ARB1}$	I/O, OC	P3	V_{SS}		K13	D0	I/O	A1
$\overline{ARB0}$	I/O, OC	Q3	$\overline{BBCLK}$	I	Q8	V_{CC}		C7
V_{SS}		N6	LACHn	I	P8	V_{SS}		D8
$\overline{BREQ}$	I/O, OC	P6	RESET	I	Q9	V_{SS}		C5
TIMOUT	O	Q7	$\overline{RSTNC}$	I/O, OC	Q5	$\overline{BUSERR}$	I/O, OC	P7
$\overline{IREQ}$	O	E15	V_{SS}		C3			

NOTES:
I = Input signal
O = Output signal
I/O = Input or output signal
OC = Open-collector signal

6.0 MPC ELECTRICAL DATA

FOR DC/AC SPECIFICATIONS, PLEASE CONSULT THE LATEST REVISION OF THE DATA SHEET. CALL YOUR NEAREST INTEL DISTRIBUTOR OR THE INTEL SALES OFFICE.

7.0 REFERENCE DOCUMENTS

Part Number	Title Description
176526	MPC User's Manual
146077	MULTIBUS® II Architecture Specifications
149299	Interconnect Interface Specifications
149300	MULTIBUS® II MPC External Product Specifications
149247	MULTIBUS® II Transport Protocol Specifications

ENHANCING SYSTEM PERFORMANCE WITH THE MULTIBUS® II ARCHITECTURE

Although the MULTIBUS® II architecture can accommodate systems with a wide range of performance, systems that take advantage of its multiprocessing capabilities can achieve new performance levels while maintaining reasonable price/performance ratios. Today, multiprocessing provides an easy path to increased functionality and processing power largely because of the availability of inexpensive memory and CPUs.

The low cost of high-performance microprocessors and RAM chips has drastically altered the cost dynamics of systems design. The material cost of a CPU and its memory are typically a small portion of the total system cost, in sharp contrast to mini and mainframe computers where the cost of the CPU and memory is the majority of system cost. The decreased cost factor means today's designer can optimize a system's price/performance by dedicating a CPU to each function in the system.

This product brief will discuss the MULTIBUS II multiprocessing capabilities and their user benefits. The capabilities include:

- A high-speed local environment
- An efficient burst transfer capability
- A hardware-based message passing facility

Higher Performance Through Multiprocessing

The key to high performance in multiprocessing systems is allowing all of the processors to run concurrently in their own private environments. For this to occur, each functional module must contain its own CPU, memory and I/O resources. It also means that the system bus is primarily used for passing commands and data between modules.

A system using this approach might consist of a host processing board and intelligent disk controller, a terminal concentrator and LAN controller boards (Figure 1). Each

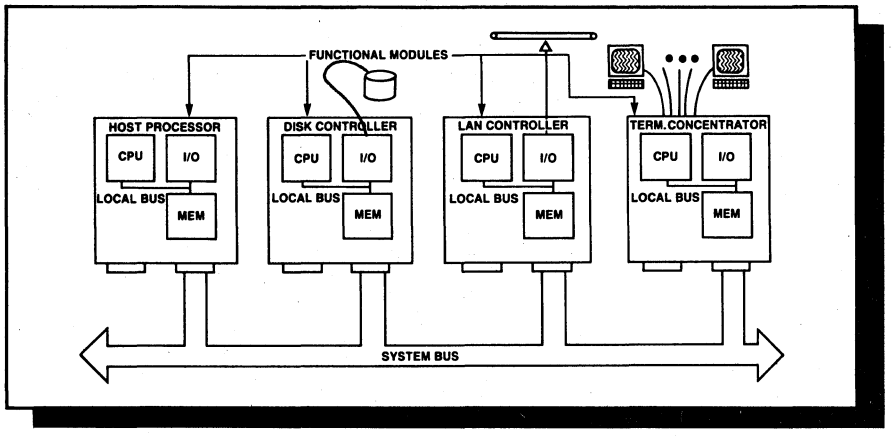

Figure 1. Functional Partitioning is the Distribution of CPU, Memory & I/O Resources to Support Different Functions in a System

functional module would contain the resources required to perform its assigned function. Further, each module would operate over its own private local bus which is decoupled from the system bus. This enables the modules to operate concurrently with each other and leaves the system bus open for communication between the intelligent modules.

High-Speed Local Environment Optimizes On-Board Resources

In multiprocessing systems, performance is optimized when all execution code and data is accessed in a local environment. The most important performance factors in a local environment are the CPU clock speed, the number of CPU clocks per instruction, the CPU instruction set, and the number of memory wait states. While the CPU choice dictates the CPU performance factors, the bus architecture can assist in providing a good CPU-memory and I/O environment.

The MULTIBUS II architecture provides a high-speed local environment through its moderate size board form factor and a local memory bus extension. The MULTIBUS II board form factor is the Eurocard Standard 233mm by 220mm (9.1″×9.0″), chosen because it allows most functional modules to completely fit on one board. This factor is critical to system performance because on-board resources can be optimized to run at their full potential without impacting the system bus. A smaller board size would force a particular function onto multiple boards with a resulting decrease in performance.

Burst Transfers

A key development to optimizing the iPSB bus for multiprocessor communications is the high-speed burst transfer capability. Since address information is transferred over the bus only once for the entire burst, performance is greatly enhanced.

The synchronous handshake capabilities of the iPSB bus nearly double the speed of burst transfers compared to traditional asynchronous handshakes (Figure 2). Burst

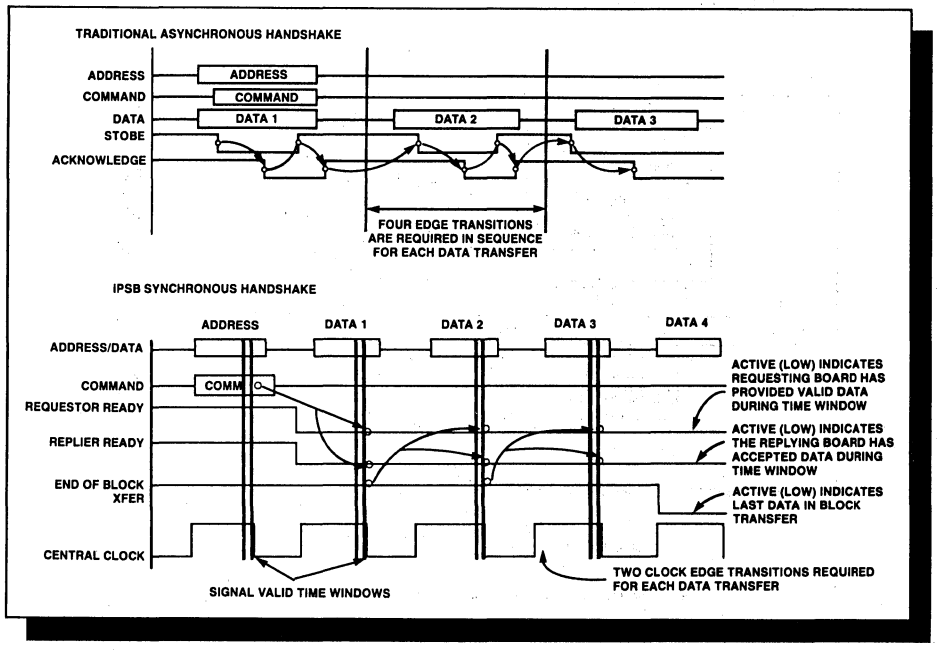

Figure 2. iPSB Synchronous Handshake Compared to Asynchronous Handshake

transfers allow boards to transfer blocks of data over the iPSB bus at speeds up to 40 Mbytes/s. This speed approaches the limit of what can be expected from TTL technology when propagation across a 20-slot backplane is required.

In the iPSB bus, a burst transfer consists of one address clock followed by multiple data transfers. The receiving board takes care of actual memory location placement (ie., auto-increments the memory address, as necessary). The actual speed of the burst transfer will depend on the abilities of the communicating boards. For example, burst transfers from an intelligent board to dual-port memory will typically be only marginally faster than single-cycle writes, due to the long access times from the system bus side of dual-port memory boards.

To achieve the true performance benefits of burst transfers, each board needs the ability to send and receive small bursts at the full bandwidth of the system bus. This can be accomplished by bus interface logic containing high-speed buffers and the ability to format and send 32-bit-wide data bursts.

In the MULTIBUS II architecture, the interface bus logic to the iPSB is defined with burst capability in a message-passing scheme. This ensures that boards developed by various manufacturers will all be able to communicate compatibly at tremendous speeds.

Message passing, as defined in the MULTIBUS II protocol, allows modules to communicate directly. In other words, one module sends a message (data) over the iPSB bus to the address of another module. This differs from the normal CPU functions of reading or writing only from memory or I/O.

Since conventional CPUs do not contain facilities to perform direct CPU-to-CPU communication, additional hardware logic is required. The hardware can be thought of as a coprocessor to the primary CPU, e.g., a coprocessor that adds the function of direct module-to-module communication at speeds many times that which the primary CPU could perform. The coprocessor logic for message passing resides in the bus interface.

An example best illustrates how message passing works (Figure 3). Assume Board A wants to send 1 Kbyte of data to Board B. First, the CPU on Board A would instruct its message passing unit to send 1 Kbyte of data (with the assistance of a DMA device), beginning at a particular location in local memory, to Board B. Next, the message passing coprocessor on Board A takes over so the CPU

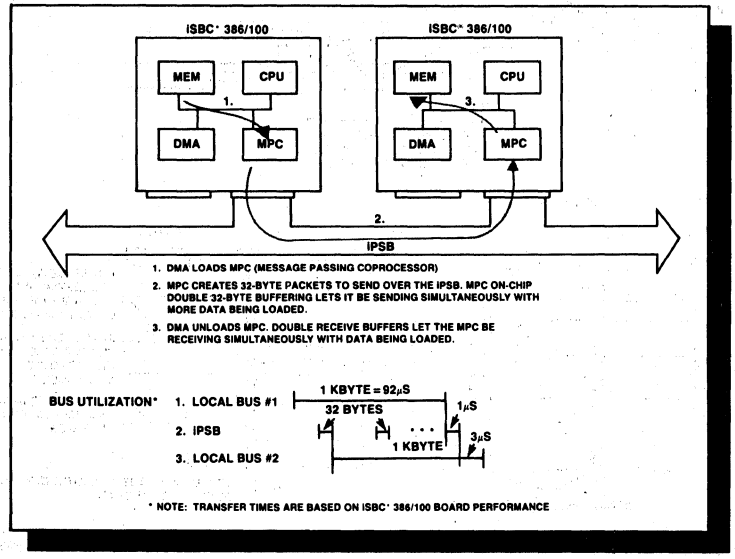

Figure 3. A Message Passing Example

can perform other processing. At this point, the DMA device loads the data into the message passing coprocessor on Board A. Once enough data has been loaded (typically 32 bytes), the coprocessor arbitrates for the bus and sends the first packet of data as a burst transfer to the message-passing logic on Board B.

While the message passing logic on Board B is unloading the first packet out of its high-speed buffers into local RAM, the message-passing logic on Board A is reading the next piece of data into its high-speed buffers. Meanwhile, the system bus is free of traffic and available for another pair of boards to communicate over.

The message-passing logic on Board A continues to build and send small packets of data to Board B's message-passing logic, and Board B continues to unload this data into its local memory until the entire 1 Kbyte has been transferred. At the completion of the transfer, the message-passing logic on both boards interrupts their respective CPUs to notify them that the transfer is complete.

Summary

Five important performance benefits result from the MULTIBUS II multiprocessing capabilities and specifically from hardware-assisted message passing. First, all single-cycle memory/IO transfers can be designed to occur in local CPU environments. These environments are optimized for single-cycle transfers over their local memory buses and usually run at few or no wait states, compared to substantial wait state delays over a system bus.

Second, transfers over the iPSB bus can be done as burst transfers between message-passing logic containing high-speed buffers, thereby transferring data at the maximum bus data rate. Third, the iPSB bus is not in use between data packets and is available for other traffic. Fourth, each CPU does not need direct access into the other board's local environment. That is, no dual port memory (which is slower than single port memory) is required. And fifth, each CPU is available to process other tasks while the data transfer is occurring.

INCREASING SYSTEM RELIABILITY WITH THE MULTIBUS® II BUS ARCHITECTURE

System reliability is more than just mechanical factors like Eurocard and DIN connectors. It involves many design factors often overlooked in traditional buses. The MULTIBUS®II bus architecture addresses the problem of system reliability not only from a mechanical point of view, but from protocol and electrical factors as well. This product brief will discuss how the following MULTIBUS II features resolve specific reliability problems while enhancing overall system reliability:

- Synchronous Timing
- Bus Parity
- Protocol Error Handling
- Bus Timeout
- Power Sequencing
- Eurocard/DIN Connectors
- Front Panel Design
- Backplane Design

INCREASING ELECTRICAL RELIABILITY

Synchronous Timing for Enhanced Noise Immunity

Traditional buses, such as MULTIBUS I and VME, are based on asynchronous timing where the edges or transitions of the bus-control signals cause the bus to perform its functions. Unfortunately, edge-sensitive timing is susceptible to external disturbances and noise. If noise causes a signal to look as though it made a transition, the transition is misinterpreted and a failure results.

The MULTIBUS II architecture addresses this problem by using synchronous sampling of all signal lines. Both the MULTIBUS II Parallel System Bus (iPSB) and the Local Bus Extension (iLBX™ II bus) employ synchronous sampling for enhanced noise immunity. The iPSB serves as a good example of the benefits of synchronous sampling.

In the iPSB bus, all signals (address, data, control, and arbitration) are driven and sampled with respect to a 10 MHz bus clock. The 10 MHz clock breaks the bus activity into 100ns increments with signals sampled at the end of each period. This method avoids looking at the signal while transitions caused by reflections and crosstalk are occurring. Therefore, signals are vulnerable only during the small sampling window.

Figure 1 shows the iPSB timing with the 100ns period divided into three intervals: driver timing, bus propagation, and receiver timing. The 40ns driver timing interval takes into account driver logic delays and the capacitive loading for a maximum of 20 loads spaced over 16.8 inches.

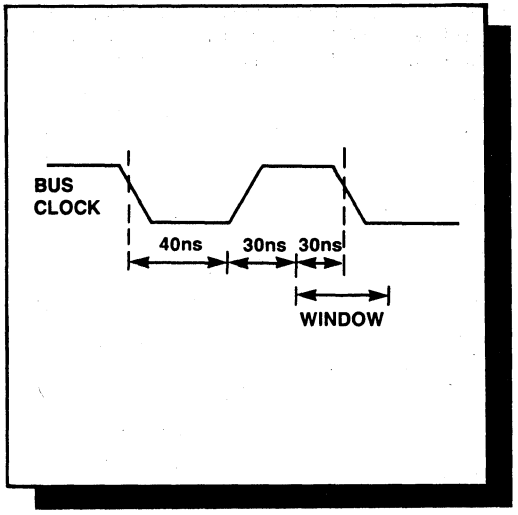

Figure 1. iPSB Timing, Showing Synchronous Sample Driving Stable Data Window

The bus propagation interval accounts for 25ns of signal transit time and 5ns of potential clock skew. A signal traveling on the backplane creates reflections on itself and crosstalk on other signals. The signal transit time allows the signal to propagate down and back on the backplane. It also allows time for crosstalk to subside. This guarantees that the signals have stabilized in spite of distance and interference from other signals.

The receiver interval consists of a 30ns receiver setup time plus 5ns of hold time which extends into the next cycle. This interval is the time the signal is stable prior to sampling on the falling edge of the clock.

Thus, the MULTIBUS II parallel bus timing creates a 65ns interval (driver timing plus bus propagation) when the bus is completely immune to noise or external disturbances. That means during 65% of the time interval, noise causing a transition or level change is simply ignored. It is only during the 35ns receiver setup and hold interval that the bus timing is vulnerable to noise. During this interval, however, the bus contains parity protection (to be discussed in another section).

Comparable Performance at Higher Speeds

A common complaint about synchronous buses is that fixed time increments limit performance compared to asynchronous buses. This may be true at slower bus clock speeds. However, at 10 MHz the differences diminish. If both an asynchronous and a synchronous bus use similar TTL technology for the bus drivers and receivers over the same backplane length, they possess roughly the same bus timing. In other words, the driver timing, bus propagation, and receiver intervals of both buses will be approximately the same with nearly equal performance. However, as we've seen, a synchronous bus offers a significant improvement in system reliability that easily justifies its use.

Guaranteed Electrical Compatibility

Synchronous sampling also has a less obvious benefit — guaranteed electrical compatibility among boards. The 100ns timing of the iPSB is based upon a worst-case environment of 20 boards over a backplane length of 16.8 inches (0.8 inch separation). All derating for loading, voltage margin, and skew is included. Thus, any number of boards, up to 20, are guaranteed to work together.

Electrical compatibility is much harder to achieve in asynchronous buses. Because they are edge-sensitive, asynchronous boards are naturally susceptible to changes in signal edge rates and timing. When the number of boards in a system change, edge rates and timing also change, in some cases adversely affecting system reliability.

The synchronous nature of the bus moves the point of synchronization to the local bus of each board. When two asynchronous CPUs communicate, synchronization between them occurs between each CPU and its interface. This provides a better electrical environment for dealing with reliability problems caused by metastability.

Bus Parity Versus Memory Parity

At this point, it is important to distinguish between BUS parity and MEMORY parity. (See Figure 2.) Both allow the detection of errors. Memory parity protects *data* while it is resident on a memory board. Bus parity, on the other hand, protects *address, control,* and *data* while in transit on the bus. In a sense, one complements the other in reliable systems. In both cases, it is possible to handle errors via retry or other mechanisms.

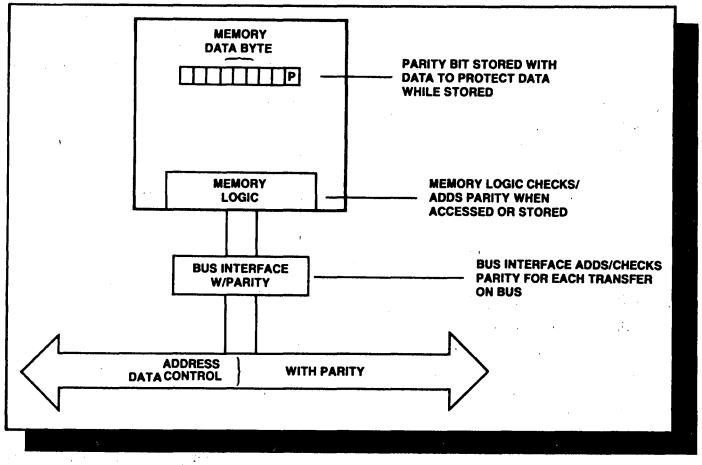

Figure 2. Parity Protects Address Data and Control from Errors which could be Incurred on the iPSB Bus

Bus parity in the MULTIBUS II architecture provides another level of electrical reliability by protecting the bus from noise and external disturbances during the receiver timing interval. It also protects the bus from failed interface components.

On the iPSB bus, the board driving the bus generates bus parity. Address and data lines use byte parity, while control lines use nibble (4-bit) parity. All receiving boards check parity during the receiver timing sampling interval. If an error is detected, the BUS ERROR line is activated. This stops activity on the bus and puts the bus into a predefined known state.

At this point, the system designer has a number of options: retry the transfer, swap in a hot spare, log the error, ignore it, or shut down the system gracefully. Which option he chooses depends on his specific system requirements. Basically, the protocol gives him the opportunity to evaluate the situation and take appropriate action.

PROTOCOL RELIABILITY

Board-to-Board Error Indications

Not all errors occur because of noise or component failure. Sometimes they occur when one board asks another to do something it is not capable of doing. Although traditional buses typically ignore these kinds of errors, they can cause system failure just as noise can. The MULTIBUS II architecture offers a solution.

In the iPSB bus protocol, when one board cannot perform the request, it simply informs the requesting board and allows it to attempt a retry. Five types of error indications are supported: data, transfer width, continuation, not-understood, and negative acknowledge.

A *data error* indicates that the replying board has detected an error with the requested data, for example a memory parity error. *Data transfer errors* occur when the replying board does not support the requested data width. For example, the requesting board might ask for a 32-bit transfer from an 8-bit device. After the replying board indicates the error has occurred, the requesting board can retry the transfer with an 8-bit width.

Although the iPSB bus protocol allows for burst transfers (multiple data cycles following one address cycle), not all boards need to support this capability. If a requesting board attempts a burst transfer with a board which does not support bursts, the replying board will return a *continuation error*. The requesting board can recover by simply retrying with the necessary address cycles.

Trying to write to a read-only memory board is a good example of a *transfer-not-understood error*. This type of error occurs when the replying board does not support the requested operation. As with other board-to-board errors, the requesting board many retry with another request.

The last kind of error, called a *negative acknowledge error*, occurs during a message transfer when resources are not available in the receiving board. This is used for flow control in the MULTIBUS II message passing protocol, a queue-based data movement protocol. Negative acknowledge errors instruct the requesting board to retry the operation at a later time, giving the replying board time to process the data in its queue.

Bus Timeout

Another protocol reliability feature in the MULTIBUS II architecture is the BUS TIMEOUT monitor in the Central Services Module (CSM). If a bus transfer fails to complete within a specified time (e.g., a failed board), the CSM, which monitors all bus activity, activates the BUS TIMEOUT line. This stops all bus activity and places the bus in a predefined known state for recovery. At this point, the error is logged and normal bus activity can resume. As an added feature, designers may define their own timeout error handling policy.

POWER SEQUENCING

The iPSB bus protocol also contains a mechanism for orderly handling of power-up and power-down sequencing. For normal power on/off and unexpected power failures, timing of the RESET, DCLOW, and PROTect signals coordinate the sequencing. The combination of the RESET and DCLOW lines signal whether the power-up operation is a warm or cold start of the system.

Once the system is running, the DCLOW signal (driven by the CSM) is used to indicate imminent loss of DC power (Figure 3). At this time, the system has a predetermined time to save state information. After that interval,

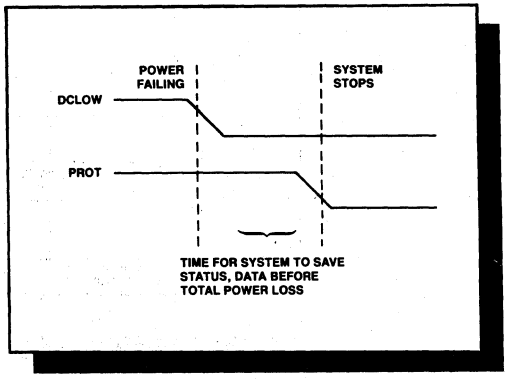

Figure 3. Power Failure Control Lines

the CSM activates the PROTect line which prevents transitions on bus lines from affecting the system during power loss.

MECHANICAL RELIABILITY

The MULTIBUS II mechanical specification is based upon the Eurocard form factor and DIN connectors. However, unlike traditional bus architectures, it goes beyond these mechanical standards with a front panel design that helps the system designer solve EMI (Electro-Magnetic Interference) and ESD (Electro-Static Discharge) problems.

Eurocard and DIN Connectors

The Eurocard family of mechanical specifications is noted for its high reliability in rugged and industrial environments. The MULTIBUS II specification calls out the two-connector 233mm by 220mm and single-connector 100mm by 220mm size boards. The two connector board contains almost the same board area as the 6.75 by 12 inch MULTIBUS I board. That is, it is large enough to allow the implementation of single-board computers with I/O, CPU, and memory onboard, even for 32-bit CPUs.

The DIN 41612 (also known as IEC 603.2) connectors are 96-pin two-piece connectors where each pin consists of a blade mating with two contact points on each side of the blade. This connector approach offers advantages over the board-edge style connectors. Among them are tighter dimensional tolerances, reduced sensitivity to vibration, improved protection from environmental contaminants, and a larger number of cycles for insertion and removal.

FRONT PANEL SYSTEM

The MULTIBUS II front panel system (Figure 4), while dimensionally compatible with standard Eurocard front panels, offers several important advantages.

(Note that while this front panel technology is different from normal Eurocard practice, the dimensioning is such that MULTIBUS II boards fit in any standard Eurocard packaging.)

Standard Eurocard front panels make it difficult to comply with EMI and ESD regulations without the use of additional shielding. Adjacent front panels form small, narrow slits between boards which function like a slot antenna at some frequencies. Through these narrow slits, EMI can enter or exit the system and additional shielding is usually required.

To solve this problem, the MULTIBUS II front panel is U-shaped. From an EMI point-of-view, this makes the front panel electrically thicker. While the size of the slit between adjacent boards is the same as the standard Eurocard front panel, the electrically thicker front panel attenuates EMI which satisfies FCC EMI regulations and protects the system from external EMI.

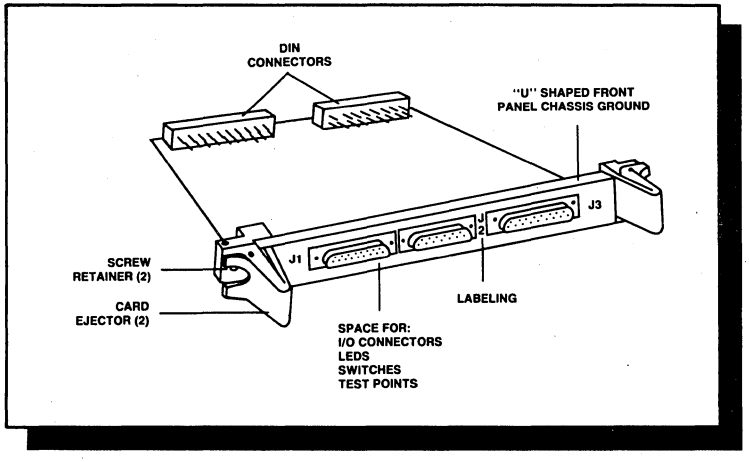

Figure 4. MULTIBUS® II Front Panel System

The U-shaped front panel also adds structural rigidity to the board and has captive retaining screws for securing the board to the system. Shielded I/O connectors located through the front panel eliminate the need for intermediary cables and connectors. In addition, the front panel is at chassis ground for protection against static discharge.

BACKPLANE DESIGN

Designed for reliability, the iPSB bus backplane consists of six layers — three signal layers sandwiched between three power and ground planes (Figure 5). The power and ground planes provide for good power distribution. Moreover, since they are in between each signal layer, they reduce the opportunity for crosstalk due to coupling between the signal layers.

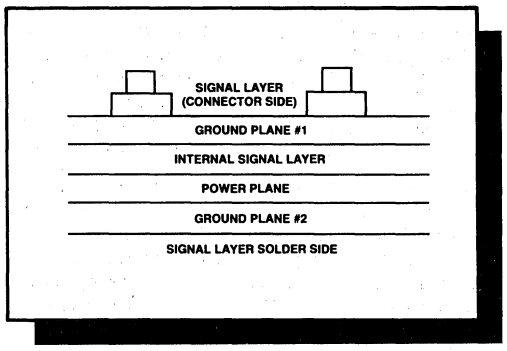

Figure 5. Backplane Design

On each signal layer, signal lines are laid out identically to minimize signal skew across the backplane. To control reflections, each signal line is passively terminated.

Both power and ground connections are evenly distributed across the connectors with 9 pins allocated for +5 volts and 15 for ground providing ample current and good ground return paths.

SUMMARY

Because the MULTIBUS II architecture addresses the problems of electrical, protocol and mechanical reliability, it is superior to traditional buses in achieving overall system reliability. Besides the mechanical reliability of its Eurocard form factor, DIN connectors, and backplane design, the MULTIBUS II electrical protocol is highly immune to noise and external disturbances because of its synchronous sampling and bus parity. In addition, the agent error capability catches common operational errors. Other operational concerns such as bus time-out and power sequencing are fully specified.

GEOGRAPHIC ADDRESSING IN THE MULTIBUS® II ARCHITECTURE

Although microcomputer board designers and system integrators have different sets of requirements for building their products, some degree of overlap exists. Board designers are concerned about factors like function and life cycle costs, testing procedures, development time, and manufacturing costs. System integrators need fast turnaround as well, but they are also faced with the challenge of trying to customize a single board design by configuring it slightly differently for each application. Like the board designer, system integrators are also concerned with testing procedures and inventory costs.

The MULTIBUS®II architecture satisfies the requirements of both board and system designers by defining a unique address space called interconnect space which provides geographic addressing. The following discussion will center on the advantages that interconnect space and geographical addressing bring to system integration and single-board computer design:

- Easy system configuration
- Improved board testing productivity
- Efficient system testing
- Reduced inventory costs

System Configuration Simplified

In traditional bus architectures, system configuration is typically an arduous and complex process. The configurable features of boards are selected manually with jumper stakes connected by wirewrap, a jumper plug or DIP switches. With complex boards, the number of jumper stakes often exceeds 150 and can exceed 300. Getting the jumpers correctly connected is rarely accomplished the first time.

Interconnect space greatly simplifies system configuration through geographic addressing (Figure 1). Critically important is the system's ability to identify which boards are installed in each slot. This allows two identical boards to be uniquely addressed and configured separately. Each board is identified through one or more data bytes accessed through interconnect space addresses. For example, the manufacturer, the board name, the board type, and other parameters are accessible in each board's interconnect space. Further information (e.g. memory size, memory protection) that is available in each board's interconnect space categorizes the exact configuration.

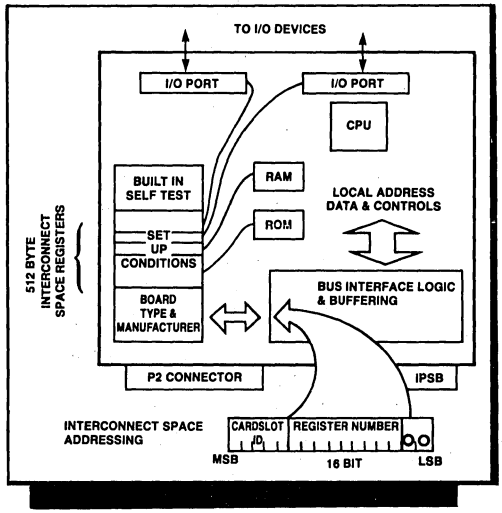

Figure 1. Board Configuration Using Interconnect Space.

Since system software can write the board parameters over the Parallel System Bus (iPSB bus), jumper stakes are virtually eliminated. If jumpers are required, as in switching from RS 232 to RS 422 drivers for example, software can still read the jumpers to verify they were installed correctly.

Another benefit of auto-configuration, is that only one version of the host operating system is needed to run several configurations of the system. For example, if a particular communications board is installed, the operating system detects the board and properly configures it into the system. Moreover, the slot picked to install the new board is irrelevant because arbitration priority and interrupt control are configured independent of the slot in which the board resides.

In addition, a level of fault-tolerant systems can be built using geographic addressing. Redundant hot spare boards can be installed into the system, but not configured by the operating system until needed. Thus, in the normal operating mode, the redundant boards are not active on the backplane. If a board fails, the operating system can isolate the board from the bus, and then configure in the new board. Again, human intervention is not needed to complete the swap.

More Productive Board Testing

Besides simplifying system configuration, interconnect space supports registers for Built-in-Self-Tests (BISTs). Diagnostic software resides on each board (in a PROM) enabling an independent processor to execute the code. That is, a secondary microcontroller and/or the primary CPU can execute board level tests and store the results in interconnect registers. The results can be accessed by any other board in the system and displayed on each board's front panel LED.

Geographic addressing also makes board testing procedures more productive. This is because one general-purpose test suite is all that is required to test many different boards. The test software goes out on the iPSB bus, identifies each board, and reads the results of the BIST for each board. It can then report to the test engineer which board failed what test. Additionally, because the same test program executes for all boards, boards can be mixed and matched on a single backplane.

Test procedure productivity also improves because several configurations of a particular board can be tested in the same general test suite. Since stake pin jumpers are minimized, the test software can actually reconfigure a board several times during the same test. For example, a 1 Mbyte memory board can be tested in an entire 16 Mbyte address range. Moreover, because human intervention is not required, tests execute more smoothly.

More Efficient System Testing

Once individual boards have passed board-level tests, they still must be tested in the systems environment. System-level testing becomes significantly more efficient because of geographic addressing. For example, just one System Confidence Test (SCT) could potentially exist for all MULTIBUS II systems. The SCT can look at all the boards in the system, examine BIST results, and execute system test software based on the BISTs. In fact, detailed results, including configuration parameters, can be displayed on a console (Figure 2).

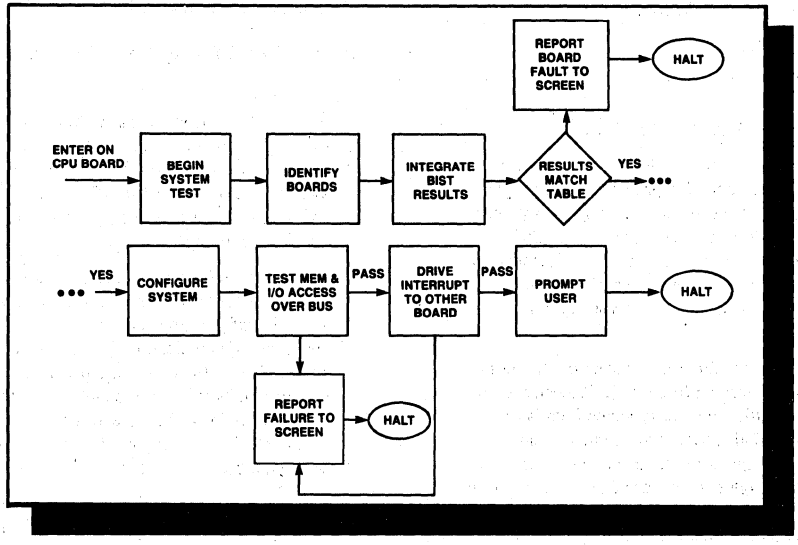

Figure 2. System Confidence Test (SCT) Flow Diagram.

System integrators in particular can capitalize on the advantages of MULTIBUS II system testing. Typically, many configurations of a base system are available from a system vendor. The system integrator only needs one system test program (much like the board vendor described above needs only one general-purpose test suite) to test all of his different systems.

Another benefit of geographic addressing is remote diagnostics. Since interconnect registers are accessible over the iPSB bus to any board, a remote terminal can address the registers through a GAN (Global Area Network) card. Thus, modem communication to a serial port in a system gives the system designer a more versatile test environment.

Lower Inventory Costs

Geographic addressing aids the industrial engineer in managing board inventories. Since board vendors typically stock a few configurations of each basic board, jumpering boards is necessary for each individual configuration. In the MULTIBUS II architecture, however, different board configurations look the same so separate bins of board inventory are not necessary. Thus, the cost and effort required for inventory management can be dramatically reduced.

The system builder stocks boards in the incoming parts warehouse. Like the board vendor above, he can now stock all the boards in the same bin, also reducing his inventory efforts. Then when the system engineers integrate their system, software configures the board to the needs of the application. Because jumpering is reduced, there is less confusion regarding which configuration is standard from the vendor, or which configuration is appropriate for the application.

Summary

Geographic addressing offers many important benefits to single-board computer designers and system integrators alike. All configuration parameters are stored in interconnect registers that sit on each board. Because the registers are accessible over the iPSB bus, a single operating system can configure the system without operator intervention. Both board and system level testing procedures are improved, as only one general test suite is needed. Finally, inventories are managed more efficiently because there are less board configurations not requiring separate bins.

APPENDIX 1. MEMORY BOARD INTERCONNECT SPACE LAYOUT

Register Number	Register Description	Format	Global Access	Local Access	Default Value			
					312	310	320	340
Header Record								
0 (00H)	Vendor ID, Low Byte	Binary	R/O	R/O	01H	01H	01H	01H
1 (01H)	Vendor ID, High Byte	Binary	R/O	R/O	00H	00H	00H	00H
2 (02H)	Board ID, character 1	ASCII	R/O	R/O	4DH	4DH	4DH	4DH
3 (03H)	Board ID, character 2	ASCII	R/O	R/O	45H	45H	45H	45H
4 (04H)	Board ID, character 3	ASCII	R/O	R/O	4DH	4DH	4DH	4DH
5 (05H)	Board ID, character 4	ASCII	R/O	R/O	2FH	2FH	2FH	2FH
6 (06H)	Board ID, character 5	ASCII	R/O	R/O	33H	33H	33H	33H
7 (07H)	Board ID, character 6	ASCII	R/O	R/O	31H	31H	32H	34H
8 (08H)	Board ID, character 7	ASCII	R/O	R/O	32H	30H	30H	30H
9 (09H)	Board ID, character 8	ASCII	R/O	R/O	00H	00H	00H	00H
10 (0AH)	Board ID, character 9	ASCII	R/O	R/O	00H	00H	00H	00H
11 (0BH)	Board ID, character 10	ASCII	R/O	R/O	00H	00H	00H	00H
12 (0CH)	Intel Reserved	BCD+	R/O	R/O	†	†	†	†
13 (0DH)	Intel Reserved	BCD+	R/O	R/O	†	†	†	†
14 (0EH)	Intel Reserved	BCD+	R/O	R/O	†	†	†	†
15 (0FH)	Intel Reserved	BCD+	R/O	R/O	†	†	†	†
16 (10H)	Hardware Test Revision #	BCD+	R/O	R/O	†	†	†	†
17 (11H)	Class ID	Binary	R/O	R/O	13H	13H	13H	13H
18 (12H)	RFU	Binary	R/O	R/O	00H	00H	00H	00H
19 (13H)	RFU	Binary	R/O	R/O	00H	00H	00H	00H
20 (14H)	RFU	Binary	R/O	R/O	00H	00H	00H	00H
21 (15H)	RFU	Binary	R/O	R/O	00H	00H	00H	00H
22 (16H)	RFU	Binary	R/O	R/O	00H	00H	00H	00H
23 (17H)	RFU	Binary	R/O	R/O	00H	00H	00H	00H
24 (18H)	General Status	Binary	R/O	R/O	00H	00H	00H	00H
25 (19H)	General Control	Binary	R/W	R/W	00H	00H	00H	00H
26 (1AH)	BIST-SUPPORT-LEVEL ††	Binary	R/O	R/W	01H	01H	01H	01H
27 (1BH)	BIST-DATA-IN	Binary	R/W	R/W	00H	00H	00H	00H
28 (1CH)	BIST-DATA-OUT ††	Binary	R/O	R/W	00H	00H	00H	00H
29 (1DH)	BIST-SLAVE-STATUS ††	Binary	R/O	R/W	00H	00H	00H	00H
30 (1EH)	BIST-MASTER-SLAVE	Binary	R/W	R/W	20H	20H	20H	20H
31 (1FH)	BIST-TEST-ID ††	Binary	R/O	R/W	00H	00H	00H	00H
Protection Record								
32 (20H)	Protection Record Type	Binary	R/O	R/O	0BH	0BH	0BH	0BH
33 (21H)	Record Length	Binary	R/O	R/O	02H	02H	02H	02H
34 (22H)	Protection Level Register	Binary	R/O	R/W	00H	00H	00H	00H
35 (23H)	Reserved for Future Use	Binary	R/O	R/O	00H	00H	00H	00H

APPENDIX 1. MEMORY BOARD INTERCONNECT SPACE LAYOUT (Con't)

Register Number	Register Description	Format	Global Access	Local Access	Default Value			
					312	310	320	340
Memory Record								
36 (24H)	Memory Record Type	Binary	R/O	R/O	01H	01H	01H	01H
37 (25H)	Record Length	Binary	R/O	R/O	05H	05H	05H	05H
38 (26H)	Memory Size — 1 low byte	Binary	R/O	R/O	07H	0FH	1FH	3FH
39 (27H)	Memory Size — 1 high byte	Binary	R/O	R/O	00H	00H	00H	00H
40 (28H)	Memory Control Register	Binary	R/W	R/W	01H	01H	01H	01H
41 (29H)	Memory Status Register	Binary	R/O	R/O	A1H	A1H	A1H	A1H
42 (2AH)	Reserved for Future Use	Binary	R/O	R/O	00H	00H	00H	00H
iPSB Control Board								
43 (2BH)	iPSB Control Record Type	Binary	R/O	R/O	06H	06H	06H	06H
44 (2CH)	Record Length	Binary	R/O	R/O	06H	06H	06H	06H
45 (2DH)	iPSB Slot ID	Binary	R/O	R/O	FFH	FFH	FFH	FFH
46 (2EH)	iPSB Arbitration ID	Binary	R/W	R/W	00H	00H	00H	00H
47 (2FH)	iPSB Error Register	Binary	R/W	R/W	00H	00H	00H	00H
48 (30H)	iPSB Control/Status Register	Binary	R/W	R/W	00H	00H	00H	00H
49 (31H)	iPSB Diagnostic Register	Binary	R/W	R/W	00H	00H	00H	00H
50 (32H)	Reserved for Future Use	Binary	R/O	R/O	00H	00H	00H	00H
iPSB Memory Record								
51 (33H)	iPSB Memory Record Type	Binary	R/O	R/O	02H	02H	02H	02H
52 (34H)	Record Length	Binary	R/O	R/O	05H	05H	05H	05H
53 (35H)	*iPSB Start Address low byte*	*Binary*	*R/W*	*R/W*	*FFH*	*FFH*	*FFH*	*FFH*
54 (36H)	*iPSB Start Address high byte*	*Binary*	*R/W*	*R/W*	*FFH*	*FFH*	*FFH*	*FFH*
55 (37H)	*iPSB End Address low byte*	*Binary*	*R/W*	*R/W*	*00H*	*00H*	*00H*	*00H*
56 (38H)	*iPSB End Address high byte*	*Binary*	*R/W*	*R/W*	*00H*	*00H*	*00H*	*00H*
57 (39H)	Reserved for Future Use	Binary	R/O	R/O	00H	00H	00H	00H
iLBX™ II Memory Board								
58 (3AH)	iLBX II Memory Record Type	Binary	R/O	R/O	03H	03H	03H	03H
59 (3BH)	Record Length	Binary	R/O	R/O	07H	07H	07H	07H
60 (3CH)	*iLBX II Start Address low byte*	*Binary*	*R/W*	*R/W*	*FFH*	*FFH*	*FFH*	*FFH*
61 (3DH)	*iLBX II Start Address high byte*	*Binary*	*R/W*	*R/W*	*03H*	*03H*	*03H*	*03H*
62 (3EH)	*iLBX II End Address low byte*	*Binary*	*R/W*	*R/W*	*00H*	*00H*	*00H*	*00H*
63 (3FH)	*iLBX II End Address high byte*	*Binary*	*R/W*	*R/W*	*00H*	*00H*	*00H*	*00H*
64 (40H)	*iLBX II Clock Frequency*	*Binary*	*R/W*	*R/W*	*DCH*	*DCH*	*DCH*	*DCH*
65 (41H)	iLBX II Slot ID	Binary	R/O	R/O	00H	00H	00H	00H
66 (42H)	Reserved for Future Use	Binary	R/O	R/O	00H	00H	00H	00H

APPENDIX 1. MEMORY BOARD INTERCONNECT SPACE LAYOUT (Con't)

Register Number	Register Description	Format	Global Access	Local Access	Default Value			
					312	310	320	340
Memory Parity Record								
67 (43H)	Memory Parity Record Type	Binary	R/O	R/O	04H	04H	04H	04H
68 (44H)	Record Length	Binary	R/O	R/O	08H	08H	08H	08H
69 (45H)	Parity Control Register	Binary	R/W	R/W	03H	03H	03H	03H
70 (46H)	Parity Status Register	Binary	R/O	R/O	00H	00H	00H	00H
71 (47H)	Bank Status Register	Binary	R/O	R/O	00H	00H	00H	00H
72 (48H)	Error Offset byte 0	Binary	R/O	R/O	00H	00H	00H	00H
73 (49H)	Error Offset byte 1	Binary	R/O	R/O	00H	00H	00H	00H
74 (4AH)	Error Offset byte 2	Binary	R/O	R/O	00H	00H	00H	00H
75 (4BH)	Error Offset byte 3	Binary	R/O	R/O	00H	00H	00H	00H
76 (4CH)	Reserved for Future Use	Binary	R/O	R/O	00H	00H	00H	00H
Cache Memory Board								
77 (4DH)	Cache Memory Record Type	Binary	R/O	R/O	05H	05H	05H	05H
78 (4EH)	Record Length	Binary	R/O	R/O	05H	05H	05H	05H
79 (4FH)	Cache Size — 1 low byte	Binary	R/O	R/O	1FH	1FH	1FH	1FH
80 (50H)	Cache Size — 1 high byte	Binary	R/O	R/O	00H	00H	00H	00H
81 (51H)	Cache Entry Size — 1	Binary	R/O	R/O	03H	03H	03H	03H
82 (52H)	Cache Control Register	Binary	R/W	R/W	00H	00H	00H	00H
83 (53H)	Reserved for Future Use	Binary	R/O	R/O	00H	00H	00H	00H
End of Template Record								
84 (54H)	EOT Record Type	Binary	R/O	R/O	FFH	FFH	FFH	FFH

Note:

† These registers are defined for Intel's use. The values in these registers are dependent upon the revision of the board and are subject to change.

†† The BIST_DATA_OUT and the BIST_SLAVE_STATUS registers are R/W registers locally. However, the Test Handler that resides on the iSBC® MEM/3XX board does not allow off-board writes to these registers.

††† BCD+ has the same encoding as a normal BCD signal except that 0FH denotes a null, and the remaining unused encodings are reserved.

†††† The registers indicated with the *italicized type* are the nine registers that *must* be programmed before the board can operate in a system. Refer to the Configuration Sequence section for more information.

R/O = READ/ONLY
R/W = READ/WRITE
DEFAULT VALUE = POWER UP DEFAULT

MESSAGE PASSING IN THE MULTIBUS® II ARCHITECTURE

The demand for increased functionality and processing power in microcomputer systems is growing faster than single-processor solutions can satisfy. Multiprocessing, which allocates individual microprocessors to different functions within a system, has proven to be a viable solution, largely because of the advent of inexpensive memory and CPUs. Today, multiprocessing is highly evident in computers where microprocessors are found not only on general-purpose CPU boards, but on intelligent disk controller boards, communication boards, and other specialized boards.

To build multiprocessor computer systems, a designer selects a set of boards that solves his application requirements. The system bus is the vehicle for connecting the boards together and the medium through which intelligent boards communicate. Unfortunately, until now, conventional buses have not addressed this communication need with the idea of improving system performance and reducing complexity.

The MULTIBUS® II architecture employs an innovative mechanism called message passing to improve performance and simplify the implementation of multiprocessing computer systems. This product brief will discuss message passing and the benefits it brings to system design.

Functional Partitioning and Microprocessor Communications

There are two general types of multiprocessing: one that employs transparent multiprocessing in a tightly coupled system architecture and another that uses a heterogeneous mix of processors in a loosely coupled architecture (Figure 1).

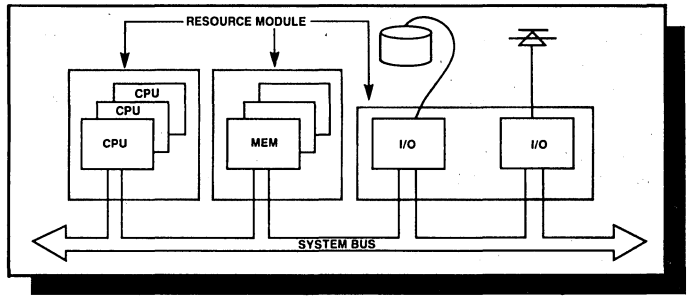

Figure 1A. Transparent Multiprocessing all the same CPUs

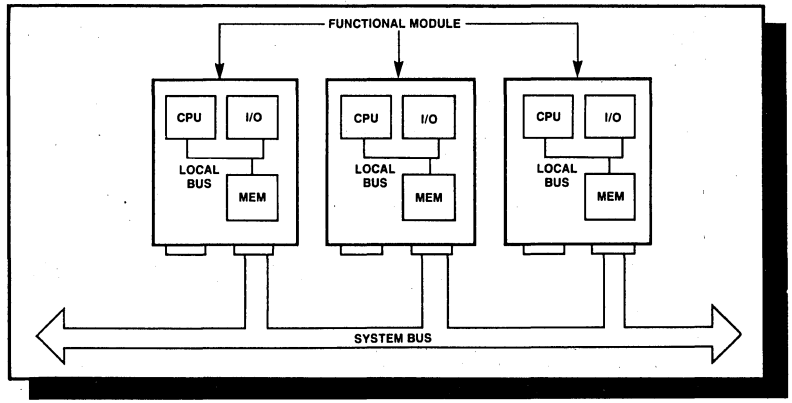

Figure 1B. Heterogenous Mix of Processors-Different Processors Selected to Satisfy Different Aspects of an Application

A functionally partitioned system is characterized by the use of a separate CPU and memory on a board with an optimized local environment. Other boards communicate via an interface which is independent of the implementation of the board. Therefore, future enhancements in the functional module can be easily integrated without redesigning the entire system. Also, since I/O, CPU, and memory technology evolve at different rates, a functionally partitioned system can be upgraded as technology allows, so the system integrator's products stay on the technological treadmill.

Key to the success of a functionally partitioned system is the mechanism for communication between the various functions. The MULTIBUS II message-passing feature was designed to resolve the problems of communication in multiprocessing systems by providing a unique approach to intermodule interrupts and data movement. In addition, the MULTIBUS II solution can be implemented in a single coprocessor device that augments the CPU, providing a cost-effective solution as well.

Solving the N x N Interrupt Problem

In traditional systems, interrupts are propagated via discrete interrupt lines. To get n processors to signal one another unambiguously, the bus needs $n \times (n-1)$ interrupt lines (this phenomenon is called the N×N problem). Since existing buses usually provide 7 or 8 interrupt lines, multiple sources of interrupts are assigned to a line, and the interrupted processor must poll to determine the source.

In contrast, the MULTIBUS II architecture uses message passing in a virtual interrupt scheme to resolve N×N problems as well as to facilitate the more complex feature of intertask communications required for a multitasking operating system. A virtual interrupt is a message that contains a destination and a source address and two bytes of qualifying information (Figure 2). In addition, up to 28 bytes of user data can be included in the interrupt. The entire message is sent as one packet on the system bus at the 40-megabyte-per-second maximum bus rate.

When the entire process of interrupt signaling is evaluated, including the software involved, sending a virtual interrupt with user data can be faster than an interrupt line approach.

Data Sharing

Traditionally, processors share data on a bus through a common memory area. This memory area is either globally available or a dual-port into one of the processors' local memories. There are several performance issues with these approaches.

First, it is necessary for one or both of the processors to use the system bus to reach the memory. When a processor uses the bus, it typically incurs an arbitration delay and the possibility of having to wait for other bus users to complete their activities.

In a dual-port approach, only one processor incurs the bus delay. However, the local processor performance is adversely affected by two factors. The first is the dual-port control logic. The second is contention from the processor accessing the local memory through the dual-port from the system bus.

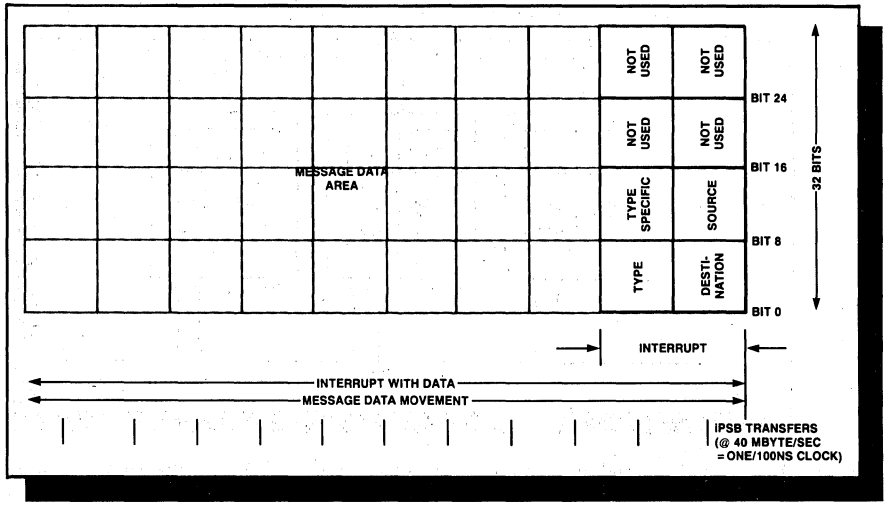

Figure 2. Message Format-Virtual Interrupt is First Two Transfers with Optional Data

In the MULTIBUS II architecture, the mechanism for moving data from one board to another is built into the MULTIBUS II bus interface hardware. The component which supports the requirements of message passing is referred to as the message passing coprocessor (MPC). A pair of MPC devices, one on each communicating intelligent board, moves the data from one board to another. Figure 3 shows a typical message-passing system with a host CPU and a disk controller using MPC devices to communicate.

For systems where the data to be shared is small and infrequently accessed, the performance impact may be trivial. However, as shared data needs increase, the CPUs pay a noticeable penalty. At this point, the system bus can also become a bottleneck. When systems software is required to coordinate and communicate the location of the shared memory, performance can further degrade. Finally, shared memory designs are also wasteful of bus bandwidth, complicated to debug, and are not easily extensible to beyond a single pair of communicating CPUs.

The MULTIBUS® II Solution

The ideal shared data system would have one CPU signal to another that it has data to share, followed by it becoming available to the second processor within its local memory. An example might be a disk system with a program or a set of data that a second processor spends a large portion of its time accessing. Getting the program or data quickly into the local memory of the second CPU is the key to achieving a performance improvement.

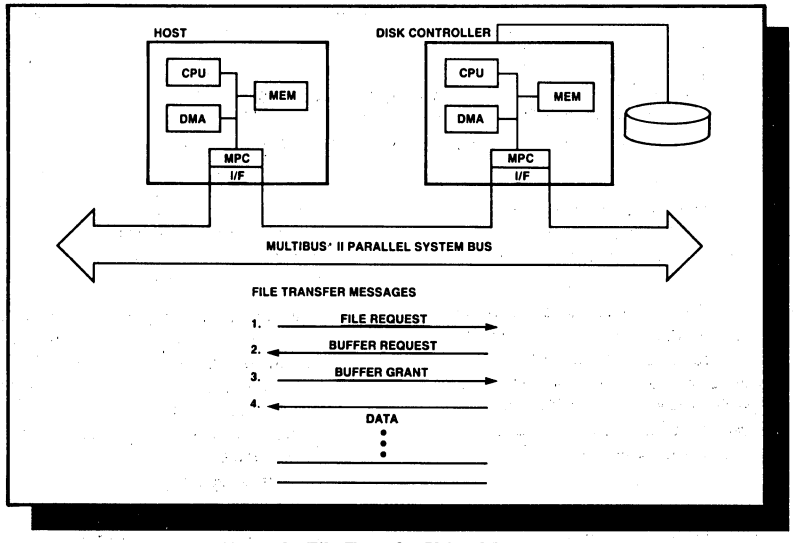

Figure 3. File Transfer Using Messages

In this example, the following is the sequence of events that occurs when the host desires a file:

1. The host requests the file using an interrupt message that uses the data field to describe the file.
2. The disk controller responds back to the host after retrieving the file with a request for memory.
3. The data is then arranged into 32-byte packets, and each packet is transmitted over the bus until all the data is at the host. The transfer is then complete.

The packets that are communicating and moving data between the MPC devices are transferring data at maximum bus bandwidths — 40 megabytes per second or 100ns per 32 bits. This constitutes a significant performance improvement, over traditional global memory and dual-port memory transfers.

By comparing this rate of data movement with today's VLSI devices, 40 megabytes/second is about five times as fast as the fastest microprocessor devices. The MPC performs a speed-matching function between the bus and the

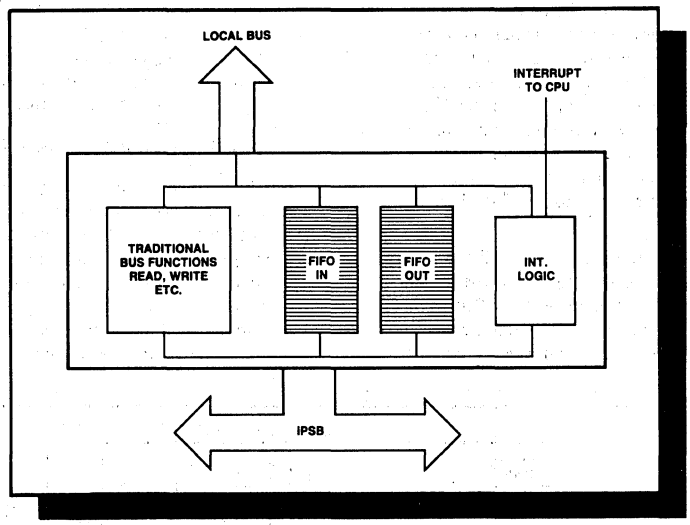

Figure 4. Message Passing Coprocessor Dataflow

local microprocessor environment. Between the system bus and the local bus, first-in first-out memories perform the speed matching. Figure 4 shows the data flow in an MPC device.

Data messages are broken into 32-byte packets because of the speed difference between the bus and the data rate that can be supported on a board. Since even the fastest microprocessor DMA devices cannot keep pace with these data rates, and real-time performance is affected if the packets are too large, it is advantageous to break a large data movement into small pieces and let the bus interface reconnect the pieces.

A 32-byte message packet only takes one microsecond of bus time (2-cycle header plus 8 cycles data×100 ns/cycle). This allows other boards to use the bus between the packets that make up a large data movement. Also, the system bus is not tied up for long periods of time when large data movements occur. For real-time applications, interrupts may be sent without having to wait for a long data transfer to complete.

Examining the Performance Benefits

A closer look at the example in Figure 3 shows the impact message passing has on system performance. Note that during the disk file request and transfer, neither CPU has to access the bus. The interrupt-like messages that request and set up the transfer as well as the transfer itself all occur through the MPC. When the MPC sends a message, message, it is packetized and moved at 40 megabytes per second over the iPSB bus. As a result, any bus overhead is paid only once per interrupt message or once per 32 bytes of the data transfer.

In addition, the CPUs never pay a penalty for arbitration or contention on the bus, nor does either CPU incur any performance penalties associated with dual port memory operation. The wait states that a CPU would traditionally incur are either greatly reduced or eliminated. Furthermore, if the boards in our example have a local DMA device, the CPUs are free to perform other tasks while the transfer is occurring.

One final point — it is important to understand that the MULTIBUS II architecture also supports the traditional methods of communication such as dual-port and global memories. Message passing is an incremental capability.

Summary

The original design goals for message passing were to provide a performance enhancement and make it easier to implement multiprocessing systems. The achievement of these goals have resulted in the following benefits: message passing has solved the N×N interrupt problem; it has provided a high-performance solution to functionally partitioned systems; and finally, MULTIBUS II message passing can be implemented in a single-chip solution, thereby providing a cost-effective answer for today's system design.

REDUCING BOARD AND SYSTEM COSTS WITH THE MULTIBUS® II ARCHITECTURE

Reducing board and system costs was a primary development goal of the MULTIBUS® II bus architecture. The effort to achieve that goal resulted in a number of important architectural features that directly and indirectly contribute to lower board and system costs. This architectural brief explores the following aspects of the MULTIBUS II bus architecture and discusses how each has contributed to reaching that goal:

— VLSI Bus Interface

— Geographic Addressing

— Front Panel Design

— Modular Board Sizes

— iSSB System Serial Bus

— Message Passing Interface

VLSI BUS INTERFACE

Generally, board-level products consist of two parts: a bus interface and on-board functions. Although silicon technology advances (VLSI) historically have greatly improved the number of on-board functions, the same cannot be said of VLSI's impact on the bus interface.

The MULTIBUS I CPU board history is a good example. In 1975, the first board — the iSBC® 80/10 board — contained a 2-MHz 8080 processor, 1 kbytes of RAM, up to 4 kbytes of EPROM, one serial and 48 parallel I/O ports. Today, the iSBC 286/12 board contains an 8-MHz 80286 processor, 1 Mbyte of RAM, up to 512 kbytes of EPROM, two serial ports, and a configurable parallel port. Overall, that is a 16X improvement in CPU, 1000X improvement for memory, and 2X improvement for I/O.

On the other hand, bus interfaces have not benefited from VLSI advances. Using the same MULTIBUS I example, the original iSBC 80/10 board used approximately 20 devices for the interface; the current iSBC 286/12 uses about 35 devices. Thus, the board area required for the interface has remained about the same, as has the bus interface cost. Technology has had little impact...until now.

The MULTIBUS II bus architecture has been defined to let the bus interface derive the same benefit from advances in silicon technology as board functions. Figure 1 illustrates the expected cost reduction of the MULTIBUS II bus interface over time.

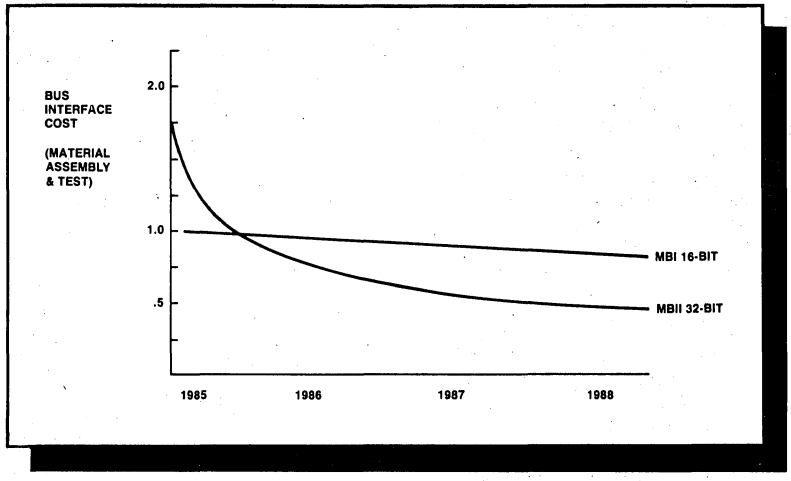

Figure 1. Cost Versus Time Graph

Achieving this improvement will be through a continuous process of integrating more and more of the bus interface into VLSI as technology allows. For a full-capability interface today, as shown in Figure 2, the interface requires about 22 devices: two gate arrays (the Bus Arbiter/Controller [BAC], and the Message Interrupt Controller [MIC]), plus about 20 programmable logic arrays and transceivers. In small quantities, the piece-part cost of these 22 devices is approximately $130.

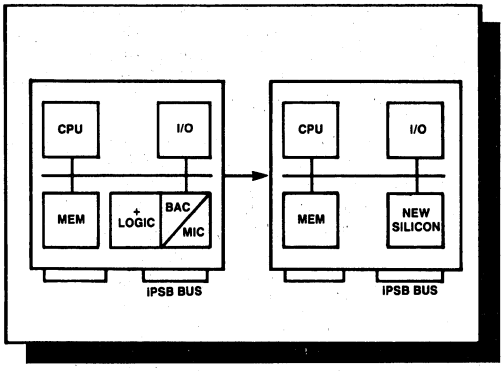

Figure 2. Interface Migration Diagram

The next step is the integration of all but the transceivers into a single VLSI device. This lowers the cost to about $100. The final step in the evolution of MULTIBUS II interface is a complete single-chip integration of all bus components, reducing the cost to about $65.

This cost reduction is made possible by the synchronous, multiplexed structure of MULTIBUS II's Parallel System Bus (iPSB). The iPSB requires only 62 lines (address, data, and control) to implement the entire 32-bit bus. In addition to noise immunity, the synchronous protocol allows the bus operation to be completely and unambiguously defined via state diagrams. The state diagram definition is compatible with today's CAD/CAE design methodologies, making both the device and board designers' jobs faster and easier.

It's important to note that in all three phases of the above evolution to a single-chip device, the bus interface implements advanced features of the bus: parity protection on the address, data, and control signals; operational error detection; distributed arbitration; and virtual interrupts. (These features are discussed elsewhere in this technical series.)

A critical factor in making a single-chip bus interface solution for a 32-bit bus is the number of signal lines. In the MULTIBUS II architecture, the total number of required device pins for the local bus, the system bus, and additional control is approximately 150 pins. It is possible to build a single-chip interface using today's silicon and packaging technologies. A non-multiplexed bus structure, on the other hand, would have pushed the device pin count into an area requiring specialized component packaging technology.

Materials cost is not the only area where cost savings result. Reducing the bus interface to a single-chip device obviously lowers the total board area required by the interface. This benefit gives the designer two choices: putting more functions on the board, thereby lowering the system cost per function; or reducing the individual board cost by keeping the number of functions the same.

Driving the bus interface to a single-chip device directly lowers board material cost and improves a system's cost-per-function ratio. Another feature, geographic addressing, reduces costs *after* the board is built.

GEOGRAPHIC ADDRESSING

Most every board user has encountered the problems of deciding which configuration jumpers to use and having to track down a misplaced or missing jumper. Geographic addressing helps solve these problems as well as making a board easier to use, debug, test, and service.

Geographic addressing is the ability to address a specific board by its slot number. When the special configuration/diagnostic registers on each board have been properly defined, system software can assume the tasks of identifying, configuring, and testing individual boards.

As a minimum, geographic addressing reduces or eliminates jumpers and DIP switches, thereby saving labor and dramatically reducing configuration errors. The MULTIBUS II iSBC MEM/312 memory board, a dual-ported cache-based board, is a good example. It contains no jumpers, yet options such as starting and ending addresses for each of the ports are software-configurable. (The closest equivalent MULTIBUS I memory board contains over 100 jumpers.)

Sometimes, it is difficult to eliminate jumpers, as when switching serial ports from RS232 to RS422 drivers. In such cases, geographic addressing still helps since software can read the jumper positions to verify they were installed correctly.

With software controlling the board configuration, only one version of the operating system is necessary. The operating system can automatically configure the system regardless of where the boards are inserted. After reset, software reads the identity of the board in each slot, configures it appropriately, and then loads the corresponding operating system drivers. In an environment where systems are customized for individual customers, this ability can dramatically reduce system-generation costs.

Geographical addressing also simplifies spares management. Within many companies, the same basic board is used in multiple applications, each requiring a different configuration. With traditional buses, this creates a spares stocking problem since either the basic board is stocked and then configured as needed, or each individual configuration is stocked separately. With MULTIBUS II boards, only the basic board needs to be stocked since the system software of each application configures each board appropriately.

Geographic addressing also reduces diagnostic costs. On each of Intel's MULTIBUS II boards, special diagnostic registers and an on-board microcontroller are included for running Built-In-Self-Tests (BISTs). With geographic addressing, software can trigger each board's BIST (controlled by the microcontroller) and read the test results. The results are also reflected on a front-panel LED for quick serviceability.

Since the diagnostic capability is run by software, even remote diagnostics are simplified. The system configuration can be observed remotely, BISTs run, and failures identified. Because special configuration is usually not required, replacement is easy. For systems requiring a level of fault tolerance, the failed board can be isolated from the bus (again by using geographic addressing), and, if desired, a hot spare (an existing board installed in the system and waiting to be used as a replacement) configured into the system. Thus, the software configuration and diagnostic capabilities can easily reduce service costs by eliminating service calls.

FRONT PANEL

Typically, Eurocard front panels consist of a thin, flat metal plate thru which I/O connectors are fitted. Placing boards side-by-side in a card cage creates narrow slots between the panels which are difficult to shield effectively to meet FCC electromagnetic interference (EMI) regulations. With such configurations, additional electrical shielding is usually required.

To solve this problem, the MULTIBUS II architecture employs a U-shaped front panel (Figure 3). From the EMI point-of-view, this makes the front panel electrically thicker. When boards are placed side-by-side, these electrically thicker panels attenuate both incoming and outgoing radio frequency energy. In most systems, this eliminates the need for additional shielding, which in turn reduces system costs.

In addition, the MULTIBUS II front panel design employs shielded D-type connectors. With this design, external cables can be attached directly to the front panel, thereby lowering cabling costs by eliminating intervening ribbon cable connections.

MODULAR BOARD SIZES

The MULTIBUS II specification allows both single and double connector sized boards. Boards designed for either size are compatible since the full 32-bit bus is defined on a single connector. This capability improves the modularity of the system: boards can be sized to meet the number of functions required.

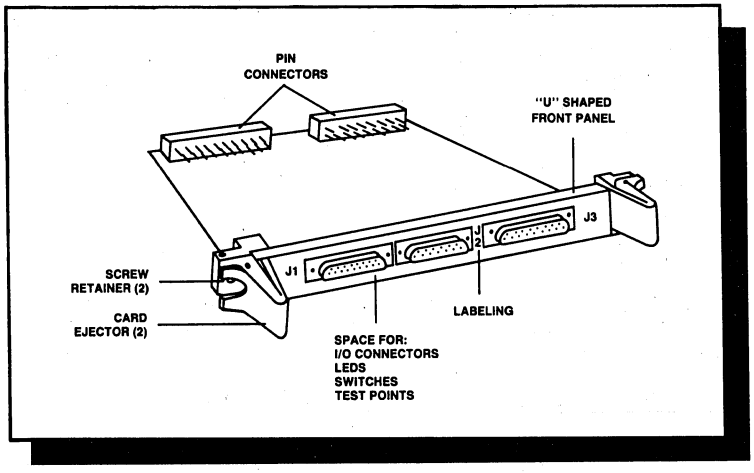

Figure 3. MULTIBUS® II Board with Integral Front Panel

For example, dumb I/O boards can use the single connector size, while intelligent boards will typically use the double connector size. Because users can choose exactly the functions they need in their systems, the system's cost-per-function is improved considerably.

THE iSSB (SERIAL SYSTEM BUS)

Future MULTIBUS II architectures will contain a special serial bus (the iSSB Serial System Bus) that will be compatible with the iPSB bus. The iSSB promises significant system-level cost reductions through physical distribution, a low-cost bus interface, and an inexpensive interconnect.

The iSSB bus is specified to operate at 2 Mbits/sec over a 10 meter twisted-pair cable. This physical distribution can simplify mechanical packaging and eliminate expensive controller boards. Figure 4 shows how a total parallel bus system solution might migrate to a serial connection. Notice that this migration eliminates the controller board. And, since the programmatic user interface (message passing) is compatible in both cases, the migration requires no change to the user software.

The bus interface cost for the iSSB is, of course, much less than for a parallel bus. On the bus side, only two lines are required. With a single-chip interface, this

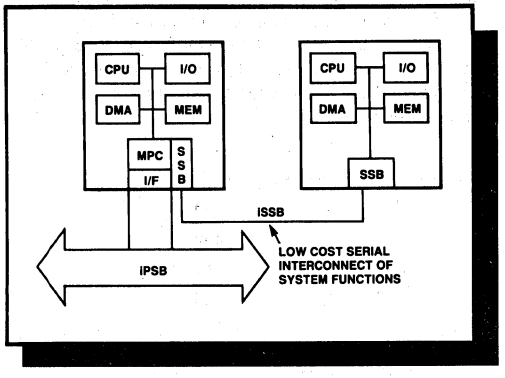

Figure 4. Parallel-to-Serial Migration Diagram

reduces the device's pin count, a major factor of device cost. In addition, because a twisted-pair cable is far less expensive than a 6-layer backplane with 96-pin connectors, the iSSB bus interconnect cost is also reduced.

FUNCTIONAL PARTITIONING AND THE MESSAGE PASSING INTERFACE

The MULTIBUS II message passing interface encourages system designers to functionally partition their systems. Functional partitioning reduces development costs because it creates a structured programming, procedural-level interface in hardware.

In a functionally partitioned system, communication between boards is typically defined at a level approaching that of high-level languages. Rather than interfacing at the bit and byte level, functional partitioning encourages procedural interfaces using such abstractions as files and messages.

With the interface defined at a level approaching a high-level language, the designer of one board is isolated from implementations used on other boards. If technology, competitive factors, or errors force a designer to alter his board, the changes are isolated from the remainder of the system, thereby minimizing the cost of implementing those changes.

A high-level interface also allows easier upgrades because the implementation is free to change and improve. In the file system example shown in Figure 5, the interface is on a file basis and boards for floppy disk, winchester disk, SMD, or tape are interchangeable.

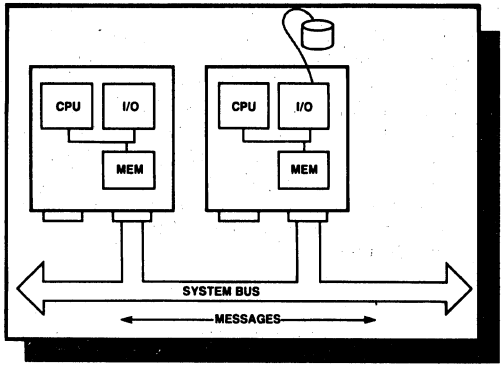

Figure 5. Host to Host Functions Communicating in Standardized Messages

SUMMARY

The MULTIBUS II architecture was defined to take advantage of technological advances to reduce a system's life-cycle costs. First, VLSI technology helps reduce the material cost for the bus interface through a single-chip interface. Second, geographic addressing contributes to significant savings for system generation costs, diagnostics, spares management, and service. Third, the front panel design reduces cabling costs and makes it easier to meet EMI regulations, while the modular board sizes improve cost-per-function ratio. In the future, the iSSB bus will provide system level cost reductions through physical distribution, a low-cost bus interface and an inexpensive interconnect. Finally, functional partitioning reduces development costs through a standardized, high-level interface that provides an easy upgrade path.

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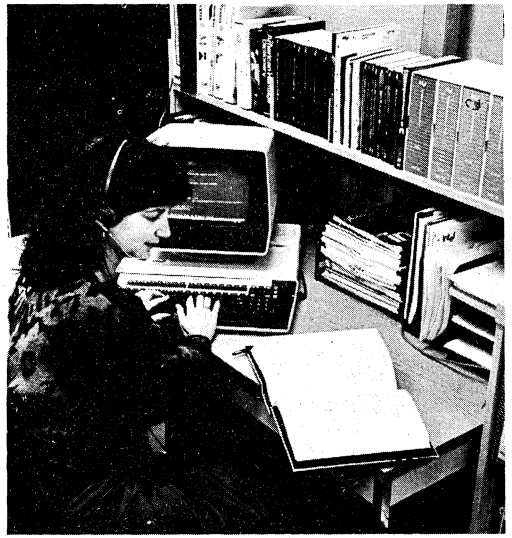
- ☐ *Comprehensive software support to address your most frequent questions*
- ☐ *Two levels of support: Standard Service or Basic Service*
- ☐ *Updates ensure that you have the latest released version of Intel software, manuals and documentation for all covered products as they are released*
- ☐ *Users kept up to date with regularly published software data*
- ☐ *Direct telephone access to Intel's trained Software Support staff to help isolate and resolve problems*



Most Commonly Requested Support Services For An Easy-To-Budget Monthly Charge

STANDARD SERVICE

TIP SERVICE	BASIC SERVICE
UPDATES	UPDATES
SUBSCRIPTIONS	SUBSCRIPTIONS

Intel's Software Support Service provides updates, manuals and documentation for covered products as released; Intel's ;COMMENTS technical newsletter; product-specific technical reports; written responses to customer inquiries under our Software Problem Reporting (SPR) Service; and access to TIP Service phone support.

Packaged in a convenient "environment" form, the Standard and Basic Software Contracts cover all supported software products that run in a particular environment.

Additional software products purchased at a later date which run in the covered environment may be added at no extra charge by simply registering the product.

A basic monthly fee is set for the first system covered. All additional systems are covered at a reduced rate per system. You are entitled to updates and subscriptions equivalent to the total number of systems covered under the contract.

Standard level service includes TIP support, for two callers for each system covered under the contract.

Contracts have a minimum one-year term and continue in force until cancelled with 30 days' written notice.

TIP Service Provides Telephone Access To Trained Software Engineers

TIP Service is a product-specific telephone information service designed to address time-critical product inquiries by providing direct access to Intel's trained Software Engineering staff. This direct response mechanism aids in obtaining maximum utilization of your Intel software products. TIP Service provides a timely response to those time-critical product questions that could not be answered by the product documentation, the Software Problem Reporting Service or the regularly published Technical Reports.

The two designated callers will have, by phone, direct access to Intel's trained Software Engineering staff within Intel's Central Customer Support Center during normal working hours (7:00 a.m. to 6:00 p.m. MST).

When you call TIP Service, the receptionist will initiate a numbered Incident Report and provide you with this assigned number for future reference. At this point, you will be able to speak with a member of Intel's Software Engineering staff. If one is not immediately available, the call will be returned within two hours.

Any new symptom, problem or work-around identified by you or the Software Engineer is added to the Software Problem Report (SPR) Service for future reference and incorporated into the appropriate Troubleshooting Guide.

Upon conclusion of the incident, the Incident Report is closed and permanently logged and filed.

Software Engineers Help Isolate And Solve Problems

Intel's Software Engineering staff is a group specifically established to provide the following services to users of Intel software and system products:

- Centralized access to Intel's engineering and support resources
- The latest technical information on Intel defined and documented product problems and deficiencies, and their associated work-arounds, temporary fixes, patches or other solutions
- Technical assistance in isolating the cause or source of a suspected product problem
- A central Software Problem Reporting (SPR) Service

Updates Ensure That You Have The Latest Released Version Of Any Intel Software

Under the terms of the contract, Intel will provide manuals, documentation, diskettes or other media of your choice for all covered updates as they are released.

When you obtain contractual coverage for your Intel software products, you must designate a primary and a secondary person for Intel to contact. Intel will send a software registration packet that will allow Intel to verify that the software to be supported is at the current release level. Intel will then record the returned information and assemble and mail any required updates, manuals and supporting documentation to the designated contact.

Subscription Service Keeps You Up-To-Date And Up-To-Speed

Intel's Subscription Service is an efficient communications mechanism intended to provide you with the latest Intel software and system product data, as well as information regarding product and documentation inconsistencies.

It is also a mechanism to enable you to report suspected product problems to Intel's engineering organization.

Subscription Service includes:

- ;COMMENTS—a technical bulletin which contains operational tips, programming techniques and other technical information.
- Troubleshooting Guides—technical information regarding current software problems, interim programming solutions and application articles. Published periodically, by product or product family.
- Software Problem Reporting (SPR) Service is a written communications vehicle for you to use to inquire about or to report suspected product problems, or to suggest product improvements. All Software Problem Reports (SPRs) are reviewed by a member of the Software Support Staff, and are answered in writing as quickly and completely as possible.

Ordering Information

Software support contracts are placed in effect by completing an Intel System Service Agreement. Eligible contract environments are listed in the current Intel price book.

Contact your local Intel Sales or Service Office to sign up for support.

☐ ***Engineering Services from highly trained and experienced Systems Engineers***

☐ ***Direct access to Intel's current technology, engineering resources and product information***

☐ ***Quick help to complete applications based on Intel products***

Systems Engineering Services

Intel provides Field Systems Engineering Services to meet your needs in any phase of your development or support effort. Our Systems Engineers (SEs) have extensive industry experience and they are highly trained on Intel's latest technology. Additionally, our SEs have easy access to Intel's vast technology and factory resources to help guide your effort or to quickly resolve a problem. Because your workload and resource requirements vary, we have established a large and growing organization of Systems Engineers so that we will have an SE available where and when you need one. The service is very flexible. You can engage an SE by the hour, week or month. Also, you can engage an SE on a retainer basis to be available to you throughout your development effort.

Systems Engineering Services Can Help You In Many Ways...

We Can Save You Time

We have anticipated your need to maximize the use of your staff to complete your development effort. That is why we provide industry experienced and highly trained SEs to assist you with the integration of Intel's technology with your product. Because our SEs are constantly working with new products on different projects, Intel SEs have many years of experience rather than a year's experience many times. This diverse industry experience enables them to understand and solve application problems rapidly.

You can use an SE in a variety of ways, ranging from assistance in using a new product, developing an application, personalized training, customizing or tailoring an Intel product to providing technical and management consulting.

Systems Engineers are well versed in technical areas such as microcommunications, real-time applications, embedded microcontrollers and network services.

Access to Intel Technology and Factory Resources

Intel SEs are equipped with our latest chips, boards, boxes, systems, software and tools so they can work at your facilities or at our local office. Plus, the SEs are complemented by other field SEs, factory support and development resources. These additional resources can lower your project cost and ensure compatibility with future Intel projects. So when you engage an SE you don't just get an individual—you get a whole team.

Quality Commitment

The quality of your completed effort is just as important to us as it is to you. As a member of your team we are committed to adhering strictly to your quality standards.

For those customers who look to Intel to set the quality standard, we have adopted the IEEE Software Engineering Standards. Intel has broadened the IEEE outline and used it to develop a System Quality Assurance Plan. The plan covers design, documentation, testing, peer reviews, coding and other essential components of a quality assurance plan. In addition, we have developed an Engagement Management Standard, which ensures you proper and timely information during the SE engagement.

Systems Engineering Services

System Software	Languages	Hardware	Applications	Systems Engineering Services
RMX®	PLM	Components	Real-time	Software
UNIX*/XENIX**	C	Microprocessors	Communications	Development
DOS	ASSEMBLER	Microcontrollers	Office Automation	System Integration
iNA	PASCAL	Peripherals	Factory Automation	Custom products
	FORTRAN	Boards	Aerospace	Consulting
		Processor	Military	Troubleshooting
		Communication	Financial	Network Design
		I/O		Project
		Systems		Management
		Real-time		
		Multi-user		

The Intel Team Is Ready To Help

You know your application needs. Our field and factory teams know our products and have diverse applications experience using them. Working together we can achieve an effective and timely solution.

Unlike other alternatives for additional system engineering resources, Intel's Systems Engineers share your commitment to make the decision to use Intel products a good decision. Our SEs are committed to help you get a successful product to market in the least possible time.

Examples Of What We Have Done

Microcommunications

- Design and implementation at all levels of integration of the ISO/OSI Seven-layer model
- Fault-tolerant, distributed real-time microcomputer network design and implementation
- Migrate 9600 baud ASCII/ASYNC to 10 megabit/sec Ethernet
- Provide file transfer capability between VAX† and iRMX with remote job execution on iRMX system under VAX control
- Port iNA to customer's custom board

Microcontrollers

- Embedded 16-bit microcontroller for automotive applications
  —Engine control
  —Chassis control

Custom INTEL Products

- Communications firmware to optimize performance and for modem control
- Diagnostics and boot PROMS
- Graphics firmware customization

Office Automation

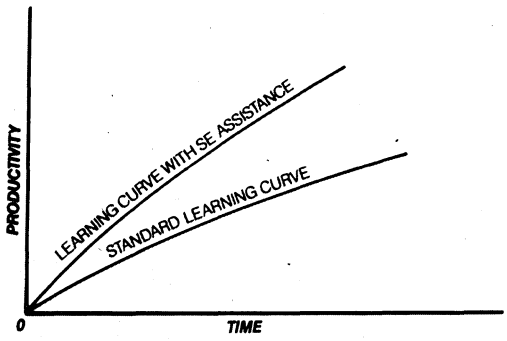
- Design 100+ node Ethernet Microcomputer network
- Design and develop customer specific network utilities
- Needs analysis and recommendations on efficient and effective use of microcomputers and ISV software packages

Real-Time Applications

- Blood analyzer control and test system
- Conveyor control system
- Remote monitoring system

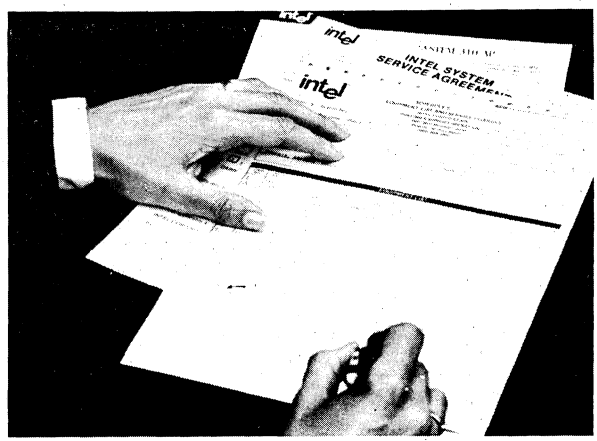
Ordering Information

Your local Field Sales Engineer or the Regional SE Manager can discuss a Systems Engineer Service which is most appropriate to your needs. They can also provide information on Terms and Conditions including price information.



* Registered Trademark of AT&T
** Registered Trademark of Microsoft Corp.
† Registered Trademark of Digital Equipment Corp.

- ☐ ***Backed by a 15-year service organization***
- ☐ ***Comprehensive hardware support options that include all necessary parts, labor and installation of engineering changes***
- ☐ ***Personalized attention from your Intel Customer Engineer***
- ☐ ***Extended coverage options to provide you support up to seven days per week and twenty-four hours per day***
- ☐ ***Preferential, priority dispatch of your Customer Engineer to your site***



Comprehensive Hardware Support Options

Intel's Customer Support Operation is an International Organization with the expertise and resources to provide on-site service on a worldwide basis.

Intel's Standard Hardware Maintenance Service is designed to keep your system running at maximum efficiency. Intel provides remedial maintenance, preventive maintenance and parts replacement, or exchange for a fixed amount. The contract includes all parts and labor during the contract hours selected at your site.

Maintenance charges are based on individual contracts, subject to applicable zoning policies and optional parts and coverage. It is recommended that all interconnected products be included in the maintenance agreement. Extended Service coverage and installation are also available.

Intel utilizes a sophisticated Central Dispatch System that promptly dispatches personnel, monitors call progress and tracks each piece of equipment you have under contract. During emergency calls you are protected by the automatic problem escalation system. Central dispatch closely monitors the situation and will escalate problems to the appropriate management and technical people. The system maintains a complete history file on each piece of equipment under contract. This assures you that the equipment will be maintained at the highest level with engineering change orders and appropriate spares stocked locally.

Preventive Maintenance Avoids Problems

Intel's Preventive Maintenance (PM) programs are designed to increase your system availability by identifying potential problems before a malfunction occurs. Your assigned Customer Engineer not only performs the preventive maintenance specified by Intel or the original manufacturer, but also will augment the service with personal experience with your products and applications. The PM services include reviewing performance, history of the equipment, executing the diagnostics to identify potential problems, making any necessary electronic and mechanical adjustments and replacing any worn or defective parts as required.

Remedial Maintenance Receives Priority

If unscheduled maintenance becomes necessary, the assigned Customer Engineer will be on-site within the contracted response time. The Customer Engineer will call the same day of your request for service to discuss the symptoms observed, ensuring that all logistical items are available to resolve the problem. Verification of the equipment being back in service will be accomplished by executing diagnostics. The Customer Engineer will then update the device history file with the corrective action taken.

Engineering Changes Installed At No Extra Cost

Assuring you of the latest engineering improvements is a standard feature of Intel Standard Hardware Maintenance Service. The changes ensure not only that the equipment operates at the highest standards but has continued compatibility with Intel supplied software and replacement parts. Engineering changes are installed during a preventive or remedial maintenance call.

Service Specifications And Options

Term

Maintenance agreements are written for a minimum of a one-year term and continue month to month thereafter until cancelled by either party with 30 days' notice.

Standard billing is monthly but flexible options are available.

Period of Coverage

9/5—9 continuous hours between the hours of 7:00 a.m. to 6:00 p.m., Monday through Friday, excluding local Intel holidays.

16/5—16 continuous hours between the hours of 7:00 a.m. to 12:00 Midnight, Monday through Friday, excluding local Intel holidays.

24/5—24 hour coverage commencing 7:00 a.m., Monday through 7:00 a.m. Saturday, excluding local Intel holidays.

24/7—24 hours coverage, 7 days a week, excluding local Intel holidays.

Maintenance Price Grid:

9/5	16/5	24/5	24/7
Standard	11%	130%	150%

Maintenance Service Response Time/Cost Grid

The time/cost grid for maintenance agreement coverage lists the available response time within service zones. As equipment location moves farther in distance from the service center, response times are extended and contract coverage cost increases by the percentage quoted below the response time. For response time of less than 8 hours or distance greater than 150 miles, contact your local Field Service Office.

Parts

Maintenance parts required for on-site service will be furnished by Intel on an exchange basis; replaced parts become the property of Intel.

Ordering Information

Contact your local Intel Field Sales or Service Office.

Class	*0-50 mi*	*51-100 mi*	*101-150 mi*	*Comments*
Standard	8-hr response	16-hr response	24-hr response	On-site
	100%	125%	150%	

NETWORK SERVICES

- **One-stop shopping for your network**
- **Complete physical and logical network design**
- **Network installation management**
- **Network user and administrator training**
- **Worldwide service and support**

One-stop Shopping

As part of the commitment to meet your total networking needs, Intel offers a full set of services to provide you with convenient one-stop shopping for all your networking requirements. This provides a single point of responsibility for installation of your network and frees your resources to concentrate on your specific applications.

Complete Network Design

Today's networking products are powerful and extremely flexible. The return they can provide on your investment via increased productivity and reduced costs can be very substantial. However, in order to obtain both maximum equipment utilization and user productivity, they need to be custom configured to your specific organizational and usage requirements. Whether installing your first network or adding to an existing one, Intel's Networking Specialist can perform this design service for you.

Physical Network Design: When planning and designing the physical layout of a network, issues such as type of building, local fire and building codes, adherence to various specifications (e.g., Ethernet, IEEE, RS232) must be taken into consideration. Intel's Physical Network Design Service can provide this for you. In addition to the most efficient cable routing and recommendation of the most reliable components, a complete bill of materials and cost information for the physical network is produced.

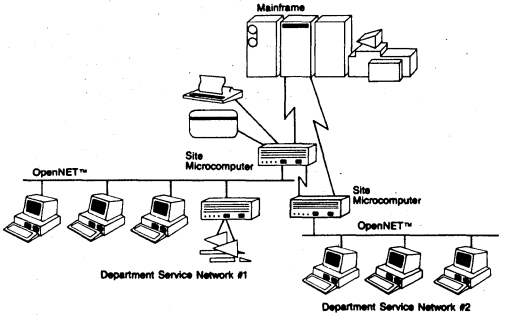
Logical Network Design: Because every organization is unique and has its own set of requirements, the network that serves it must be logically designed and configured to meet these requirements. Just as there is no generic data base design, there is no generic network design. Issues such as the most efficient use of file and print servers, host communication servers, network security, and system and network administration must be taken into consideration. An Intel Networking Specialist will interview your users to understand their requirements and then logically design the network to meet those requirements. This Logical Network Design Service produces the software "blueprint" to be used by the network installers and ensures immediate use of your network upon completion of its installation.

Network Installation Management

Once the physical and logical design of your network has been completed and agreed upon, the implementation phase begins. An Intel team will manage the installation of the physical network, set up and install all nodes, and install and configure all software according to the logical design "blueprint" produced as a result of the Logical Network Design Service. Before the installation team leaves, they will ensure that your network is fully operational.

Network User and Administrator Training

Just as the design of the network is critical to its maximum utilization and productivity so is the proper training of your users. Intel's Customer Training provides a comprehensive selection of courses for both your end users and network administrators. By training your staff in parallel with network installation, they will be in a position to start using the network immediately upon its installation.



June 1987
Order Number: 270309-02

■ Worldwide Service and Support

Because a network can be equated to a large multiuser mainframe, ensuring maximum network uptime, operational efficiency and timely repair is extremely important. Intel's Customer Service provides a full range of network maintenance services that can be tailored to meet your specific needs. Among these are Software Support which includes free updates to all Software, and Hardware Maintenance of all system nodes, PCs and attached peripherals as well as the network "backbone" cable, transceivers, transceiver cables, connectors and repeaters. In the event of network problems, Intel's Customer Service personnel are equipped with proprietary software diagnostic tools which help to locate and analyze any problems quickly. These same tools can also be used to conduct a periodic performance "tune up" of your network. Options as to level of service, response time and hours of coverage are also available.

Over 865 trained professionals in 80 service locations are dedicated to providing you with top quality, world class service.

■ Custom Network Management Services

If you have a large network installation, Intel's team of Network Specialists can put together a custom proposal that will provide a wide range of Network Management Services to meet your specific needs. These include, but are not limited to, the following:

- Network administration
- Coordination and administration of customer user groups
- On-site first level support
- Node relocation management
- Consulting and application development

intel

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PAYMENT

Cheques should be made payable to your local Intel Sales Office.

Other forms of payment may be available in your country. Please contact the Literature Coordinator at your local Intel Sales Office for details.

The Completed form should be marked for the attention of the LITERATURE CO-ORDINATOR and returned to your local Intel Sales Office.

UNITED STATES
Intel Corporation
3065 Bowers Avenue
Santa Clara, CA 95051

JAPAN
Intel Japan K.K.
5-6 Tokodai Toyosato-machi
Tsukuba-gun, Ibaraki-ken 300-26

FRANCE
Intel Paris
1 Rue Edison, BP 303
78054 Saint-Quentin-en-Yvelines Cedex

UNITED KINGDOM
Intel Corporation (U.K.) Ltd.
Pipers Way
Swindon
Wiltshire, England SN3 1RJ

WEST GERMANY
Intel Semiconductor GmbH
Seidlstrasse 27
D-8000 Muenchen 2

HONG KONG
Intel Semiconductor Ltd.
1701-3 Connaught Centre
1 Connaught Road

CANADA
Intel Semiconductor of Canada, Ltd.
190 Attwell Drive, Suite 500
Rexdale, Ontario M9W 6H8

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