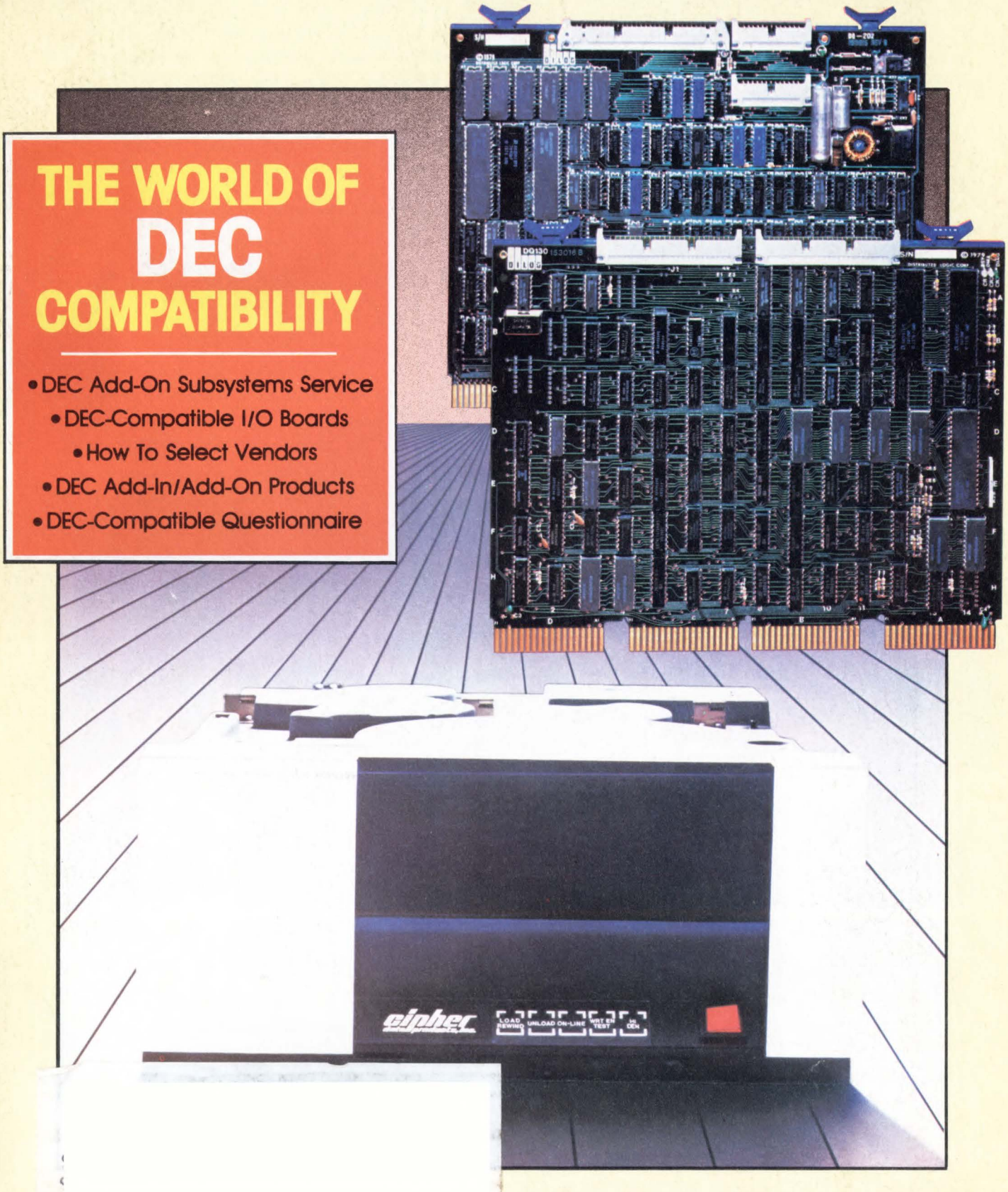
VOLUME 10, NO. 8

AUGUST 1980

Digital Design

Computers • Peripherals • Systems



7-UP & LEVI'S

Special effects take more than a computer.

Hollywood's Robert Abel & Associates holds nine Clios—advertising's Oscars—for making computer-controlled dramatic effects for products like 7-Up and Levi's.

Ask Bob Abel and he'll tell you he relies on System Industries' disk storage for his PDP-11/60s. When he's in the thick of creating TV commercials that dazzle the eye and capture the imagination, the last thing he wants to hear about is equipment failure.

"In this business, concept and esthetics must be supported by unfailing hardware," says Abel. "That's why we'll buy System Industries when we expand our storage."

Reliability isn't a special effect. It's another good reason why you should select System Industries to help you cut minicomputer disk storage costs.

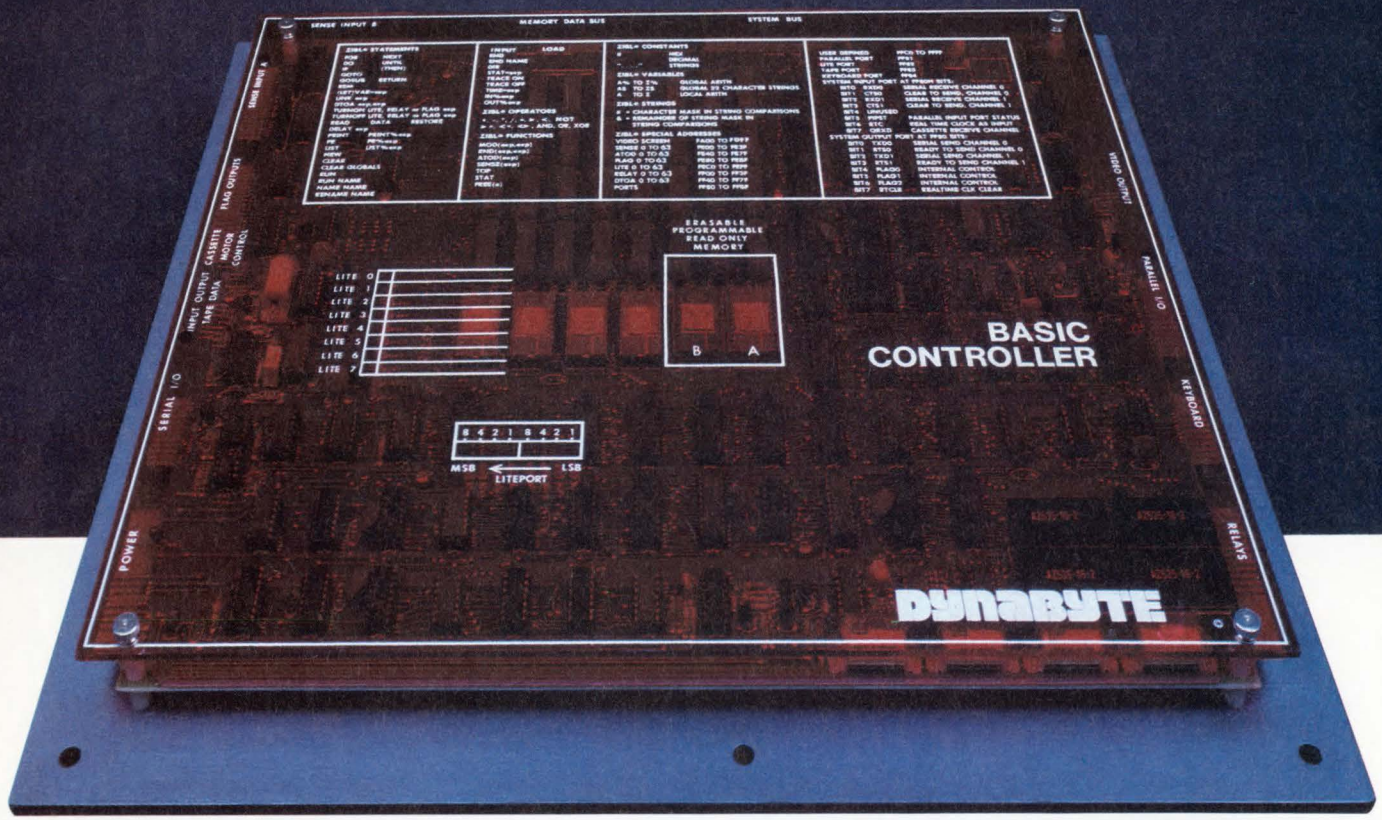
7-Up, PDP-11/60, and Levi's are registered trademarks.

System Industries

In the U.S.: 525 Oakmead Parkway, P. O. Box 9025, Sunnyvale, CA 94086, (408) 732-1650, Telex 346-459. **In Europe:** System Industries U. K., System House, Guildford Road, Woking, Surrey, GU22 7QQ, England, (048 62) 5077, Telex 859124. **Atlanta:** (404) 231-3640 **Boston:** (617) 332-3220 **Chicago:** (312) 642-5456 **Cincinnati:** (513) 771-0075, (513) 874-5503 **Houston:** (713) 497-7224 **Los Angeles:** (213) 557-0384 **New Jersey:** (201) 839-8650 **New York:** (212) 953-0315, (516) 482-6082 **Orange County:** (714) 754-6555 **Rhode Island:** (401) 739-8070 **Washington, DC:** (703) 734-9700 **West Germany:** (06102) 5464/5 **Sweden:** 08-63 62 74

Circle 2 on Reader Inquiry Card

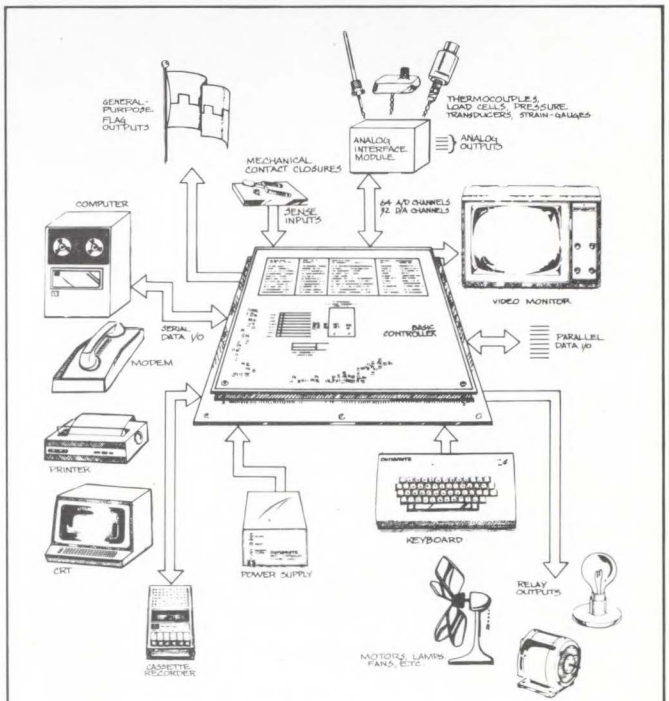
The Single-board Computer System for the Man Who Doesn't Have Time to Build His Own*



***Or can't afford to**

So-called "single-board" computers are a long way from being single-board computer ***systems***. Analyze what it really takes to make one: CPU board, memory boards, I/O boards, rack-mount, software development system, and weeks (sometimes months) of construction, programming, and debugging.

Now consider the BASIC CONTROLLER™: one board. Period. CPU, RAM, EPROM sockets, video generator, keyboard and cassette interfaces, 24 hour clock, serial and parallel ports, a multitude of "real-world" I/O's — even an EPROM programmer — are all included. And our built-in ZIBL™ (Z80 Industrial BASIC language) interpreter will reduce your programming time to hours, instead of weeks. So you can concentrate on your application, not hardware and software. If your needs are less than 200 ***systems*** per year, you really can't afford to use anything but a BASIC CONTROLLER™.



THE BASIC CONTROLLER™ WORLD

DYNABYTE
115 Independence Dr., Menlo Park, CA 94025 (415) 329-8021

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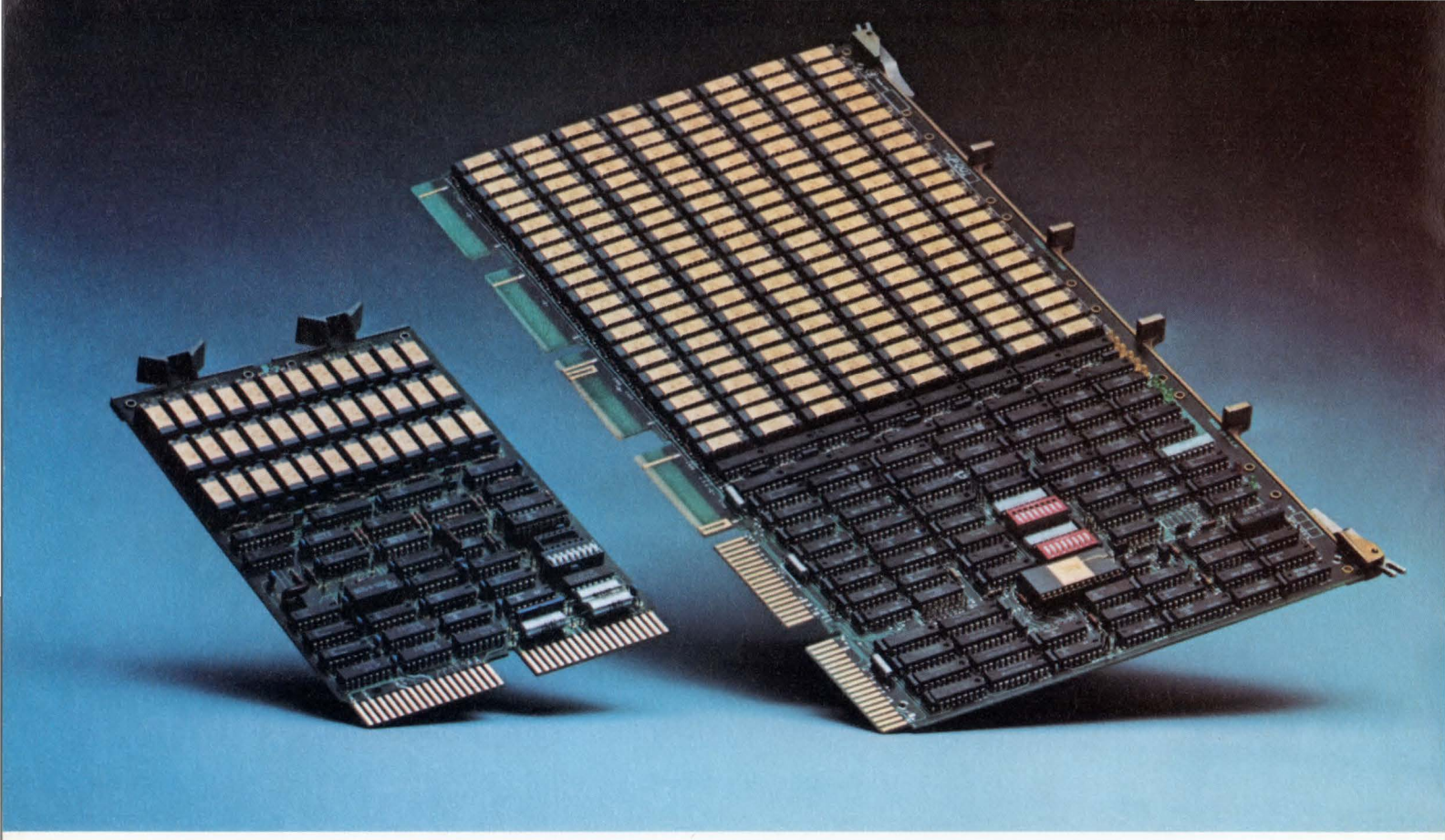

More memory on board and a custom-design capability. Memory systems from Texas Instruments.

Quality. Reliability. Compatibility. And more memory on board than anybody else can offer. These are just a few of the many user benefits inherent in TI's new add-in memory modules.
Here's more:

TMM20000 modules

This high-speed module is fully compatible with the DEC PDP-11 family of UNIBUS† computers. It's the only available module that offers enhanced system reliability through error detection and correction (EDAC) on board.

High-density, 256K x 16 bits organization *plus* 6 bits for EDAC, make TI's new TMM20000 the densest add-in module ever. Operation from a single 5-V supply with low power consumption is another big plus.

Programmable options include modified or extended UNIBUS, I/O page size, control status register address location, and error status register. Twenty-two address lines allow for expansion to 2M words.

TMM10000 modules

Two versions. Both Q-BUS† and Q-BUS PLUS† compatible. Q-BUS for LSI-11/2. Q-BUS PLUS for the newly announced LSI-11/23. The TMM10000-01 with parity. TMM10000-02, without. Both modules use 5-V only technology storage devices for high performance and low power.

These add-in modules, organized 64K x 16 bit words, with an additional 2 bits for parity (01 only) are the densest available on a standard DEC "dual" board. An optional feature allows extended addressing to 1 megabyte. Fast access and cycle times, too.

Basic storage unit

All TI-designed add-in memory systems employ a state-of-the-art 5-V memory technology. The basic storage unit makes possible such module features as increased board densities, lower power dissipation, improved performance and enhanced system reliability.

These same advantages will be available to users who require production of custom memory systems.

Custom capability

If you need custom memory systems in production quantities, be sure and talk to TI. We'll custom-design modules for specific applications with the same high quality, reliability and meticulous attention to cost-effectiveness that our standard modules offer.

For price and availability information, call your nearest TI Semiconductor sales office or authorized distributor. Or contact Texas Instruments, Box 1443, M/S 6958, Houston, Texas 77001. (713) 490-3746.

Fifty Years of Innovation

TEXAS INSTRUMENTS
INCORPORATED

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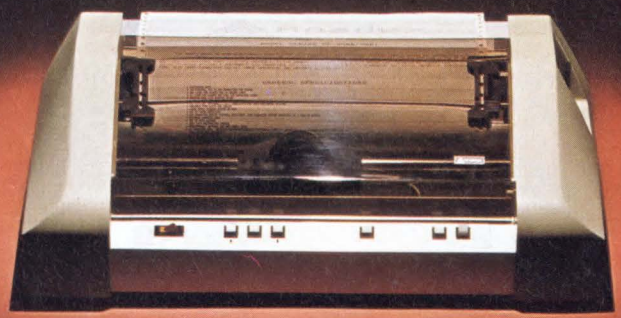
85211A

Circle 5 on Reader Inquiry Card

Meet two new Printers from Anadex.

Resolutionary!



Introducing two totally new alphanumeric line printers from Anadex - Models DP-9500 and DP-9501 - featuring 132/175 or 132/220 columns, respectively.

Both models employ a new, Anadex-manufactured 9-wire print head with 150 million character life (optionally, 650 million) that makes them ideal for high-resolution printing requirements including high-density graphics where print quality and reliability must go hand in hand.

The full standard 96 character ASCII character set, including descenders and underlining of all upper and lower case letters, can be printed bi-directionally on up to 5 crisp copies at speeds up to 200 CPS. Adjustable-width tractors, accommodating paper from 1.75 to 15.6 inches wide, allow the printers to adapt to your application.

The three ASCII compatible interfaces (Parallel, RS-232-C, and Current Loop) are standard in every printer; so interfacing is usually a matter of "plug it in and print." With simplified interfacing, the printers also feature sophisticated communications capability including control of Vertical Spacing (6 or 8 lines/inch), Form Length and Width, Skip-Over Perforation, Auto Line Feed, and full point-to-point communications capability.

Other standard features are a 500 character FIFO buffer (optional, an additional 2048 character buffer), shortest distance sensing logic, self test, and replaceable ribbon cartridge with 6 million character life.

For complete details, attractive OEM pricing, and a demonstration, contact Anadex today.

Anadex®

ANADEX, INC. • 9825 DeSoto Avenue • Chatsworth, California 91311, U.S.A. • Telephone: (213) 998-8010 • TWX 910-494-2761

ANADEX, LTD. • Dorna House, Guildford Road • West End, Woking, Surrey GU24 9PW, England • Tel: Chobham (09905) 6333 • Telex: 858762 ANADEX G

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Complete systems for computer graphics and image processing.

And, we do mean complete! Grinnell systems can include computers, disc drives, terminals and software operating systems. Plus a FORTRAN software and driver package; high resolution TV monitor, camera, and hard copy color printer.

There are also other options to meet any special requirement you might have.

Of course, you may already have some of the necessary hardware. That's why Grinnell systems work with standard TV monitors and cameras, and why plug-compatible interfaces are available for most minicomputers.

We also give you a complete product line to choose from:

GMR 270 Series: 512 x 512 resolution frame buffers and full color pipeline image processing systems.

GMR 260 Series: 1024 x 1024 resolution frame buffers for grey scale, black and white, pseudo color and full color.

GMR 27 Series: High speed, modular graphic and image display systems.

GMR 37 Series: Low cost graphic display systems.

So, whether you want to analyze images from outer space or monitor a process in a plant, Grinnell has a complete system that can do it. For complete specifications and/or a quotation, call or write today.

GRINNELL SYSTEMS

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VOLUME 10, NO. 8 AUGUST 1980

Digital Design

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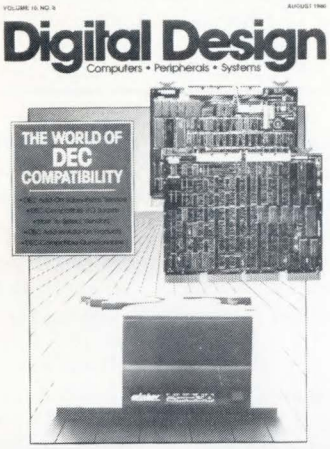
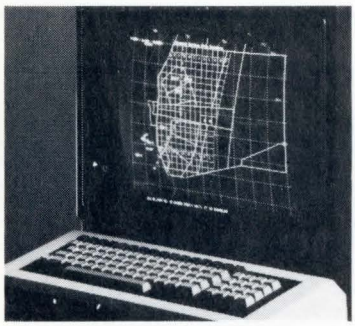


ON OUR COVER

Sharing our "World of DEC Compatibility" issue cover this month are Cipher Data Products' "Microstreamer" tape drive for Winchester backup and Distributed Logic's LSI-11/ (8" and 14") Winchester Disk Controller and magnetic tape coupler for streamer drives.



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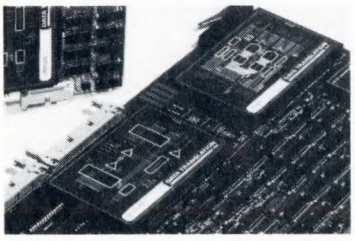

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42 DEC-Compatible Equipment: How to Select Vendors

Vendor (and product) selection from A to Z is covered in this article; follow these rules and you can select the best DEC-compible boards and peipherals available for your system needs.

48 How To Select DEC-Compatible Analog I/O Boards

Data acquisition requires a variety of por products to enable end users to connect to an infinite variety of real world signals.

60 Buying DEC Add-On Subsystems? Consider Service

There are many good reasons for buying third party controller and storage peripherals for expansion of DEC computer system capacity. Lower cost, quicker delivery, wider selection, compact packaging and better specs enable system builders to reach the market sooner.

62 Designers' Guide to Magnetic Bubble Memory Systems

Custom interface and support circuits free the system designer from the details, letting him concentrate on the interfacing.

94 Designers' Guide To DEC Add-In/Add-On Products

Evaluation of add-in/add-on products in the DEC-compatible market requires that system integrators and builders avoid overlooking certain factors in his selection process.

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FOR A MICRO-LIKE $2950* YOU GET THE WHOLE 16-BIT SHEBANG!

the new Bytronix Series 500 is an entry-level CPU system with access to the full-performance world of superminis

- System contains 16-bit CPU, real-time clock and 64K bytes of MOS memory
- Controllers for cartridge disc (to 20MB), CRT and printer
- Packaged within its own video display
- Teletype I/O port allows addition of second CRT
- CPU has NOVA-™ equivalent instruction set
- Uses several commercially-available, high-level BASIC or COBOL operating systems.

™NOVA is a trademark of Data General Corporation

The Series 500 is software-compatible with Bytronix Series 1000, 2000 and 3000 CPU system packages.

These packages have CPUs with up to 256K bytes, cartridge disc and storage module controllers, asynchronous communications multiplexers, printer controllers and multi-user operating systems.

*Approx. OEM 100-quantity price; unit price $3950

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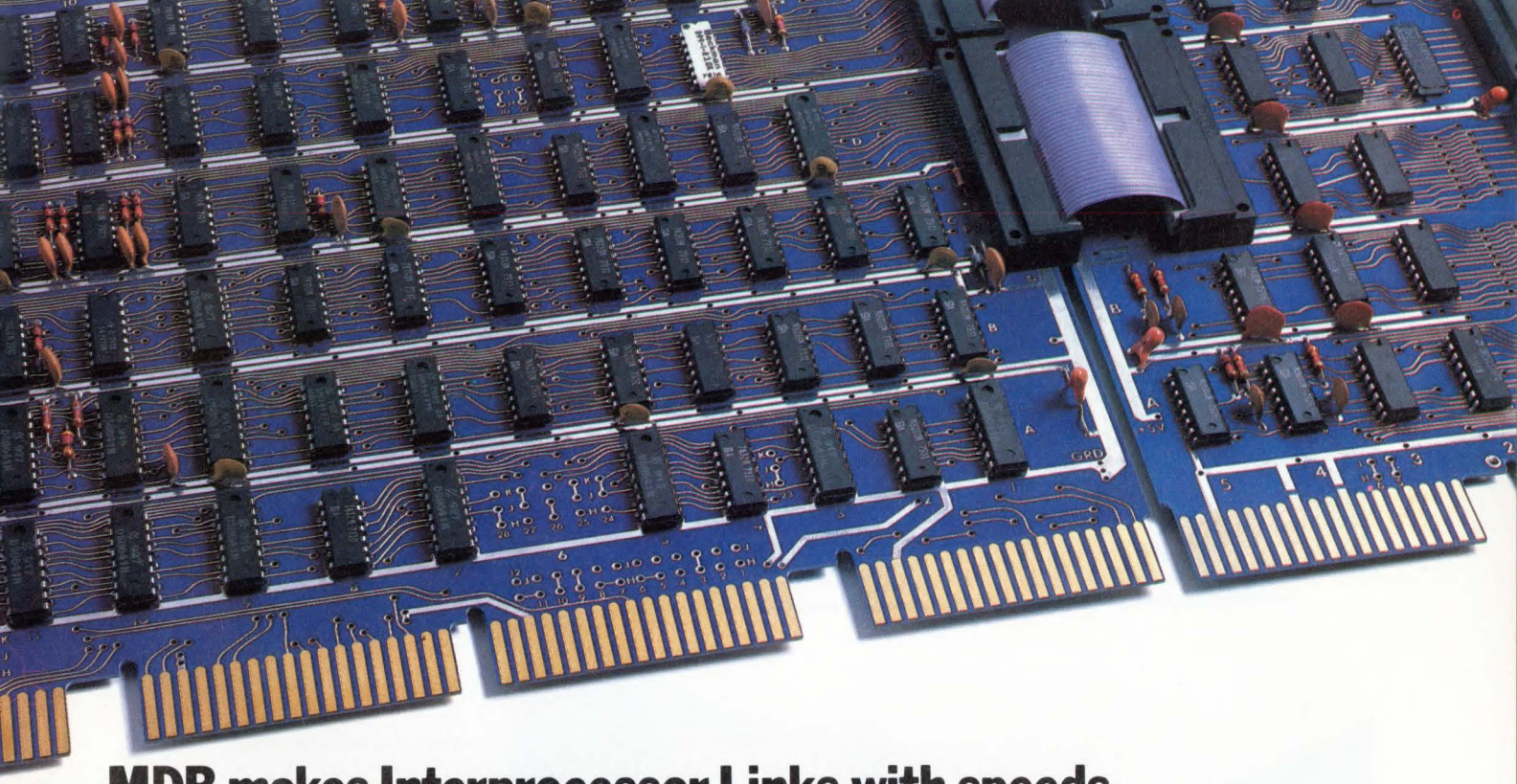

MDB makes Interprocessor Links with speeds of 500 KHz/sec. for distances up to 3,000 feet.

Imagine what else we can do!

Hook 'em up. Networks of PDP*-11, VAX*-11/780 and (never possible before) LSI*-11/2 and 11/23. Name your configuration, even PDP to LSI or LSI to LSI,—MDB interprocessor links will provide high speed DMA (parallel) data transmission at speeds as high as 500 K words/sec. For extra long line applications MDB's PDP-11 to PDP-11 boards are equipped with differential drivers and receivers for high speed operation up to 3,000 feet. The security of optically isolated receivers is standard on all boards for LSI and available for PDP & VAX models. Optical isolation provides AC/DC circuit and ground loop isolation at distances up to 1,000 feet. All this performance is compactly housed on MDB's small size boards—a hex for PDP models and quad for LSI. And you get the convenience of complete DEC DA11B software compatibility.

Imagine even more. Because MDB manufactures the most complete line of interface products available for DEC, Data General, P-E and IBM Series One computers. We make boards for H-P and Intel too. Like our line printer controllers—we offer more than 100 printer/computer combinations. Our communications interfaces range in performance from plain vanilla to plain incredible and all MDB foundation modules require only one card slot. We've got PROM memories that let you program ROM on the board and multiplexors that allow mix and match of 20 milliamp and EIA.

All MDB products are warranteed for a full year. Most can be delivered in 30 days or less and you can buy them under GSA contract #GS-00C-01960. What else can we do—for you?

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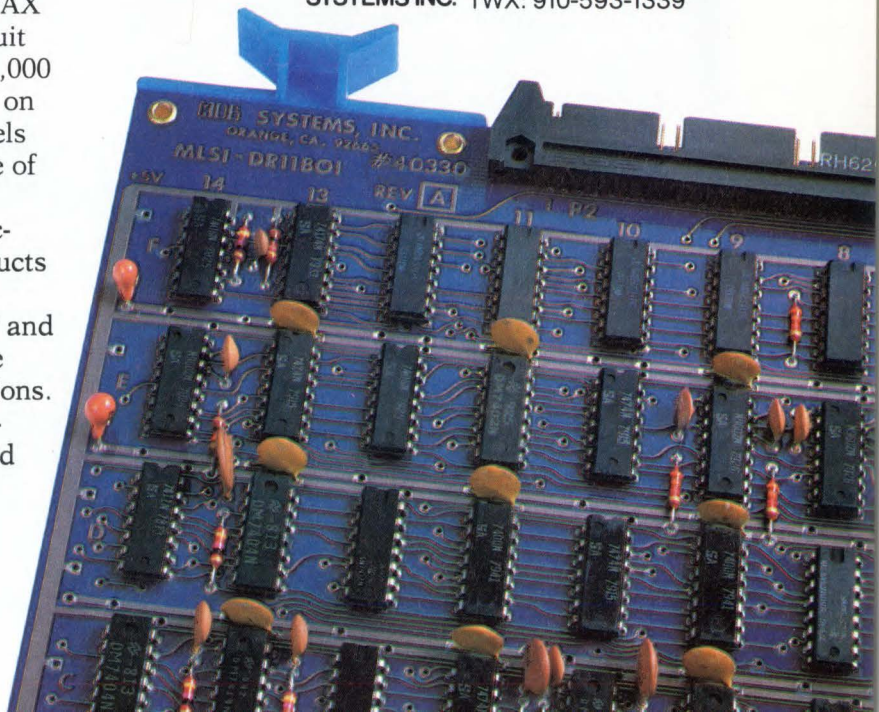
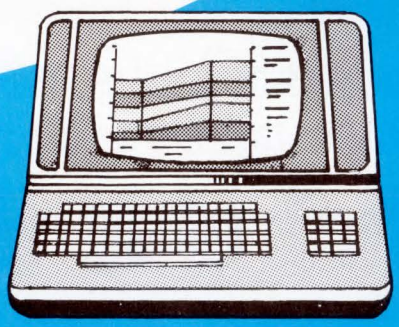


See us at Wescon #2639.

*Trademark Digital Equipment Corporation.

Circle 70 for LSI-11, 71 for PDP-11, 72 for DG 73 for PE, 74 for IBM.

CONVERT RGB to NTSC with LENCO'S CCE-850 COLOR ENCODER.



Now you can display computer colorgraphics on a standard NTSC color television monitor, or videotape the information for distribution.

Lenco's CCE-850 Color Encoder is specifically designed to encode high-resolution RGB colorgraphics computer displays regardless of scan rates.

This small, self-contained unit may be used in either tabletop or 19″ rack-mounted configurations, and includes a built-in color reference bar test pattern to ensure proper NTSC color monitor alignment.

Check these outstanding features:

- RGB-to-NTSC
- Detail Enhancement
- Color Test Pattern
- Auto Sync Detector
- High Resolution
- Self-Contained

Call or write today for detailed specifications, application notes, and price.

LENCO, INC., ELECTRONICS DIVISION

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5454 Blossom Acres Dr., San Jose, CA 95124, (408)356-0221

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Letters

Uniface Correction

Regarding the appearance of Able Computer's UNIFACE in the January issue, to make sure there are no misconceptions involving UNIFACE, there are two supplementary points which should be made. These include the following: (1) price: not yet established, but targeted at $4500 list, (2) applicability: for major OEM's only. Able will not offer UNIFACE to end-users, universities or small OEMs because support requests for applications engineering and UNIFACE-driven product development could be overwhelming.

Industrial Espionage

Dear Editor:

On the article on espionage and IEEE aiding the Red Chinese by helping to transfer U.S. computer technology to them (pg. 22, March), I would say this is nothing new. Let the FBI and CIA work in secrecy; there are no rules in spying. If the Russians are guilty of spying, then the Americans are also.

Geoffrey S. Woolfson
Emidata/Malco
Garrison, MD

Specifics Hit Home

Dear Editor:

Paul Snigier's editorial, "The Time Has Come," was concise, germane and very specific; few have stated the problem with such clarity.

Dr. John Matthelos
1 Wyoming St.
Dayton, OH

Contact Point

Dear Editor:

We appreciate your including us as an information source and product supplier in your March article on single-board computers. However, the address listed is our sales office in Wellesley. The contact point should have been our headquarters: RCA Solid State Div., Route 202, Somerville, NJ 08876.

Walter B. Dennen
RCA Solid State Div.
Somerville, NJ

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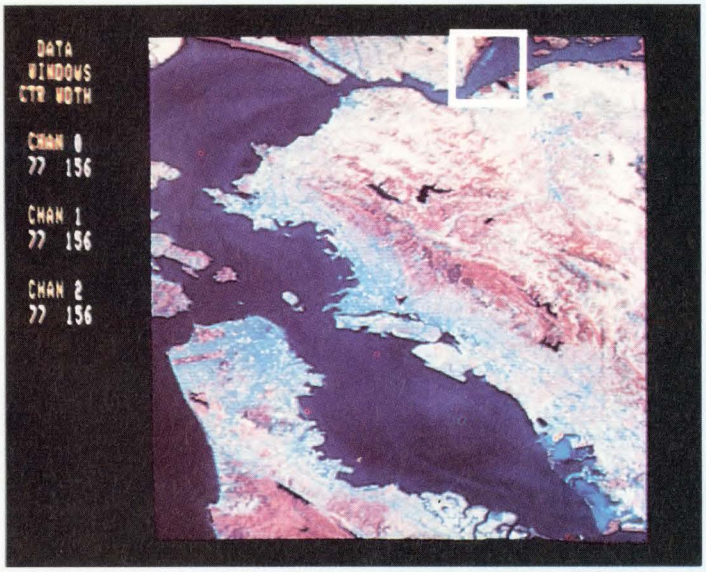
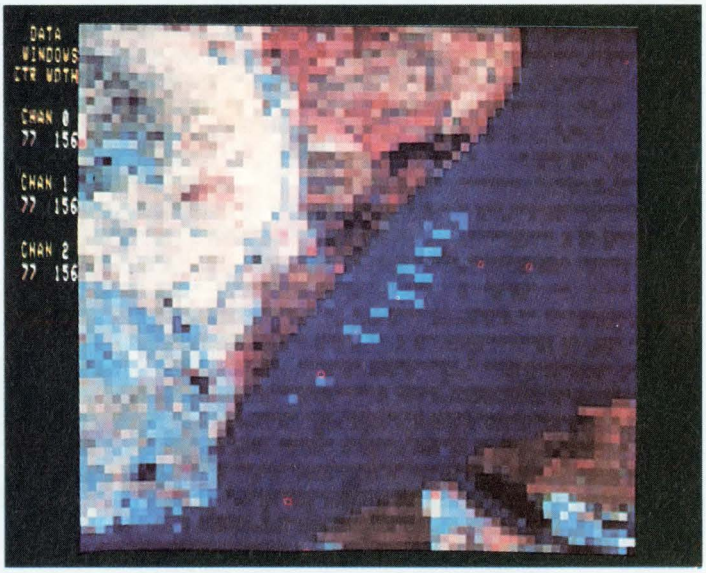
THE IMAGE ARRAY PROCESSING SYSTEM



Three band LANDSAT image of San Francisco Bay



Eight-to-one zoom of Suisun Bay

If image analysis and aquisition is your problem, you need the IP 5000 Image Array Processor.

The display system that:

- Stores up to one megabyte of data for single or multiple image arrays.
- Has complete independence between refresh memory (raster scan output) and host computer addressability of memory.
- Includes memory management and data control for direct high speed access to refresh memory.
- Includes a powerful, pipe-line processor to perform high speed image array processing and statistical analysis.
- Performs pixel replica zoom of 2:1, 4:1 or 8:1 in real time.
- Can selectively change format between 525 line and 559 line video formats with external sync capability for 525 line formats.
- Is capable of scrolling, in any direction, a pixel or line at a time or multiple pixels and lines without causing tearing of the visible image.
- Digitizes video signals up to 8-megahertz bandwidth with true 8-bit precision.
- Has multiple intensity transformation tables for grey scale, color or pseudo color displays.
- Has proven reliability with field installation at some of the top names involved in image processing and display.

For further information and a list of satisfied users, contact DeAnza Systems, Inc., 118 Charcot Ave., San Jose, CA., 95131, (408) 263-7155.

De Anza Systems Incorporated

GIVE YOURSELF A BETTER IMAGE

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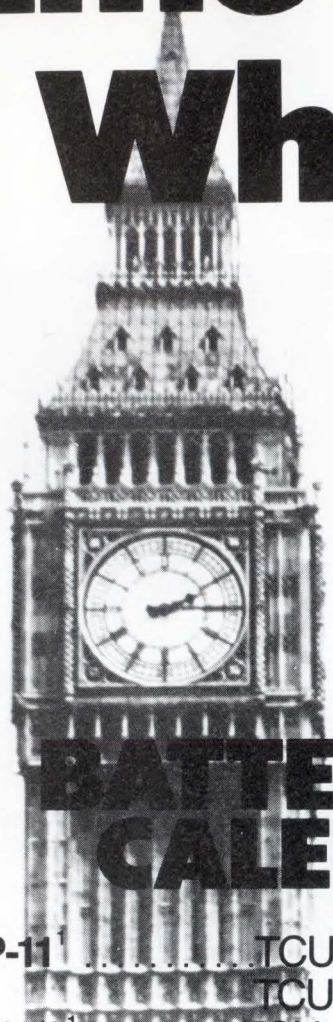
Time is precious Why lose it?



BATTERY SUPPORTED CALENDAR CLOCKS

PDP-11[1]	TCU-100 • $495
	TCU-150 • $460
LSI-11/2[1]	TCU-50D • $325
Multi-Bus[2]	TCU-410 • $325
EXORcisor[3]	TCU-68 • $325
HP 2100	TCU-2100 • $395
Lockheed SUE	TCU-200 • $550
Naked Mini[4]	TCU-310 • $385

Serial Line Clock . .SLC-1 • $640
(RS 232 or 20mA) Microprocessor controlled. Auto message intercept and response. 10 Digit display option $190.

If automatic and accurate date and time entry is important to your system on power-up — you need a Digital Pathways battery supported calendar clock. All Digital Pathways' TCUs have on board NICAD batteries to maintain date and time during power down (typically up to three months). Timing is provided by a crystal controlled oscillator. Prices are U.S. domestic single piece. Quantity discounts available.

For more information on these timely products, contact:

Digital Pathways Inc.
1260 L'Avenida
Mountain View, CA 94043
Phone: (415) 969-7600

[1] *Trademark of Digital Equipment Corp.*
[2] *Trademark of Intel Corp.*
[3] *Trademark of Motorola Inc.*
[4] *Trademark of Computer Automation Inc.*

DIGITAL PATHWAYS

Circle 36 on Reader Inquiry Card

How to cut the cost of Winchester backup.

Circle 8 on Reader Inquiry Card

Low cost head crash insurance.
Save up to 50% by using a data cartridge system.
With a transparent controller by Western Peripherals.

The controller makes the CPU think it's working with a half-inch tape drive.

Piggyback as many as eight ¼-inch, 3-M type cartridge drives – and dump nearly 140MB of data.

For low cost archival storage, backup storage or economical head crash insurance, count on data cartridge systems – with controllers from Western Peripherals.

☐ Yes! Please send complete information about low cost mass storage.

NAME _____ TITLE _____

COMPANY _____ ADDRESS _____

CITY _____ STATE _____ ZIP _____ ( ) TELEPHONE _____

CPU Type: ☐ DEC LSI-11* ☐ PDP-11* ☐ Data General NOVA/Eclipse**

western peripherals

Division of Wespercorp
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Tustin, CA 92680 (714) 730-6250

*Trade name of Digital Equipment Corporation.** Trade name of Data General Corporation.

Technology Trends

Visit Wescon At Anaheim

Wescon/80, September 16-18, actually gets under way Monday, September 15th, at Anaheim's Convention Center with a full day of preview activities, including the annual Marketing Conference and Keynote Luncheon, both at the nearby Disneyland Hotel Grand Ballroom. Keynote Speaker Dr. Simon Ramo is a TRW founder and former Chairman of the President's Committee on Science and Technology.

Telecommunications, satellite systems, testing technology, memories, LSI and μPs head up the Professional Program. A full block of sessions on telecommunications from the user's viewpoint covers robot satellite communications and advances in telecommunication semiconductor technology to advances in telephone switching transmission equipment and new initiatives in satellite systems and services. Applications of bubble memory in harsh environments and memory concepts for the 80s also will be explored. There will be presentations on electronic packaging and interconnections, semi-custom LSI – gate arrays; CAD; optical fiber transmission; multiplexed liquid crystal displays, power cells and aircraft collision avoidance.

IEEE Life Members will present a special session Wednesday morning, September 17, on the electric automobile, its potential and its promise. As we go to press, the latest word is that several versions of electric automobiles will be on display.

Wescon will present three blocks of professional sessions each day – not the traditional two-per-day blocks. Sessions start at 9 AM, noon and 2 PM each day. The number of sessions remain the same as in past years, but the new format allows you to attend more sessions and avoid possible conflicts.

1,200 booths

Wescon contains more exhibits than at any time since 1969 and 1968. The earlier two years would have been surpassed this year if additional space had been available, since a long waiting list of extra exhibitors existed since mid-March.

Exhibits, in four exhibit hall groupings (color-coded for easy recognition), include instruments/instrumentation and control systems; production, packaging and test equipment; components, microelectronics and fiber-optics; and mini and microcomputers and EDP peripherals.

Exhibit hours are 9 AM to 6 PM on Tuesday and Wednesday, September 16 and 17, and 9 AM to 5 PM Thursday September 18.

Interested in personal computing in engineering and business management? Then, be sure to visit the special exhibit of 24 "own-your-own computers" and demonstrations of their features. Since we understand that leading manufacturers of small computers competed for inclusion in this special exhibit, it should be first rate. Computers will be entered in a multi-category contest judged by leaders from science, industry, business and the trade press.

Into the crystal ball. . .

Marketing procedures and trends will be explored Monday at the Marketing Conference (Disneyland Hotel). Panelists who appeared at the Wescon Marketing Conference two years ago to comment on foreign influences in U.S. electronics marketing return for a review of their predictions and to explain what's happened since then. They will examine the overall electronics marketplace today for aerospace, military, commercial/industrial and consumer needs. They will also examine the interplay among engineering, sales, purchasing and distribution. New forecasts will be made (and dissected). You and other conference attendees can speak up and make predictions. The experts will comment.

The Marketing Conference begins at 8:30 AM and continues until 5 PM. For your $25 registration fee you get admission credentials for the Wescon exhibition and Professional Program and Keynote luncheon.

For the first time, Wescon includes a program by and for purchasing executives. Sessions (90 min) held each morning (10-11:30) at the Inn-at-the-Park Hotel cover purchasing and the computer, helping salesman help purchasing managers and how distributors and reps can best aid purchasing. Registration for the Purchasing Seminars is included in basic Wescon registration. Be sure to visit *Digital Design's* booths for a friendly chat. Or, if you have an idea for an article on a design project of yours, or have a unique design idea, this is an ideal time to touch bases with our editors for some ideas or tips on how to go about it.

– Paul Snigier

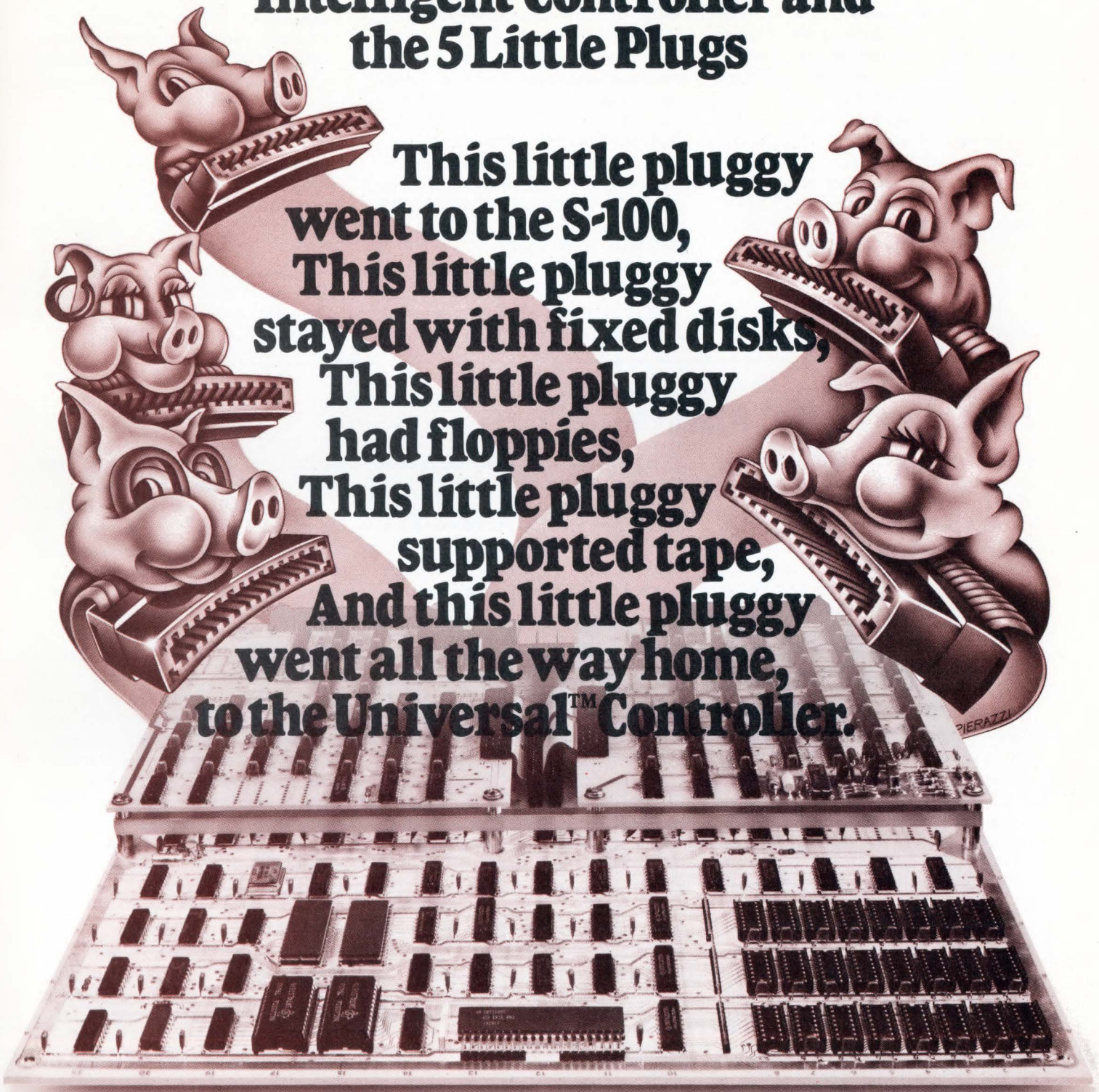
NIPS: The Giants Clash

Will high-speed nonimpact printers (NIPS) fare well over the next few years? Yes! Larger organizations are seeking faster ways of putting information on paper and are turning toward nonimpact printers – whether ink jet, laser or xerographic. Reasons include speed, quietness and lower maintenance. Installations of some 6,400 units by yearend 1984 represent an anticipated increase of 228% over last year's installed base of 1,950 units.

The big three

Twelve month's ago there were only four vendors of high-speed nonimpact

The Universal™ Intelligent Controller and the 5 Little Plugs



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printers: now there is a fourfold increase as *Digital Design* goes to press this month. The big three are IBM, Xerox and Honeywell. IBM's 3800 will take a 46% share of the market with 2,900 units installed by yearend 1983. Xerox, phasing out its Model 1200 in favor of the 9700, is in second place. Last year, they held 31% of the market, with 1200 sales and another 10% on 9700 sales, coming in at a 41% total market share (combined installed base of 790 units). The 1200 is disappearing and the 9700 will grow rapidly, increasing to 2,000 units installed by yearend 1983, for a 31% market share.

Honeywell's Page Printing System (HPPS), the least expensive of "the big three," is $31,606 (versus $36,300 for the 3800 and $35,240 for the 9700); it will maintain a steady market share of 11%, reaching 700 units installed by yearend 1983. Other printers include Itel's 7800, Univac's 0777, Documation's Laserpage, and Datagraphix's 9800. The Uppster's high-speed PEP-6510 uses fiber optics, pulsed light and electrophotography to print. But, it now looks like these other models may only account for 3% of the market by the end of this year; by 1983, they could increase to 9% of the total.

While HPPS is the *lowest priced* printer of the big three, it has four serious drawbacks. (1) It uses coated, dielectric paper (much more costly than plain paper used in Xerox's 9700 and IBM's 3800). (2) Creation of custom forms require system builders are software controlled, requiring only a change in programming to create custom forms. (3) HPPS cannot work as a WP system; 4700 can. The various printers handle paper differently: both purchase individual printing drums at $335 each. All forms on Xerox's 9700 Xerox models and HPPS use cut sheets. The HPPS relies on roll paper – not single sheets. IBM's 3800 uses continuous forms paper. The cut sheet format is superior: it's more flexible. It's bound to become more popular in tomorrow's offices.

Lower speeds

Most high-speed nonimpact printers are at large computer sites; their high volumes justify the high costs of a 9700, 3800 or HPPS. Is there a need for lower-priced, slower NIPS? Yes, in many general-purpose computer sites. This year will see lower-speed NIPs take 2% of the market; by 1983, this percentage will increase to 20%.

IBM Invades WP Markets

New markets for OEM system builders and integrators will open soon due to IBM's recent invasion of the word processing field. On first glance, the impact would seem confined to end users and WP makers; in reality, it is far more significant: it will eventually be felt directly or indirectly throughout the industry. It also is one tip of IBM's overall strategy, which will unfold (although that's a different story).

Will affect OEMs

IBM's imminent mass assault on the WP market will force plummeting prices and intense competition; second, it is only the initial salvo that will speed the long-forecast arrival of the automated (paperless) electronics office and factory (and eventually, home); and thus, third, it will be a key force leading to a sudden, explosive and insatiable demand for semiconductor memory, peripherals and μC-based products.

When private and public message systems, executive terminals, WP/DP systems, low-cost OCRs, true voice data entry and satellite communications all come together – perhaps by 1985 – we predict that opportunities and profits for OEM system builders and integrators will dwarf all the experts' predictions, and that it will occur suddenly when these products and events fall in place. IBM is well-positioned in each of these fields.

Separately, these products are significant; but, when interconnected in networks, their mind-boggling capabilities overshadow all predictions. As just one example of newly-created demand, consider the vast quantities of information and records that businesses now store in steel file cabinets that will be transferred to electronic storage/retrieval libraries – which will create a sudden and mind-boggling demand for tape, videodisks, etc.

Communications crucial

IBM's WP systems directly compete with "personal computing" systems – and more sophisticated WP systems from Xerox, Wang, Lexitron and others.

On June 17, IBM's Office Products, DP and General Systems Divisions issued WP announcements and a policy statement reassuring users that all future office systems would be compatible in terms of protocols, file structures, etc. Although critics had raised criticisms about compatibility in terms of file structures and communications protocols, IBM laid these to rest. Communications provided will support integration of these and future IBM WP/modern office systems into coherent, unified systems, so users needn't worry.

The Displaywriter challenges cluster VDTs systems, since three units can be connected to share a common printer. Cost? Such a tri-workstation system goes for $29,000. It communicates in asynchronous, binary synchronous or other modes. Communications won't be available until late summer of 1981, although Displaywriter itself will be available in January. This gives IBM time to meet expected demand.

Although most customers in the past purchased equipment from one of the IBM divisions, so that conflicts rarely took place, critics harped on the potential for trouble with different WP, file structure and communication approaches due to approaches taken by the different divisions. Now, there's no worry, IBM has reassured users: none of IBM's WP/modern office units will displace IBM's present data communications structure. By creating a "document interchange architecture", IBM has ensured its new units will handle interfacing. Although future units won't be completely software compatible in terms of things like instruction sets, file structures and data format, it won't matter.

Slashing costs

Displaywriter is a low-cost typewriter-replacement, an 8086-based standalone system that isn't that much different from other WP units already on the market. It has a display, one 8″ 284-kB floppy (a second, optional), a printer and 160-kB to 224-kB of memory (all 16-k RAMs) – certainly nothing that sets it apart from the rest of the pack (Xerox, Wang, Lexitron, Vydec, A.B Dick, etc). The price does. At $7895 for a basic system, this is much lower than the competitors ($12M to $18M.)

What you get for your $7895 includes a Selectric-type golf-ball printer. A 40-cps Daisywheel is an extra

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½ MByte
TM-100-3 (Single-sided)
Capacity (unformatted):
500K bytes
TPI: 96 or 100
Tracks per side:
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Recording density:
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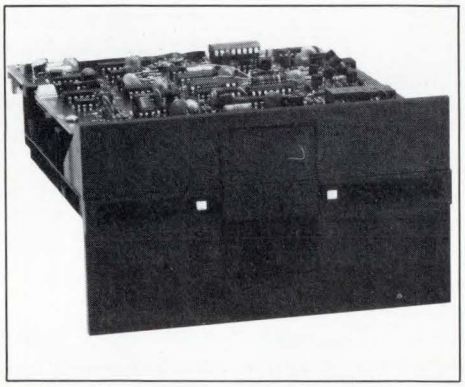
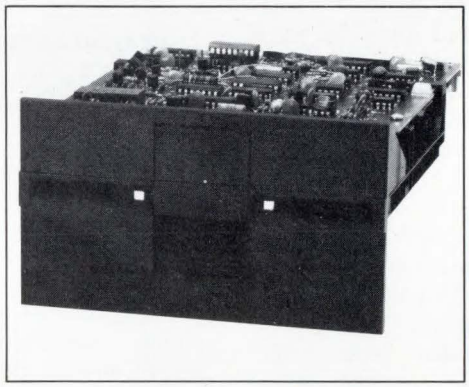
Access time:
• Track to track: 3ms
• Average: 90 ms





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Capacity (unformatted):
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Recording density:
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Access time:
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$1,075. Or, if you like, IBM now makes its own 60-cps Daisywheel. The 60-cps IBM Daisywheel resembles the Diablo, Qume and Dataproducts "Daisys". IBM uses a rotating screw rather than linear motor to drive its printhead.

IBM challenges TRS-80/Apple III

Tandy and Apple are trying to penetrate the modern office markets from the bottom. Unfortunately, a model I TRS-80 for WP hits the $6,000 region – not to mention things like its lack of memory (48k, max.). Of this, Radio Shack's Scripsit package takes up 16k of the 48k – certainly not a selling point. Added to this, Scripsit cannot drive its printer bidirectionally nor will it underline. It's a pygmy in giant country. Then, too, adding a Daisywheel and decent WP software to the Model II drives its price beyond IBM's Displaywriter. By way of comparison, TRS-80 Model II's *maximum* size is only 64 kB while Displaywriter *minimum* memory is 160 kB.

Meanwhile, on the higher end of the WP spectrum are the Wangs. After IBM's Magcard Typewriter and Office System/6 WP systems stumbled, Wang and others grew in the vacuum. Unlike certain EuroAsian nations, rather than restructure secretarial tasks, the American trend was to bring office automation to the secretary's desk. IBM failed to do this; Wang and others did. The others saw the need for multifunctionality (universality), ease of usage, simplicity and eye appeal, and took into account consumer considerations (eye appeal, colors, quietness, etc.). For example, DEC with its DDS-408 Datasystem 408 – ($9,445 less preprogrammed software and $12,545 for a letter quality printer) – is sold in DEC's computer stores (in main cities) and is multi-functional: it does both WP and accounting. By way of comparison, Wang, DEC and others advertise their WP units in the *Wall Street Journal*; Apple and the low-enders, in small businessmen's publications.

Typos corrected

A spelling verification algorithim (not a lookup table) catches typos in 50,000 commonly-used English words; and, if desired, a user may add up to 500 specialized words of his own choosing that are encountered in his line of work. Upon command, Displaywriter checks a string of text for possible typos and highlights them. This feature, found mostly on the larger cluster WP systems, is an added plus that signals future trends in WP equipment and executive terminals for the future. Executives dislike typing at executive terminals. Executives make typing errors, and a typo-correcting feature helps stem executive opposition (not to WP systems, but to executive terminals).

The future

IBM WP units will be integrated into single networks, enabling them to handle electronic mail, interdepartmental communications, accessing data bases etc. This will spur competition, lower prices and even hasten the day of the automated office and increase demand for mass memory storage.

– Paul Snigier

Unlimited Speech Recognition: A Pipe Dream?

Can a computer transcribe speech composed of sentences drawn from a 1,000-word vocabulary and read to it and convert this into printed form? Not yet. But a lab version now exists. In the best accuracy yet obtained under complex experimental conditions IBM has achieved 91% accuracy.

Long road ahead

Dr. Frederick Jelinek, head of the continuous speech recognition group at IBM's Thomas J. Watson Research Center in Yorktown Heights, NY, said continuous speech recognition won't come overnight, but that lab results now indicate *this goal is reasonable.* The ideal voice recognition device will provide, as you speak into a microphone, instantaneously transcribed speech and an immediate verbal editing feature to correct mistakes and make ongoing revisions.

A computer that recognizes continuously spoken speech is a far cry from today's speech-input devices. Devices that sort packages by destination codes or controlling inventory use built-in μPs to respond to a *very small vocabulary enunciated in a very careful way.*

"At IBM Research we are now working on the recognition of continuous speech," noted Dr. Jelinek, "but without the aid of artificial pauses between words or artificial constraints – and with a limited vocabulary. As of this time, ours is the only place in the U.S. and – as far as we know, the world – where speech recognition experiments of such complexity are being attempted."

Experiments are carried out on a System/370 Model 168 in a "quiet room" with high-fi equipment. After a speaker talks into a microphone, there is a period of analysis (it may be quite long). Then the computer recognizes the words, which it displays on a VDT.

The computerized voice analysis methods adapt easily to different speakers. It is accurate and flexible as the speaker or system components change and self-organizing programs remain valid.

– Paul Snigier

IBM Research scientists have used a computer to transcribe ordinary speech, composed of sentences drawn from a 1,000-word vocabulary and read at a normal speaking pace, into printed form with an accuracy of 91%.

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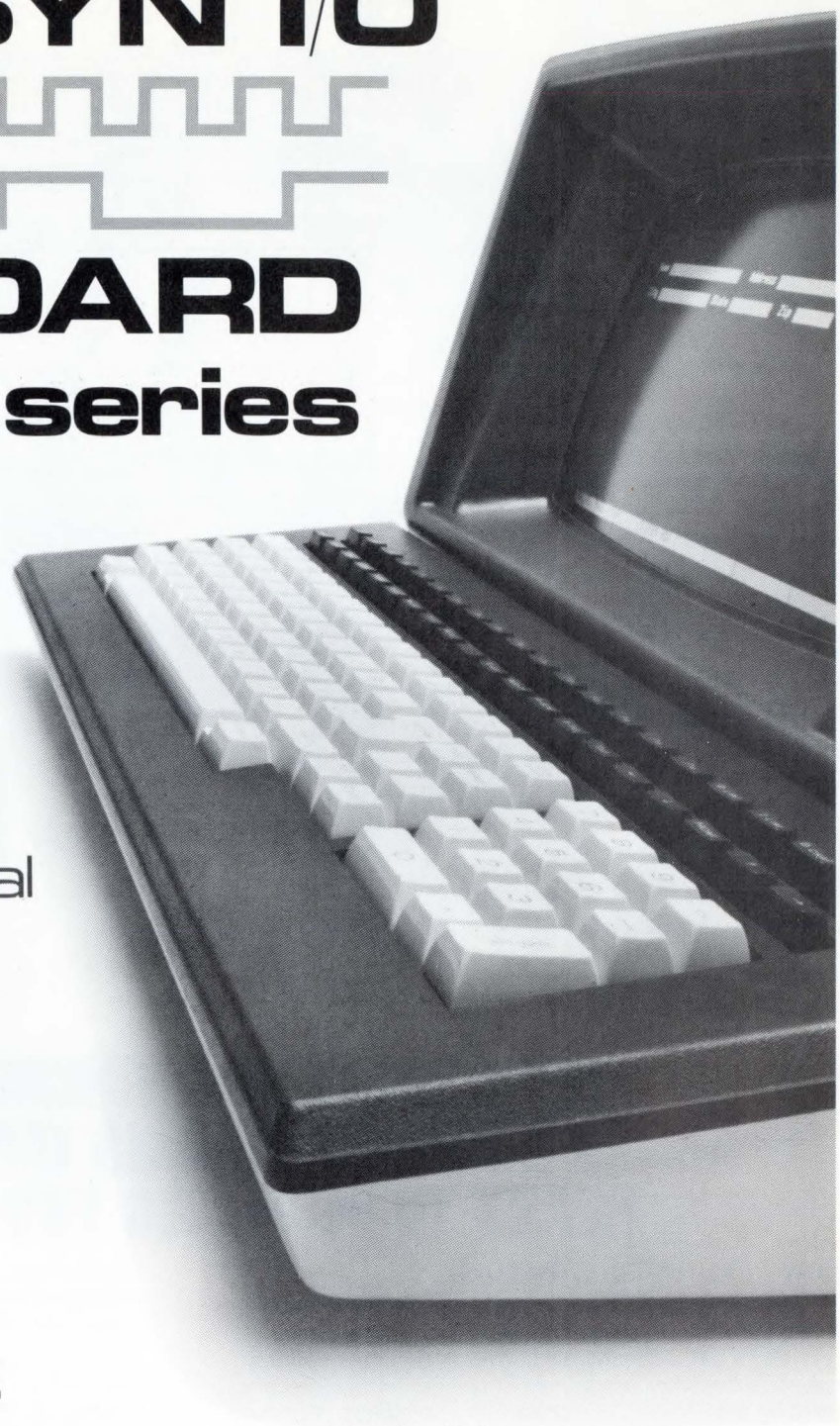

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Physically, the drives together occupy less than 15¾ inches of vertical rack space, and the controllers occupy one LSI-11 or PDP-11 slot each. Functionally, both subsystems are DEC software compatible. A stand alone streaming mode disc-to-tape backup routine is supplied.

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Speakout

Paul Snigier, *Editor*

DEC-Compatible Directory

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Just fill out the form below and mail it to: Directory Editor, *Digital Design,* 1050 Commonwealth Ave, Boston, MA 02215.

Please use one form per product. Photocopy the form as needed. Please include press releases, photos, manuals, literature, articles, etc. Also, tell us who can our editors contact for more information?

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Product Name/Model No. _____

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Computer/Manufacturer (DEC, DG, Interdata, Varian, Intel, etc.) _____

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Add-in/add-on memory (semiconductor boards, core, solid state disk) _____

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Vendor maintenance available?

Field offices _____ Third Party _____ None _____

List specs _____

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Price(s) _____

Company contact (sales) _____

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Innovative Software

Current Trends and Developments

Software Transportability

Data General struck a blow for software transportability by introducing its Eclipse MV/8000 32-bit virtual memory computer. Incorporating an instruction set that is compatible with the 16-bit Eclipse set, the MV/8000 can run 16- and 32-bit programs simultaneously; it even uses both size instructions combined within the same program. The MV/8000's operating system, called AOS/VS (Advanced Operating System/Virtual Storage) can run 16-bit programs previously developed under AOS without modification and at faster speeds. This capability helps current Eclipse users who would like to upgrade their systems to 32-bit virtual machines without costly software conversions and delays in running existing production codes. Also with it, programmers can develop software on the MV/8000 to be run on other 16-bit AOS-based Eclipse systems. In addition, AOS/VS offers a broad range of commercial and scientific software in three other 32-bit languages that conform to ANSI standards: AOS/VS FORTRAN 77, AOS/VS PL/I and BASIC. Other compatible software includes ANSI '74 COBOL, RPGII, Data General's Data Base Management System (DG/DBMS), its Transaction Processing Management System (TPMS), its AZ-TEXT word processing software, and its RJE80 (2780/3780) and RCX70 (3270) communcations capabilities. AOS/VS manages up to 128 users each accessing up to 512 megabytes of logical address space.

PASCAL

Onyx Systems announced the availability of UCSD PASCAL operating software for is Model C8001 microcomputer system that consists of two editors, one line-oriented and the other screen-oriented, a compiler for PASCAL programs, a Z80 assembler package provides a powerful set of softfor the 8001's native code and a file handler. The Onyx-UCSD PASCAL ware tools by integrating compiler, assembler, editor, linker and file handler into a single system. According to Onyx president Robert Marsh, "PASCAL availability means advanced program development for our C8001 users. It gives them flexibility that other software can't provide." Onyx licensed the PASCAL software package from Softech Microsystems of San Diego.

Besides microcomputers, PASCAL is being applied to color graphics terminals. Ramtek recently introduced a software package, Pascal Graphic Procedures (GRAPHPRO), written in the licensed version of UCSD PASCAL. In Ramtek's 6000 series colorgraphic computers, the package permits users unsophisticated in graphics to develop comprehensive applications with a minimum of programming. A pamphlet, entitled "Pascal, A Programming Language for Today" is now available from Ramtek.

PASCAL has also shown up recently in a Remex product introduced at NCC '80. This stand-alone configuration of its Data Warehouse intelligent disk system contains an embedded PASCAL Microengine 16-bit single board computer (a Western Digital product) and 64K bytes of memory. The system executes PASCAL instructions and comes with two RS232 serial ports and a dual 8 bit parallel interface port.

APL

Do you love APL? Do you hate the limitations of the time-sharing APL systems? Are you tired of the limited access to your in-house mainframe? If you answered yes to any of the above, you may be ready for a solution offered by Vanguard Systems of San Antonio, TX. This firm now offers its APL/DTC desktop computer which uses a 4MHz Z80 processor, includes two dual-sided double density mini disk drives, a video terminal, an APL character generator, an object code disk and documentation. The system supports a number of optional features, including data communications, raster graphics, two additional minifloppy disk drives, hard copy and A/D conversion for monitoring information available as continuously-variable voltages.

The system uses an enhanced version of Vanguard's APL for Z80-based microcomputers and provides 35K bytes of usable active APL workspace. In addition to standard APL functions, this version includes Boolean, relational, selectional, structural and general functions such as execute and format. Also included are system variables and system functions such as canonical representation, function fix, share offer and share retract. The APL supplies disk-based workspace and copy-object libraries, and supports arrays of up to eight dimensions. The basic APL/DTC configuration:

Arithmetic
+−×÷**| ⌈⌊!

Boolean and Relational
~<≤=≥>≠

Selection and Structural
/\[;]↑↓⍴,

General
∈⍳

Vanguard offers word processing software as an option. Since the microcomputer utilizes a standard CP/M (Digital Research Corp.) operating system, it allows optional languages other than APL, such as BASIC, FORTRAN, COBOL, PASCAL and Z80 assembler. The maker promises 30 to 60 day delivery ARO; it also provides maintenance in major metropolitan areas.

PL/65

Rockwell International has introduced for its AIM 65 μC a high-level system

implementation language with the power and flexibility of assembly language and the structuring potential of a high-level language. Called PL/65, the language achieves its flexibility through an ability to combine its high level features with the efficiency of assembly language when required. High level control statements, such as conditional execution (IF-THEN-ELSE) and conditional looping (FOR-TO-BY), plus simplified block capability, support structured program design. Where the application demands timing or code optimization, PL/65 incorporates assembly language code in line with high level code. The PL/65 compiler which generates R6500 assembly language is contained in two 4K byte ROMs. These devices plug directly into the AIM 65 master module.

Debugging Through Software

Intel has introduced a software package for use in conjunction with its Intellec development systems and ICE-86 in-circuit emulator. Called 8089 real-time breakpoint facility (RFB-89), this software helps designers debug their applications programs for multiprocessor prototypes based on Intel's 8086 microprocessor and 8089 I/O processor.

The software extends ICE-86 capabilities with fourteen commands that allow the user to start and halt 8089 programs, set breakpoints, display memory and register contents, and save program code and symbol table on diskette. Designers can now load 8089 applications programs from their Intellec system into RAM set aside for the 8089 within their prototype system, and halt, examine and modify the programs as required.

RFB-89 offers other advantages. Users can set up to twelve breakpoints, and have the option of displaying memory contents in either assembly or hexadecimal form. Also, since like ICE, RFB-89 accepts symbolic references, it spares the user the trouble of keeping track of addresses and address changes. The ability to execute, halt, examine and modify code provides the basis for systematic and efficient program debugging; it makes RFB-89 a powerful tool for designers. Intel says its RFB-89 works with any Intellec system with a minimum of 64K bytes of RAM, version 3.4 or later of its ISIS-II operating system and version 2.0 or later of ICE-86, RFB-89 is available now. — *Loren Werner*

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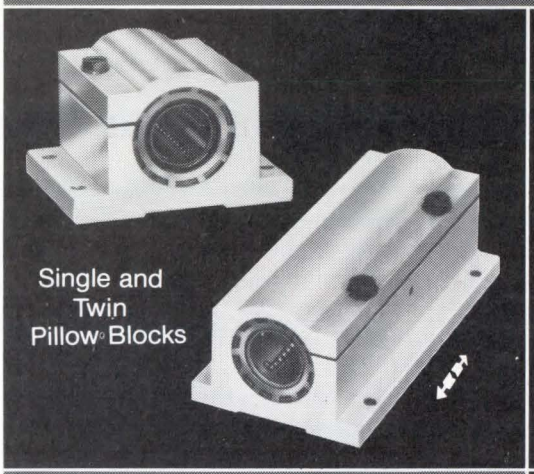

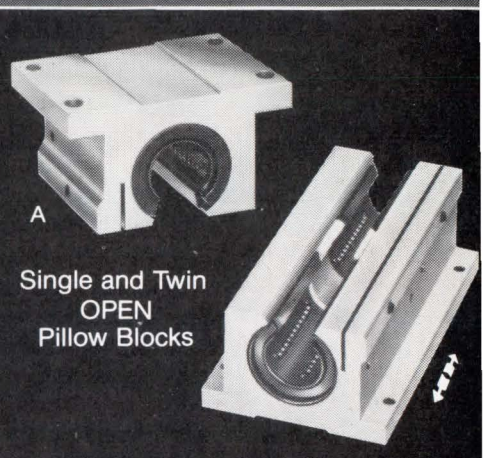

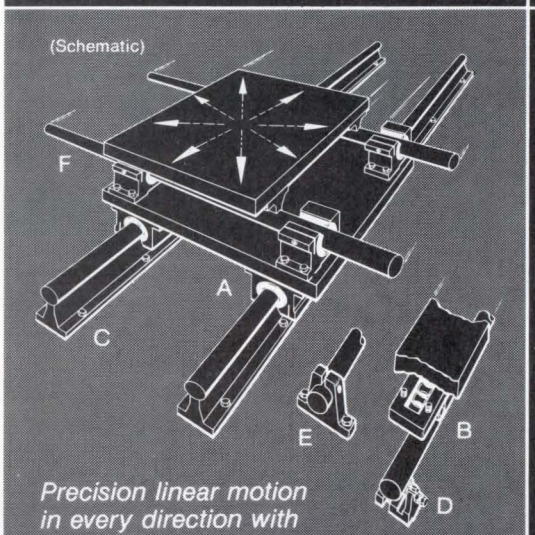

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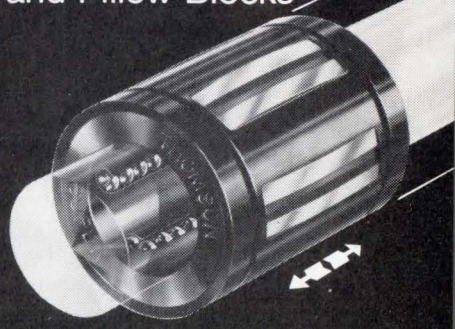

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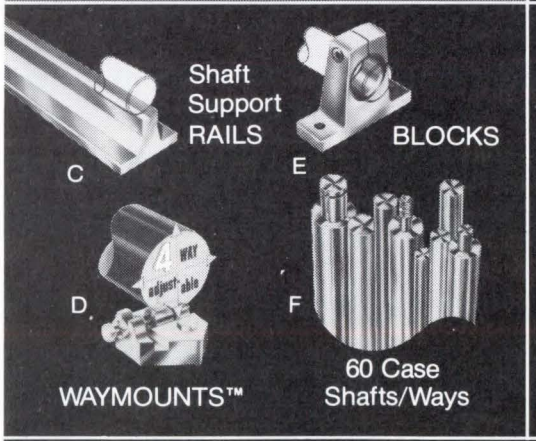

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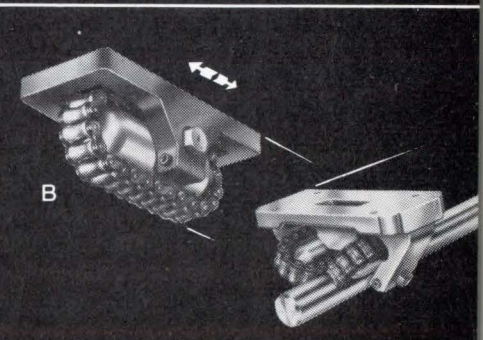

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Plain Talk For Your RSX-11M

Mnemonics are, by definition, abbreviations designed to assist memory. Computer mnemonics, however, are often so complex and incomprehensible that operators feel like foreigners at their own terminals. And no matter how fast an operating system is, it can't make up for an operator who must type with one hand and page through a reference manual with the other.

Digital Command Language (DCL) is a command language with straightforward English commands, such as DELETE, PRINT, and SHOW. Many DEC operating systems, including RT-11, RSX-11M-PLUS, IAS, and VAX/VMS already use DCL, making these systems at least partially compatible with their human interface. A notable exception has been RSX-11M, which uses Monitor Console Routine (MCR), a terse command language with concise mnemonics which are often difficult to remember.

Andrew Rubel and Associates, whose aim is to make computers "easy for people to use," filled this gap with their RSX-11M DCL interpreter, which supports MCR without replacing or interfering with it.

In the past, operators who wanted to compare two blocks of information on their RSX-11M were required to type in:

CMP TI:/BL/FF=A,B

With DCL, the command is:

DIFFERENCES A B

In addition, users need only type enough of the command to make it unique – in this case:

DIF A B

Features of the RSX-11M DCL interpreter include:

- Syntax compatible with VAX/VMS and RSX-11-PLUS DCL
- On-line help for all commands, parameters and qualifiers, plus on-line helpful hints and examples of each command
- Prompts for any mandatory parameters omitted by user **(Fig 1a)**
- Descriptive error messages for syntax errors **(Fig 1b)**

DCL consists of three independent but related software modules, designed through the use of high level utility programs that generated and documented new DCL commands. The three software modules are: a table-driven DCL parser, DCL command action routines, and a FORTRAN callable parsing library **(Fig 2)**.

The **DCL parser** obtains a line of input, matches the command name, and uses a syntax table to divide the rest of the line into *tokens,* which may be command parameters, qualifiers, or qualifier values. Each syntax table describes a single DCL command **(Fig 3a)**. The parser checks syntax of command lines for such things as number of parameters, and validity of keywords, file specs and numeric values. If the parser finds a syntax error, it issues an error diagnostic including the location of the error, and the command action routine is not executed. Parser output is a list of tokens; all keywords and numeric values are decoded, and appropriate values returned with the token list.

DCL command action routines

Fig 1 (a) EXAMPLE OF DCL COMMAND WITH PROMPT

User types:	TYPE MYFILE	. . .User issues the DCL Type Command and a File Specification
or		
User types:	TYPE	. . .User issues the DCL Type Command
DCL prompts:	File(s)?	. . .Computer requests the omitted File Name
User types:	MYFILE	. . .User provides the File Name

Fig 1 (b) EXAMPLE OF DCL ERROR MESSAGE

User types:	PRINT/COPIES=W MYFILE	. . .User requests that W copies of the File MYFILE be printed
Error Message:	%DCL – Invalid INTEGER PRINT/COPIES=W MYFILE	. . .Computer indicates the error, then echoes the line, and points to the error

DCL INTERPRETER IMPLEMENTED IN THREE PARTS

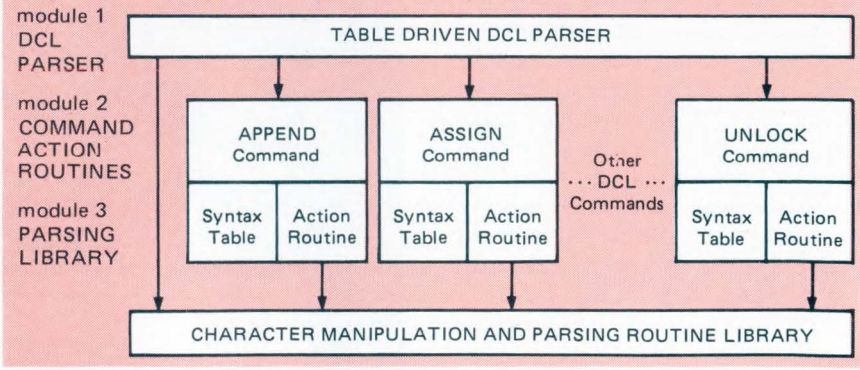

Fig 2 RSC-11M DCL was implemented as three distinct projects: a table-driven DCL parser, a set of DCL command action routines, and a library of general purpose FORTRAN callable routines.

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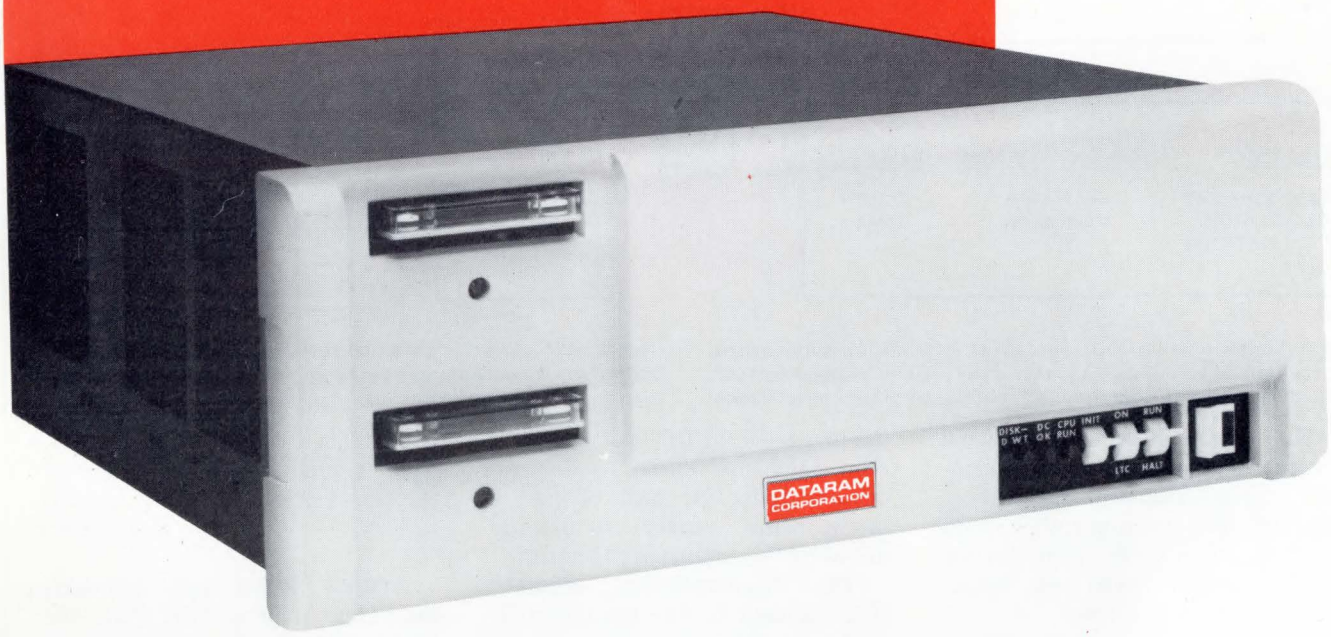

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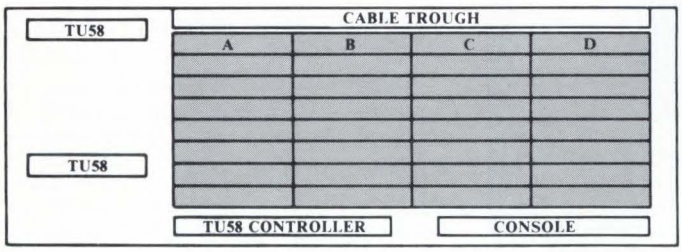

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perform the specific command functions. Each of the forty action routines formats a new command line which is passed to MCR for execution. Routines are greatly simplified, since the parser completes syntax analysis, error detection, keyword look-up, and value decoding before action routines are invoked.

tion of new commands, Rubel and Associates implemented two utilities, called command generator and documentation generator.

The **command generator** allows creation of a new DCL command by typing in two simple tables. Following the formats in **Fig 3a**, these tables describe command parameters, qualifiers, and qualifier values. The command generator **(Fig 3b)** inputs these tables and creates source code for the more comprehensive syntax tables

and an RSX-11M help file.

Rubel says that software resulting from this project, which took him and his associates eight months to design, has other uses in character manipulation and in creating new commands conforming to DCL syntax. Design concepts developed for the project – notably table driven applications and high level utilities automatically producing tables, source programs, and documentation – will receive further application in many areas, especially,

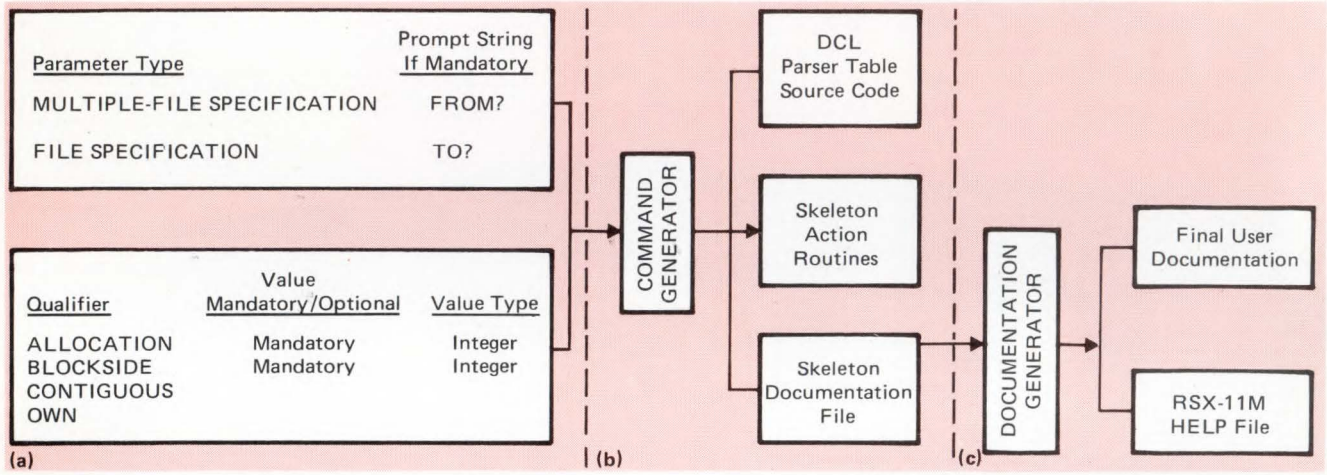


Fig 3 To create a new DCL command, implementor types in the two syntax tables (a) using any text editor. Command generator (b) uses these tables to create the actual DCL command source code (parser table and skeleton action routine) and skeleton documentation file. Documentation generator (c) uses the filled in documentation file to make final user manual and on-line help file.

The **parsing library** is a general purpose library of routines for character manipulation and line parsing. Routines include string and keyword matching, input buffer manipulation, and decoding of integer, real, logical, string, and filespec tokens.

To ease creation and documenta-

used to drive the DCL parser. A skeleton command action routine and documentation file, both of the "fill in the blank" variety, are also produced by the command generator.

The **documentation generator (Fig 3c)** reads the documentation file, producing final user documentation

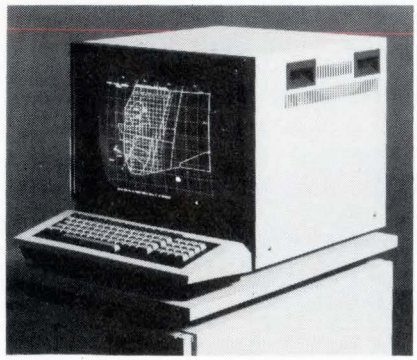
says Rubel, in high performance dynamic graphics. RSX-11M DCL interpreter, $795; additional support, $250/yr. *– Bob Hirshon*

Andrew Rubel and Associates, Inc., One Soldiers Field Park 605, Boston, MA 02163. **Circle 200**

3-D Raster Display Generates High Resolution Color

Seated before a color graphics terminal, the Air Force captain watches a split-screen image of three F-15 fighter planes flying smoothly along at supersonic speeds. He presses a terminal key, and one fighter lurches suddenly to the side, spins out and plummets into a mountainside.

Although this sounds like a test for some new ultimate antiaircraft weapon, it's actually a class for training novice fighter pilots. Through the use of color graphics, trainees sit inside mock fighter plane cockpits and experience the visual sensations of actual flight, while instructors moniter their progress on a display outside. Real life situations, like blown engines or severe cross winds, can be included in the software and punched in by the instructor. After a crash, trainees can watch flight replays to see what went wrong – a luxury unavailable

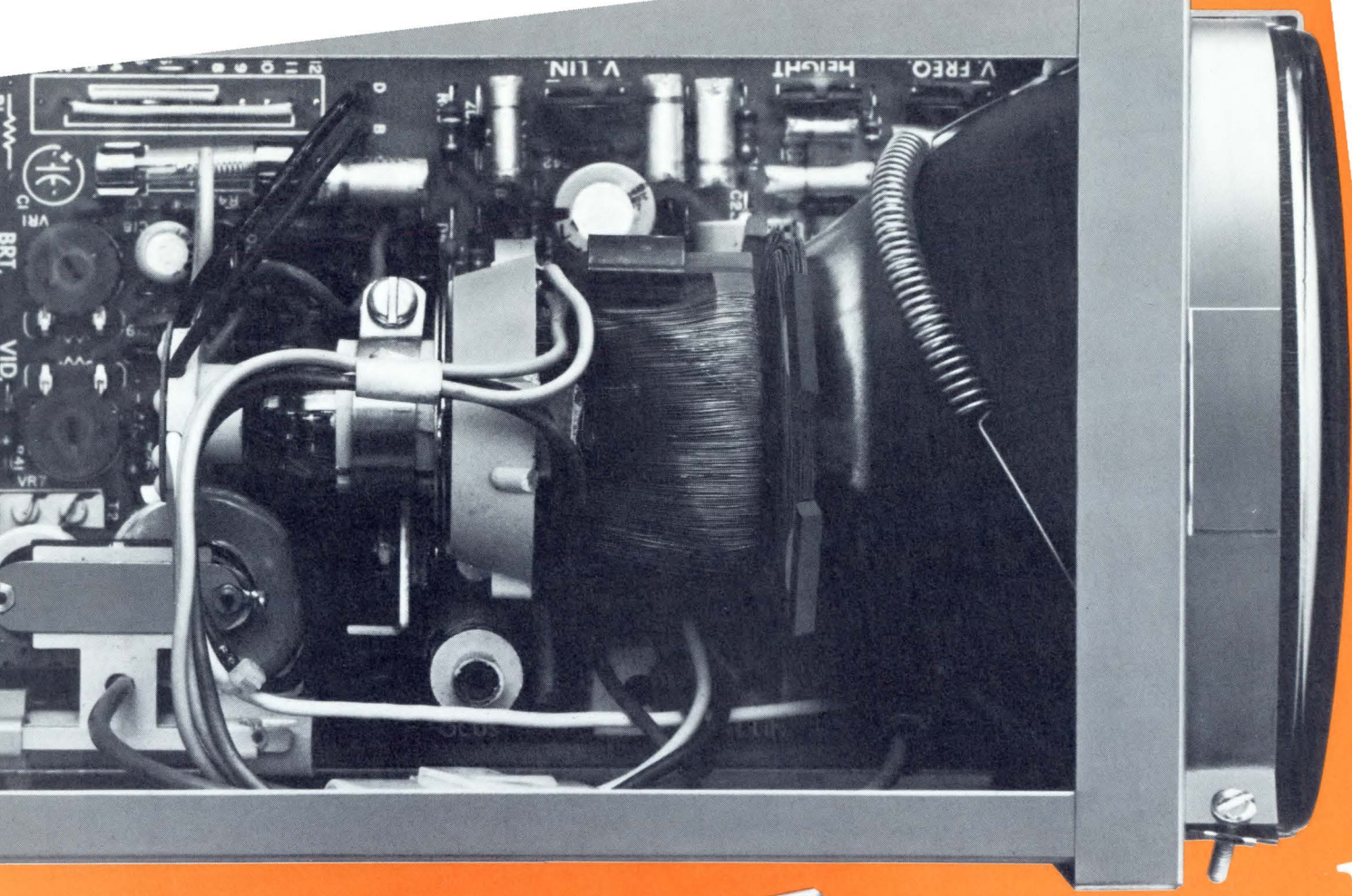


Sanders Associates' Graphic 8 provides 3-D, high resolution and quick update.

to those who train in real planes.

Command and control displays for flight simulator systems, as well as most process control and image processing systems, have thus far been random scan, or stroke refresh, displays. Sanders Associates has just introduced a high resolution raster scan color graphics system, called Graphic 8, that is expected to compete in that market.

Sanders, themselves leading manufacturers of random scan graphics systems, designed the raster scan Graphic 8 to meet needs their stroke refresh systems could not. For example, random scan graphics terminals can display only four colors. Raster scan terminals produce consider-



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ably more; in fact, Graphic 8 can simultaneously display 256 colors. This increased palette vastly extends the quantity of information that can be displayed at any given time. If blink is desired – to signify an emergency condition, for instance – the palette is halved to 128, since one of the eight bit planes of each pixel must be allocated to this function.

Random scan terminals are limited to framework figures – coloring in large areas is time and memory consuming. Graphic 8 features "polygon fill," that allows filling in of any outlined area with any available color.

One of the drawbacks of raster scan displays has been their low resolution. Sanders' Graphic 8 accommodates resolutions of up to 1024^2 pixels, providing detail and clarity comparable to their stroke refresh systems, Sanders claims.

Since raster scan terminals require far more memory than random scan displays, updating the screen rapidly has been another problem. Sanders built a dual memory into the Graphic 8, permitting quick update of complex images by displaying from one memory while simultaneously updating the other.

Before designing the Graphic 8, Sanders Associates conducted a lengthy study to determine what customers wanted in color graphics displays and what was currently available. In implementing customer requests, trade-offs were necessary; some features were incorporated only with great difficulty, while others were abandoned altogether. For example, Graphic 8 accomodates a variety of resolutions and can refresh the image at either 60Hz or 50Hz. Since timing varies under each of these conditions, engineers had to design a phase-lock loop to provide proper synchronization in each format.

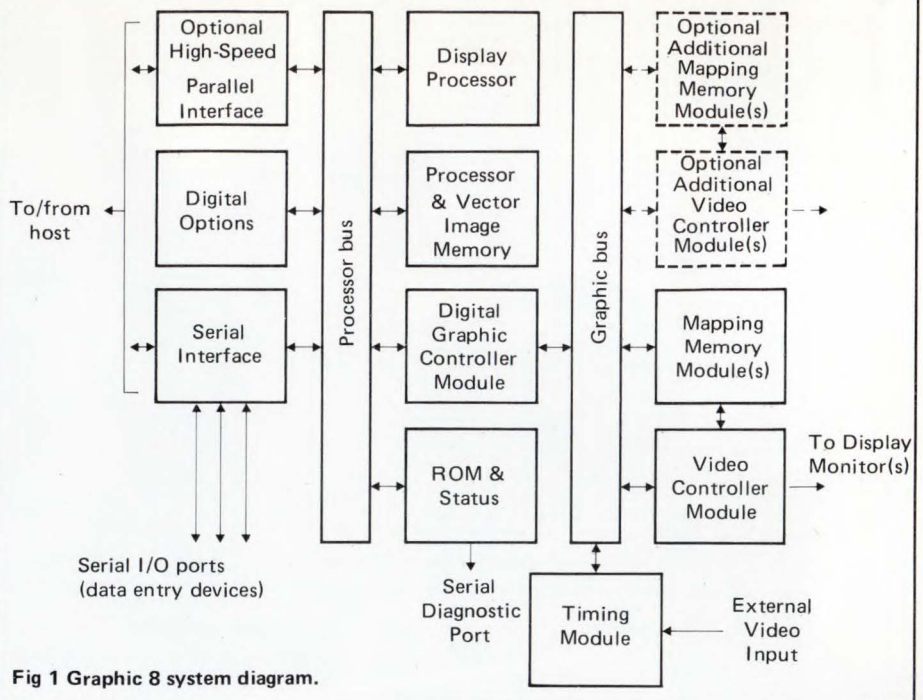

Fig 1 Graphic 8 system diagram.

A unique feature allowing external video input from a camera to be overlaid on the display was incorporated, but only after considerable breadboarding to produce the necessary analog circuitry for high-speed mixing.

Hardware zoom capability was abandoned (software handles the function now), as was a programmable cursor (one fixed cursor is provided). These were compromised to minimize board size which, Sanders maintains, results in a more rugged unit. Even without the deleted functions, designers went to eight layers in the video controller board, using 160 ICs.

Numerous options are available for the Graphic 8, including keyboard, joystick, trackball, data tablet, 3-D capabilities, and hard copy units. A minimal system with monochromatic display monitor, controller, serial interface and keyboard costs $23K in quantities of 20/year. Color display raises the cost to $29K, and a 3-D option boosts that to $36K. Color hard copy, in the form of a Dunn Instruments color camera interfacing directly with the CRT, adds another $17.5K. Production deliveries are slated for the first quarter of 1981.

– Bob Hirshon

Sanders Associates, Inc., Daniel Webster Highway, South, Nashua, NH 03061. **Circle 198**

LSI-11 or 11/23 Number Crunching For Under $4K

Array processor number crunching has always been a costly add-on, well out of the price range of most μC users. SKY Computer's new MNC-11 is a single quad size module floating point array processor that enables your Q-bus processor to do 1D and 2D Fast Fourier Transforms (FFTs), digital filtering, image processing and matrix manipulations like a mainframe, all at μC size and cost. Priced at under $4K (OEM quantities), MNC-11 was developed for users who need floating point processing and powerful instructions to do complex arithmetic, but who can't afford a major investment.

Combining an MNC-11 with an 11-based host μP produces a Micro Vector Processor (MVP) allowing inexpensive numerically intensive computation at MEGAFLOP speeds. MNC-11 shares the host processor's main memory and provides users with micro parallel processing capability. Enough internal MNC memory is provided to allow overlapped input and processing and chaining computations. Most computations involve taking data from main memory, processing it, and returning it to main memory. Therefore, with shared memory once the host initiates a task, it is free to do other computations and housekeeping tasks while the MNC-11 computes an answer and returns it to main memory.

By definition, an array processor (AP) is a specialty computation unit

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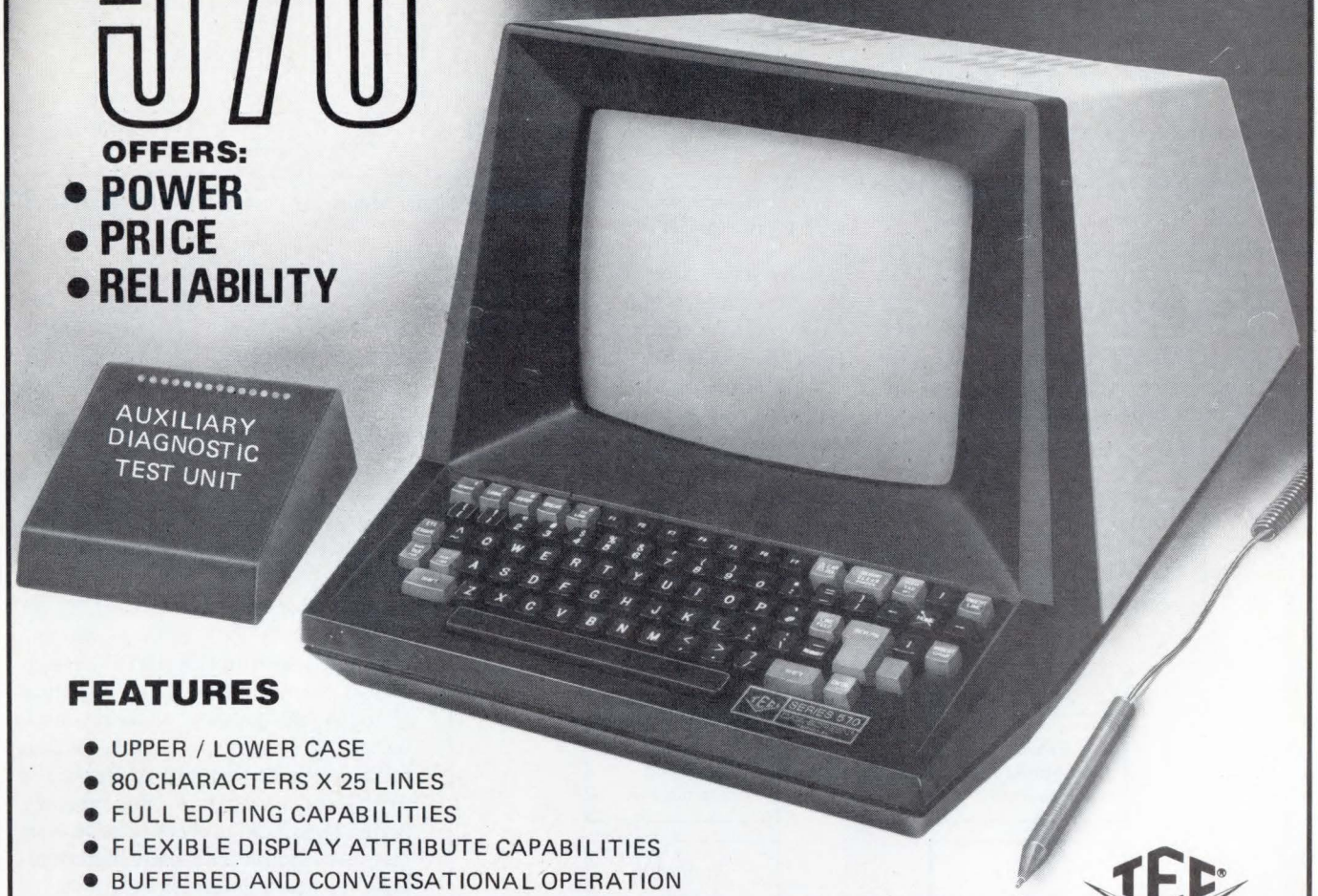

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designed to compute iterative functions quickly and efficiently (see **DD** 7/78). AP architecture is highly efficient at high speed iterative arithmetic operations on large sets of numbers such as vectors and matrices.

The basic design goal of the AP is to supplement arithmetic performance of the general purpose computer. In such a partnership, APs operate as either loosely coupled or tightly coupled co-processors specializing in high-speed arithmetic.

In tightly coupled systems (TCS) the AP attaches directly to the host computer memory. Data is normally transferred directly between the local memory and the host or the arithmetic unit of the AP. Loosely coupled systems (LCS) are attached to the host through either a channel or direct memory access port; LCS have their own internal data memories so a data transfer is required from the host to the LCS internal memory before execution. The LCS must perform as much computation on the data as possible; data may stay in memory for more than one computation.

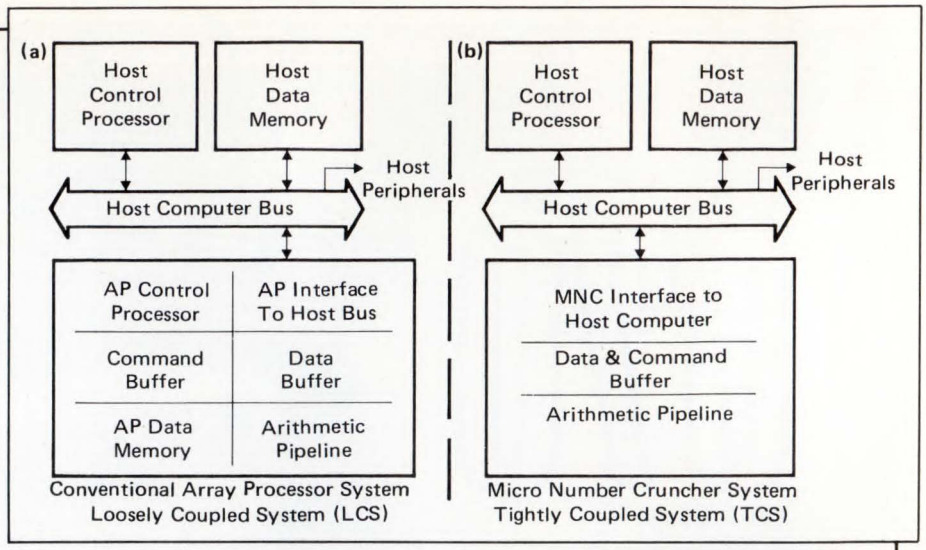

Fig 1 Architecture of array processor systems, comparing Loosely Coupled System (a) with Tightly Coupled System (b).

An AP system can achieve arithmetic performance by either pipelining or paralleling several arithmetic elements. Pipelining is very effective on vector operations because data can be flowed through the pipelines at fixed rates. Parallel systems can be very efficient when the algorithms to be performed can be decomposed to match timing and throughput of parallel elements.

SKY Computer's MNC-11 is an example of a TCS with a pipeline arithmetic section (**Fig 1b**); its design differs from traditional architecture (**Fig 1a**) substantially, allowing elimination of control processors (where tasks duplicate and add to the host's work) and a separate data memory (often larger and more expensive than the host computer's own memory). MNC-11 also eliminates coordination and dual program flows between host and co-processor as well as the need to support separate language, utilities and support software.

MNC architecture, according to SKY President Dr. Gerald N. Shapiro, is intended to be simple for the user and efficient for the host computer. MNC uses the 11/23 or 11/03 existing resource base, minimizing computation overhead and keeping memory expansion costs under user control. As an extension of the 11-based systems instruction set, MNC allows 11/23s to perform basic vector math and compound math such as FFTs and convolutions. Providing MEGAFLOP power, MNC gives an 11/23 or LSI-11 power approaching that of the larger super minis, according to Shapiro. Other features include: built-in diagnostic paths, choice of interrupt

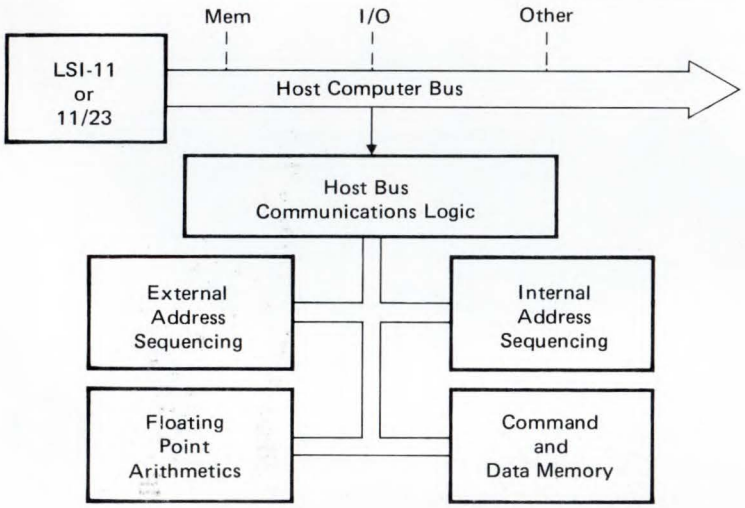

Fig 2 Architecture of the MNC consists of five functional areas: 1) Communications and interface logic which does the programmed I/O, direct memory access and vector interrupts. The normal means of communications between host and MNC is through the Command Block **(Fig 3)**. 2) The external address sequencer (EAS) takes matrix data from memory in a sequence that isolates desired vectors, rows or columns and puts that vector data into local MNC operating memory. Host doesn't need to do data selection and movement; MNC combines data movement with computation. 3) The internal address sequencer (IAS) takes the vector data from local MNC working memory in scalar sequence and inputs the scalar data to the floating point arithmetic unit. Local memory holds up to 64 operands, removing the burden of controlling each individual operation from the host. 4) The arithmetic unit contains a floating point multiply and add pipeline; scalar data is processed through the pipeline and the computed floating point answer is returned to MNC local data memory. Computation inside the pipeline can be either 32-bit single precision or 48-bit extended precision **(Fig 4)**. 5) Data and command memory provides working space for 64 floating point numbers (128 16-bit words) and the capability to manage a backlog of 15 outstanding commands. Thus the host can load up a backlog of words for the MNC, and then go away to do other work. Interrupts can be set to activate the job again when the MNC finishes.

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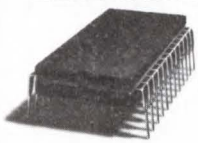

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driven software mode to exploit software coding styles, and construction on Quad-size module which fits into Q-bus backplane.

To allow faster and easier array manipulations, SKY developed Vector Instruction Packets (VIPs). These are microcoded instruction sequences which operate on arrays of floating point numbers. VIPs can replace FORTRAN Do loops, performing simple repetitive operations and allowing users to do what they couldn't before – compute FFTs, do digital filtering and image processing with LSI-11 or 11/23, all in about 1/50 to 1/100 of the μP's standalone time.

Another feature of MNC is a CONTINUE instruction, which SKY claims can significantly reduce the number of instructions required of the host computer when processing long vectors. MNC-11 has the built-in ability to operate on data sets of up to 64 or 32 complex numbers with one VIP. However, for more simple uses – for instance, as a fast vector and matrix manipulator – the ratio of 64 flops to one VIP may not be good enough, tying up most of a slow host's capacity just directing the MNC. In these cases, the one word operand CONTINUE picks up where the last VIP left off, allowing any length vectors to be handled with a minimum of host effort. Software is also simplified, since the various basic function routines have a unique initial VIP specification, but a common sequence of CONTINUE codes after that to complete partitioning of the desired vector length into packets of 64 words.

Multidimension functions showcase the capabilities of the MNC. In such calculations, MNC computes a 32 point complex FFT as the basic building block, using chained computations to minimize memory bus traffic. Moreover, with the VIP's general addressing capability, this 32 point FFT can be taken from data spaced on either dimension. In general, a 2D transform of N complex points times M complex points takes the same time as a 1D transform of N X M complex points. For example, time for a 1D 1024 point complex FFT is the same as time for a 32 X 32 point complex FFT (about 46 ms). Thus MNC allows a small computer system to accomplish what were once considered complicated main frame jobs. SKY provides one module array processors for Q-bus, MULTIbus, VERSAbus and S-100 bus μC users. MNC-11 is the Q-bus version and will be available for shipment by the fourth quarter of this year. – *Bob Hirshon*

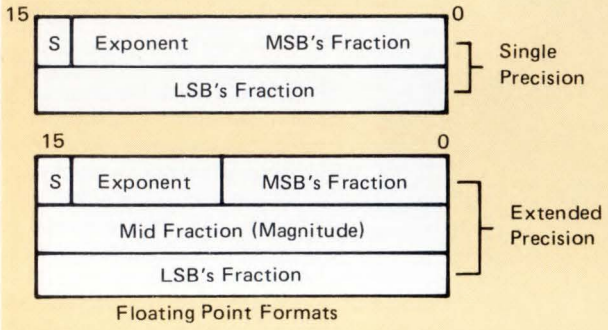

Fig 3 Single and extended precision floating point formats. Extended precision is three 16-bit words, allowing enough data accuracy for running sums, as in inner products, without unnecessary overkill.

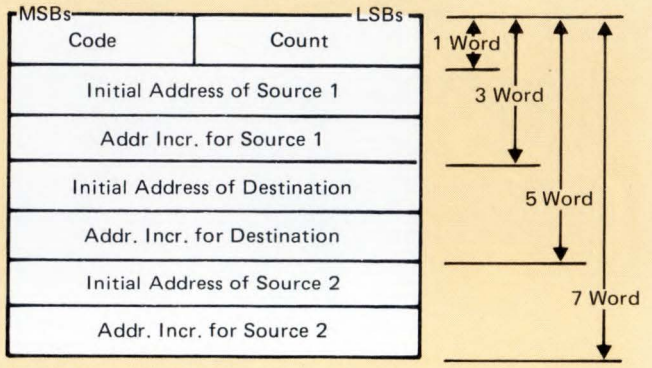

Fig 4 Command block contains up to seven 16-bit words telling MNC Op code and number of words, operand starting address, and step size between real/complex numbers of operand vectors.

SKY Computers, 3 Kennedy Dr, PO Box 1006, North Chelmsford, MA, 01863 **Circle 197**

Drive Designs Make Life Easier For Floppies

In the endless quest for higher density, floppy disk drives face an uphill struggle. Unlike Winchesters, that lead sheltered lives, floppy disks must cope with life's hard knocks. And as more and more information is packed onto the floppy, the effects of those hard knocks are compounded, resulting in higher data error rates.

To insure that floppy disks live longer and, most importantly, more productive lives, DataMaster recently incorporated two new design concepts into their Megamaster floppy drives. The first involves disk centering. Currently, floppies are centered by a plastic cone that pushes the diskette into a centered position. The force of the cone's inclined edge on the floppy is in the direction of the diskette's least rigidity. This results in deformation that may, in time, cause permanent damage leading to eccentric rotation and, consequently, more errors.

DataMaster's centering technique (**Fig** 1) uses a horizontal force applied along the diskette's line of greatest rigidity. This force is applied by a pin that revolves in a circle equal in diameter to the diskette hole. Retracted into the spindle hub, this spring-loaded centering pin remains out of the way most of the time. However, inserting the diskette into the drive triggers a switch starting the drive motor, which turns the spindle hub – when the spindle hub moves relative to an inertial pin release wheel, the centering pin is released. This pin revolves within the diskette hole once, centering the disk perfectly. An electronic timer reads floppy disk index pulses, thereby determining when one revolution is complete; then a metal clamp moves down, simultaneously locking

Innovative Design

the diskette in place and resetting the pin in the inertial disk. The result, according to DataMaster, is a fourfold increase in disk-centering accuracy.

Dual-sided floppy disk drives offer higher storage capacities but, unfortunately, higher diskette wear as well. The damage is caused by the arrangement of the read/write heads: misalignment of the diskette relative to these heads may cause between-the-head pinching, resulting in increased wear or even diskette failure.

DataMaster's Megamaster 2 eliminates this problem by driving two floppy disks simultaneously, with two read/write heads sandwiched between them. In this manner, two sides are constantly on line, providing 1MB capacity. Simply swapping the two diskettes brings a second MB on line and, since the diskettes are *swapped* and not flipped, they are completely compatible with conventional dual-sided drives. *– Bob Hirshon*

DataMaster, 389 N Carmen Dr, Camarillo, CA 93010. **Circle 199**

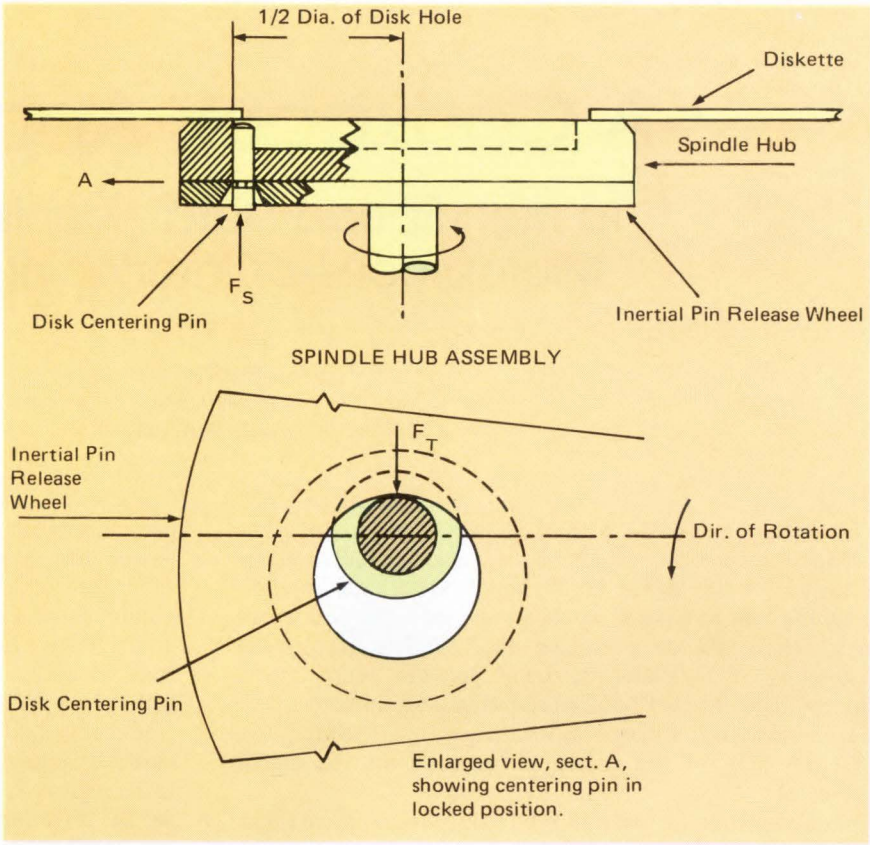

Fig 1 The centering device consists of a spring-loaded pin added to the usual disk hub. Beneath the hub, a spring-loaded metal plate, called the inertial disk, holds the pin in place, until it is released by the inertial action of the disk drive mechanism.

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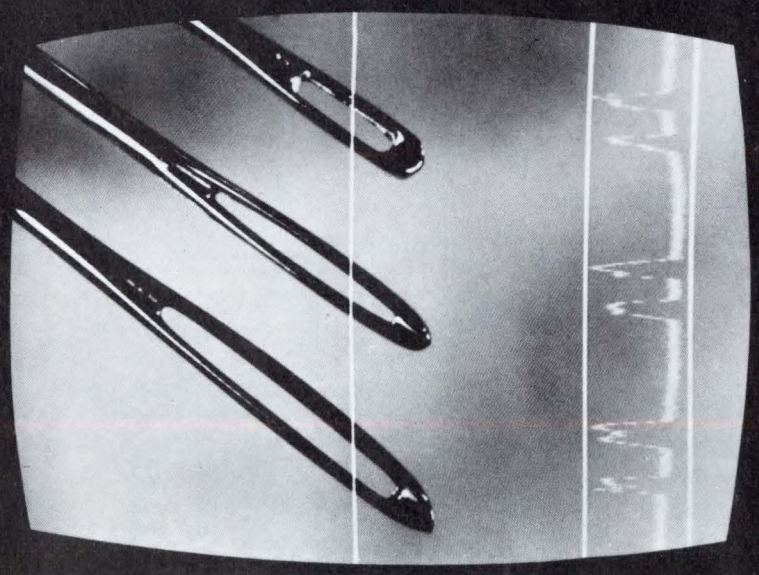

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A Cookbook Approach

To High-Speed Data Acquisition and Microprocessor Interfacing – Part 1

Ed Sliger
Intersil, Inc.
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The development of LSI and microprocessors (μPs) has helped the growth of digital data processing (DP) become explosive. DP has leaped far beyond its traditional number-crunching computational applications, into the real world where nearly all the processed data consists of physical parameters of an analog nature – pressure, temperature, velocity, light intensity and acceleration, to name but a few. In every instance, a data acquisition system (DAS) requires the conversion of the analog information into its digital equivalent.

Data acquisition systems and the ability to interface them to μP-based systems are thus assuming key roles in the design of many new products. As a result, many engineers, who in the past have had limited experience with analog circuitry, are forced to come to grips with the characteristics of A/D and D/A converters, S&H circuits, multiplexers and differential or operational amplifiers.

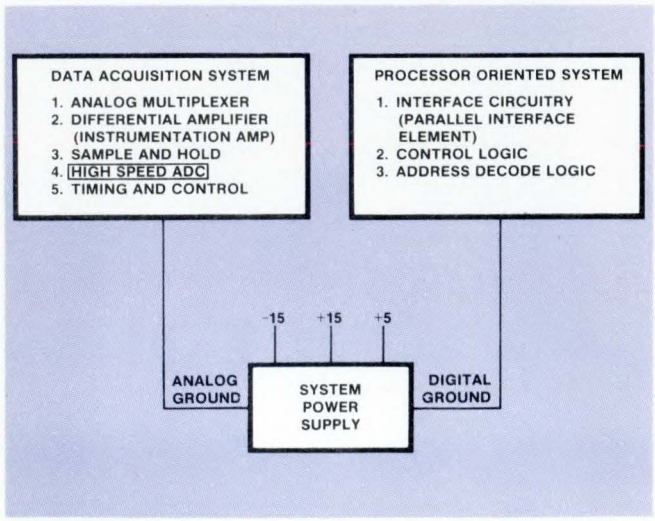
There is nothing mysterious about these components and the ways in which they interface with one another or with a μP. Many of them are also available in LSI form. With a little care and some knowledge of their characteristics, a designer can turn a block diagram incorporating data acquisition system components and a μP into a piece of hardware with relative ease.

The fundamentals

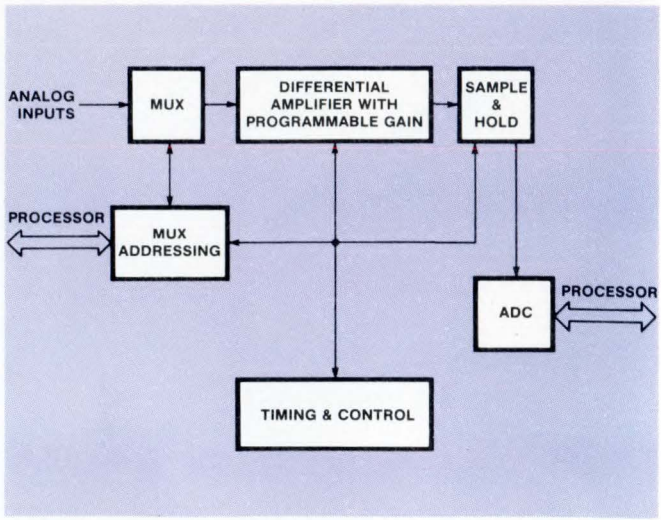
To the right are the basic building blocks which make up typical tada acquisition system (DAS). Starting with the input, an analog multiplexer directs the various channels of analog information to be digitized into the A/D converter. Before reaching the A/D converter, the analog inputs usually require some sort of signal conditioning. The second block in the DAS, the differential amplifier, performs this function, which consists of summing a pair of analog inputs together in a differential fashion – including electrically programmable gain and filtering. The complexity of this block depends largely on the application and the types of inputs to be digitized. Once the input signal has been conditioned for the A/D converter, it must then pass through a sample-and-hold before it reaches the A/D converter input.

The analog A/D converter is the heart of the DAS and its architecture depends solely on the throughput rate required. It uses successive approximation for high-speed data acquisition, or dual slope techniques for greater resolution and accuracy, when speed is not an important consideration. The last block, the timing and control section, determines the order in which the events take place.

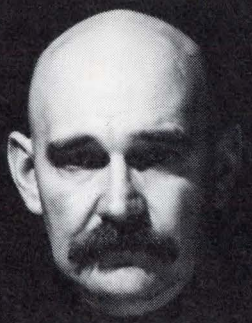
The successive approximation technique of A/D conversion is by far the most popular for microprocessor-compatible converters of relatively high speed and accuracy. It can convert data at speeds as fast as two μs at 12-bits resolution. But the nature of this technique requires that the analog input signal remain constant during the entire conversion process. For this reason, the device needs a S&H amplifier block to buffer the successive-approximation A/D converter in the DAS.



Data acquisition system consists of these basic building blocks.



Block diagram of a high-speed data acquisition system.



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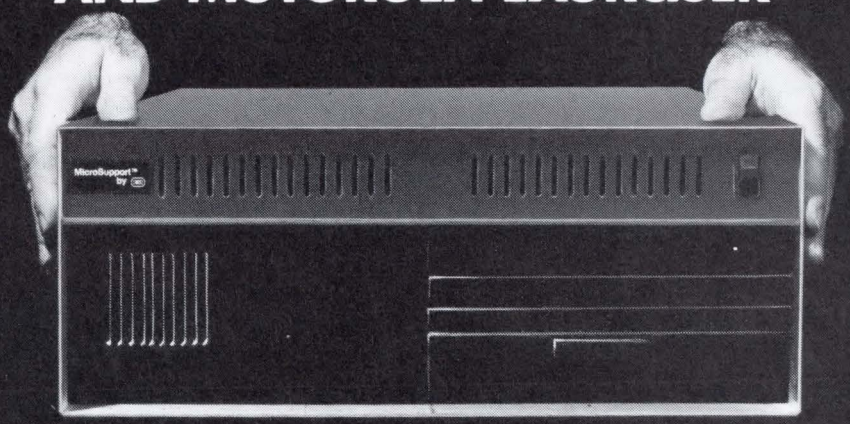

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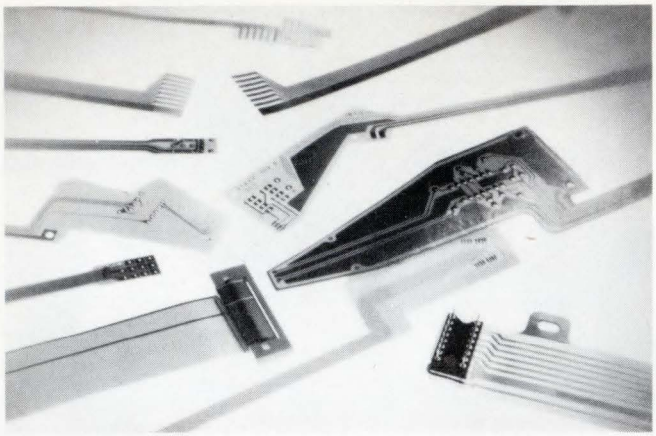

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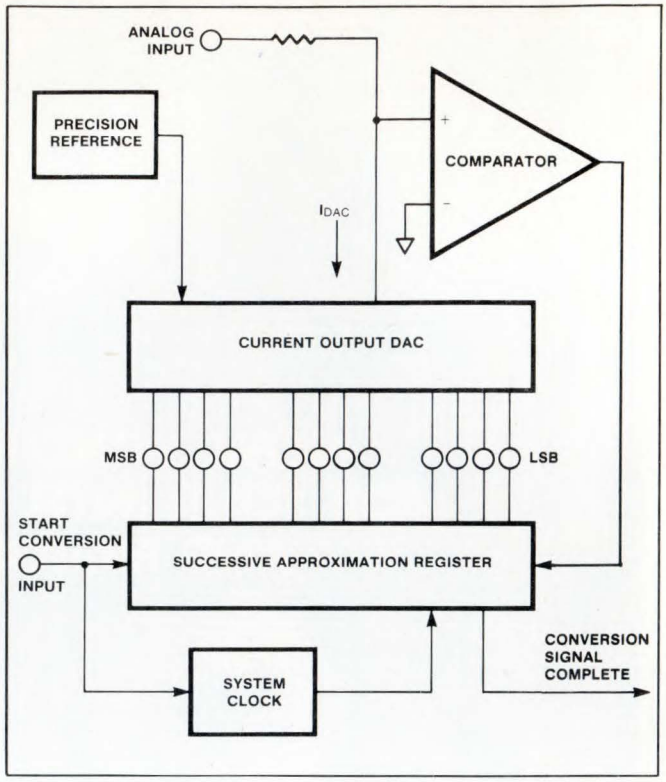
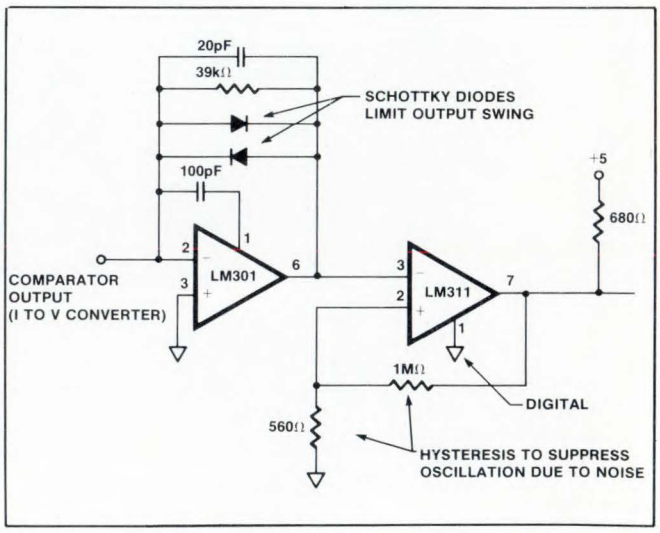


Block diagram of a 12-bit successive approximation analog-to-digit converter.

Successive approximation ADC operation

Above is the block diagram of the successive approximation ADC. The basic ADC loop consists of a successive-approximation register (SAR), a current output D/A converter (DAC) and a comparator. To initiate a conversion, the "start conversion" input is pulsed and the conversion sequence begins. The SAR initially sets up a "0" and all "1s" on its outputs, equivalent to half-scale minus a least significant bit (LSB). Under unipolar operation, the initial setting of the SAR-outputs programs the DAC to half-scale minus an LSB and that value of current flows into the DAC. The condition of the input (less than or greater than half scale) determines comparator output polarity. On the



In this low cost, high-speed comparator, the Schottky diodes limit the output swing of the LM301 op amp, and the 560 ohm and 1 Megaohm resistors provide the hysteresis to suppress oscillations due to noise.

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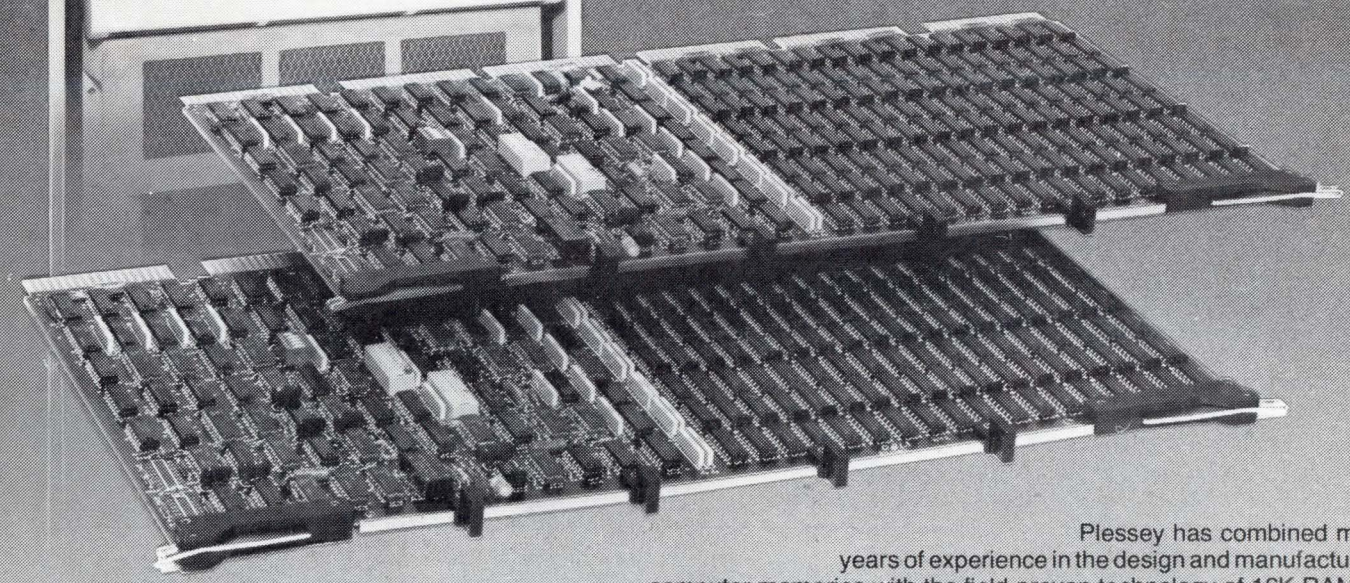

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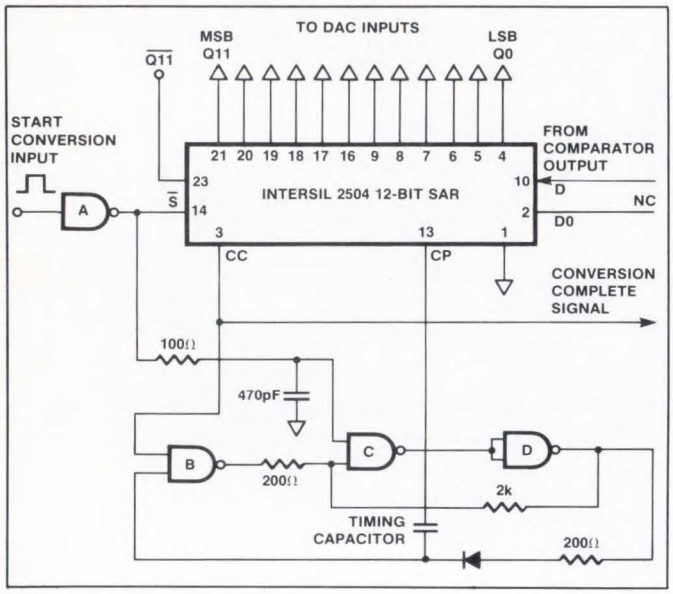
arrival of the first clock pulse from the system clock, the resulting polarity signals the SAR to make a decision on the most sigificant bit (MSB). On the rising edge of the first clock pulse, the SAR programs the MSB to its final value, and at the same time sets the second bit to a logic low. This



Successive approximation logic for a 12-bit A/D converter.

step allows the SAR to make a decision on the second bit and set up for the third bit on the rising edge of the second clock pulse. The process continues in descending order until the operation programs the LSB. At that time, the "conversion complete" signal changes state to signify the end of conversion, with the final digitized input latched at the outputs of the SAR.

Before designing the ADC block, it is necessary to know the accuracy and throughput rate requirements of the DAS. These factors are partly a function of the requirements of the microprocessor-based system with which the DAS must interface. DAS accuracy directly specifies the resolution and accuracy of the ADC. However, the throughput rate only indirectly specifies the speed of the ADC. To calculate this value, subtract the settling times of all the blocks – beginning at the input up to the ADC from the input – from the inverse of the throughput rate of the DAS as a whole. For example, assume that the DAS rate equals 30 kilosamples per second. If the multiplexer, differential amplifier, and sample and hold amplifier have a combined settling time of 8 microseconds, the ADC must convert each signal in 25 μs or less to maintain the 30 kHz throughput rate. It turns out that system design involving 12 bits or less, with conversion times greater than 25 μs, is relatively easy. However, as the conversion time drops below 20 μs, problems increase almost exponentially for many reasons.

Any system is only as fast as its slowest node. One of the slowest points in the DAS loop, the DAC output node, appears at the comparator and the analog input joint. During the conversion, the SAR programs the DAC output current in an attempt to equalize the current flow through the input resistor by the time the conversion ends. While the successive approximation process is taking place, the difference between the two currents (which varies in magnitude throughout the conversion) charges the nodal capacity at some rate to drive the output of the comparator at the proper polarity to signal the SAR. Due to lack of overdrive, the speed problem occurs when this current difference is

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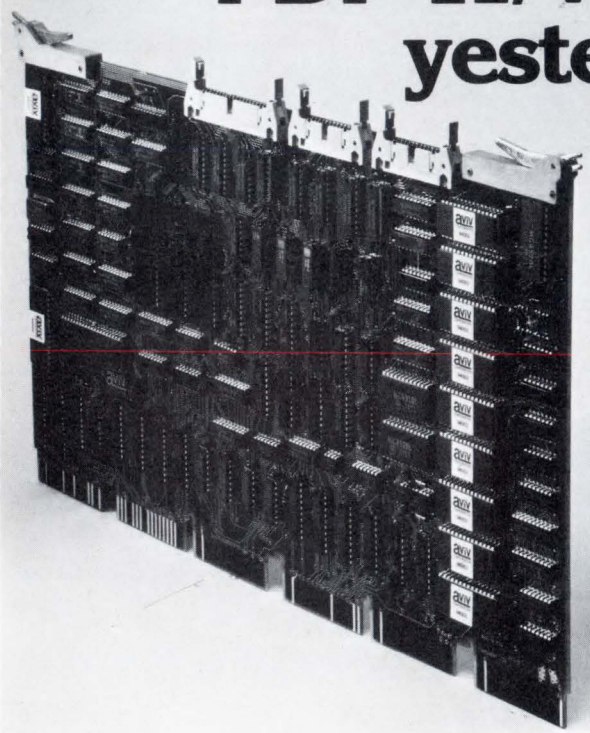

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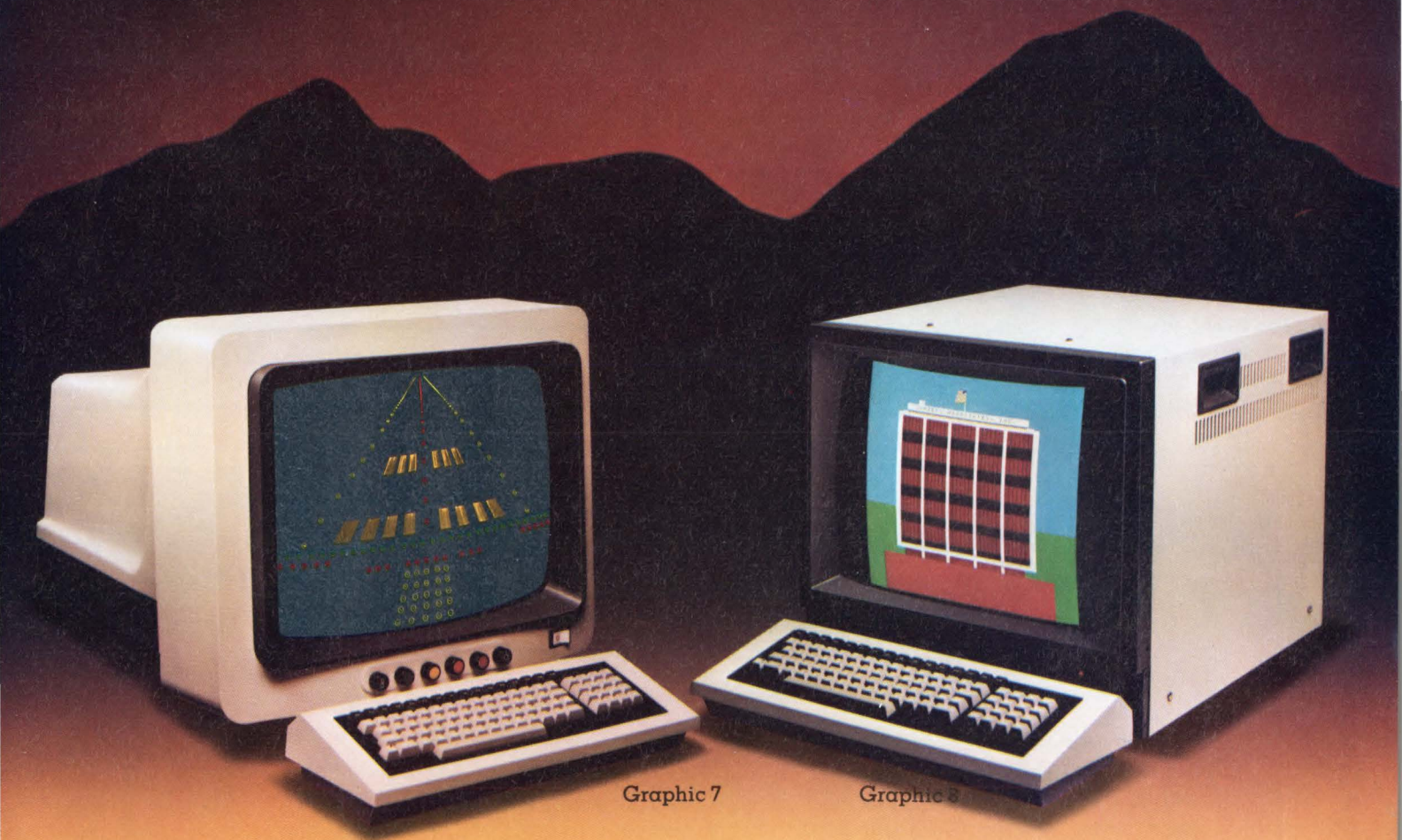

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very small and insufficient time is available before the next clock pulse for the nodal capacitance to charge to a voltage level sufficient to switch the comparator. Inadequate overdrive then results in a conversion error.

A high-speed comparator and a high-current DAC can help eliminate this problem, which is common in below 20-μs converters. One solution to the comparator loop problem uses a very fast, low overdrive device of the LM361-type, which typically switches in 14 ns, and provides a 5-mV overdrive. A second and less costly solution involves a comparator scheme that uses an LM301 op amp in a feed-forward configuration with an LM311 comparator. When combined with a fast settling current output DAC, this circuit provides 12-bit A/D conversion at times as low as 25 μs.

Maintaining overall system accuracy

Since the DAC subsystem block is the element in the entire DAS most responsible for maintaining overall system accuracy, the block must not only be fast settling, but linear, monotonic and stable over its temperature range as well. Again, the type of DAC used depends on the DAS throughput requirements. For less than 25 μs conversion times, an LM361 high-speed comparator with a discrete high current DAC can be used. However, for conversion times slower than 25 μs, the system DAC can be easily implemented using a monolithic current output device of the Intersil ICL 7112-type to provide 12-bit accuracy and resolution. Since on-board monolithic references generally offer very poor temperature stabilities, an external reference device, such as the very widely used temperature-compensated Zener diode must be added, plus an op amp for gain buffering.

Supporting the A/D converter

Two monolithic circuits, the Intersil 2504 successive approximation register and the standard TTL 7400 quad-NAND gate provide all the necessary logic to support a 12-bit A/D converter. NAND gates B, C and D form an oscillator circuit which the SAR, with its signals of start ($\overline{S}$) and conversion complete (CC), control. The start conversion input requires a positive pulse, buffered and inverted by gate A. On the positive transition of this pulse, gate C provides the CP input of the SAR with a positive transition. This change initializes the SAR by setting the CC output (conversion complete) signal to a logic one state and the bit outputs to a condition of zero and all ones; the MSB is equal to zero. The RC delay between the output of gate A and the input of gate C ensures that the $\overline{S}$ input will possess the necessary set-up time before the rising edge of the start conversion pulse clocks the CP input. As soon as the start conversion input pulse returns to a logic low, the conversion begins. Once the conversion process starts, gates B, C, and D provide the SAR with a series of clock pulses at a frequency set by the clock timing capacitor. The hysteresis effect of the 200 and 2K ohm resistors around gates C and D helps to provide a fast clean clock for the CP input.

A serial form of the present conversion is also available at the serial data output (DO). When used with a delayed clock signal as a strobe, this output provides the user with a viable means of transmitting the digitized analog input signal over long distances using only three wires.

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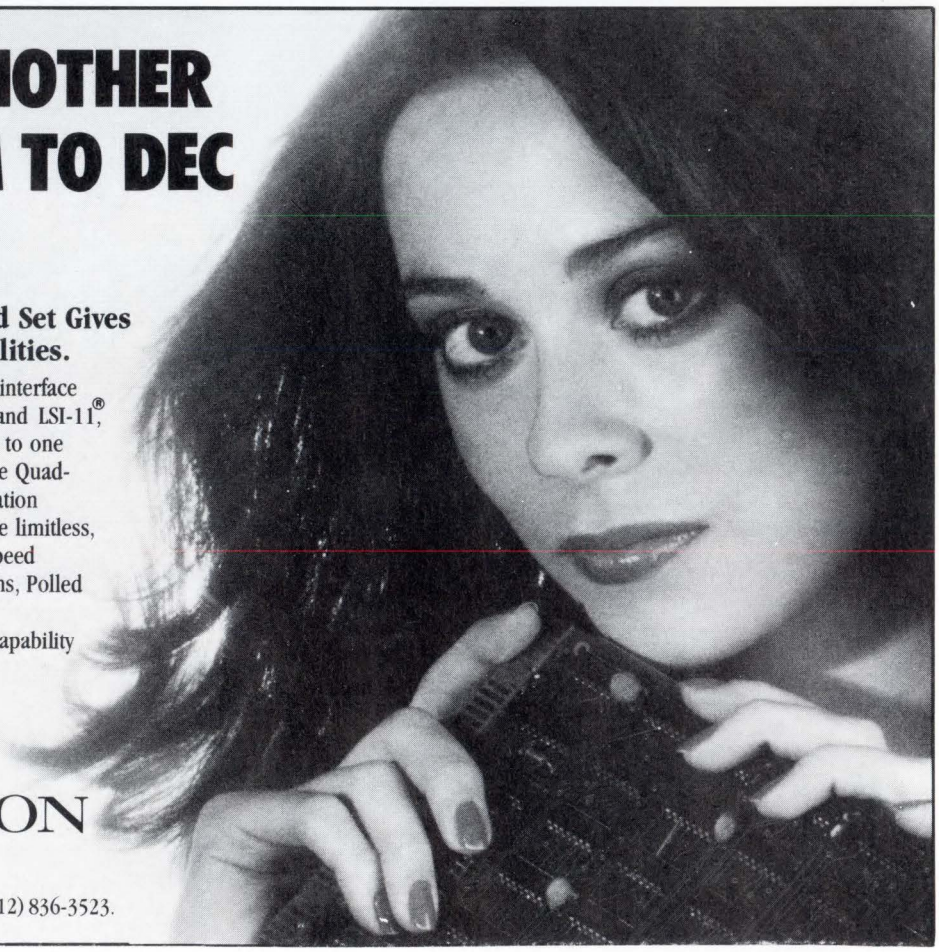

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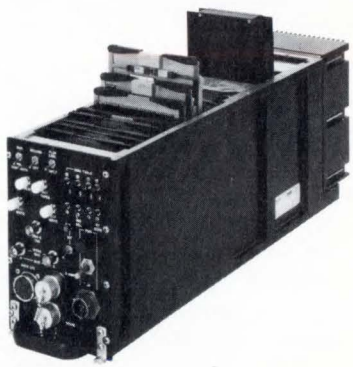

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DEC-Compatible Equipment:
How To Select Vendors

Jack Olson
Wespercorp (Western Peripherals Div.)

In 1970 DEC dropped the first minicomputer "Atom Bomb" of the ever escalating revolution – the PDP-11 – and almost single handedly created a new industry: the independent suppliers of minicomputer peripherals. It was something new and different from the already-established suppliers of IBM and Univac plug compatibles for large main frames. Although those large buck operations were not ones that an entrepreneur with less than $50,000 could hope to penetrate, the burgeoning minicomputer market, on the other hand, was ripe for the small start-up type of business.

In the beginning, DEC was so busy building computers that peripherals were all but ignored. From out of the woodwork came thousands of engineers, salesmen, programmers and university students with an equal number of brilliant ideas to enhance the PDP-11 for solutions to a variety of real and imagined user problems. Of the businesses launched, many were ill-conceived and under capitalized.

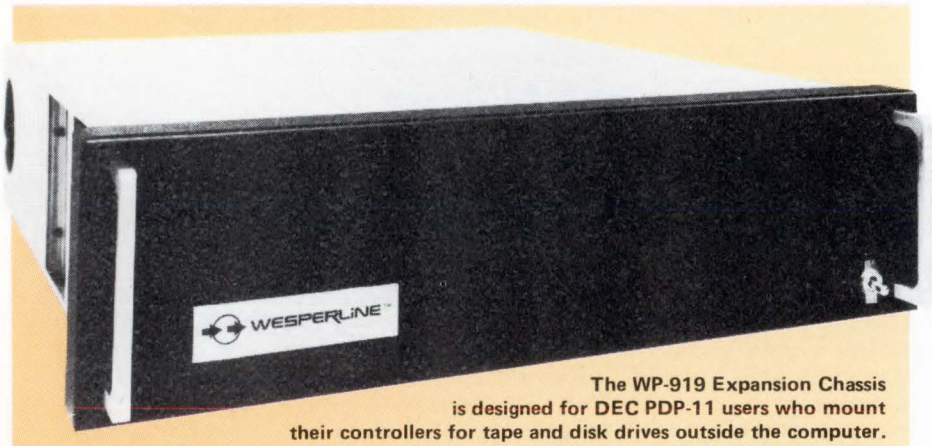
Users were inundated with add-ons. Along with the bargains came the rip offs; and, along with viable suppliers came garage shop operations. Today, virtually any "state-of-the-art" device is being interfaced and offered by someone as an add-on to DEC computers. All this activity spelled confusion.

Vendor selection: a problem

The problem for system integrators and users is one of what is available and where to get it. Proper product and vendor selection is important. How can you make these selections? Here are some ground rules to make a good selection.

Since you will probably spend a lot with the firm you select, be sure they supply you with answers to almost any questions before you decide. Remove the kid gloves and ask some very pointed questions about their product and company. *Insist on answers.* You may not like some of them, but you'll be able to balance the good with the bad and probably head off any unpleasant surprises later on.

Required information falls into two equally-important categories: the product and company. The world's most advanced, best designed peripheral controller is of little use if its vendor lacks facilities or personnel to meet your requirements – or if he's out of business six months after you've committed your system to his product. On the other hand, no matter how capable the company, if its controller won't do the job, your only consolation may be the knowledge that someone will always answer the phone when you call to un-load on him.



The WP-919 Expansion Chassis is designed for DEC PDP-11 users who mount their controllers for tape and disk drives outside the computer.

The product

Before choosing, consider performance, reliability and maintainability. First, will the controller do the basic job function? You are trying to fit the peripheral to the application, not the other way around.

Second, is it software transparent? Notice the key word is "transparent", not compatible. Here, I assume that the preference is for a device that emulates some DEC equivalent, and that the operating system requres no changes to run the device. Compatibility can mean a lot of things. A controller is compatible if it doesn't interfere with the operation of the CPU or other peripheral devices. It can also be "software compatible" if patches are required to the operating system, or even if the DEC device handlers have to be replaced by the controller vendors' drivers. Although this may be an acceptable condition for you, remember that since DEC frequently updates its operating systems, this could obsolete your non-DEC handler. Consider the cost of supporting vendor software as the operating system is upgraded.

Transparency, on the other hand, implies that the peripheral emulation to the DEC equivalent is so close that

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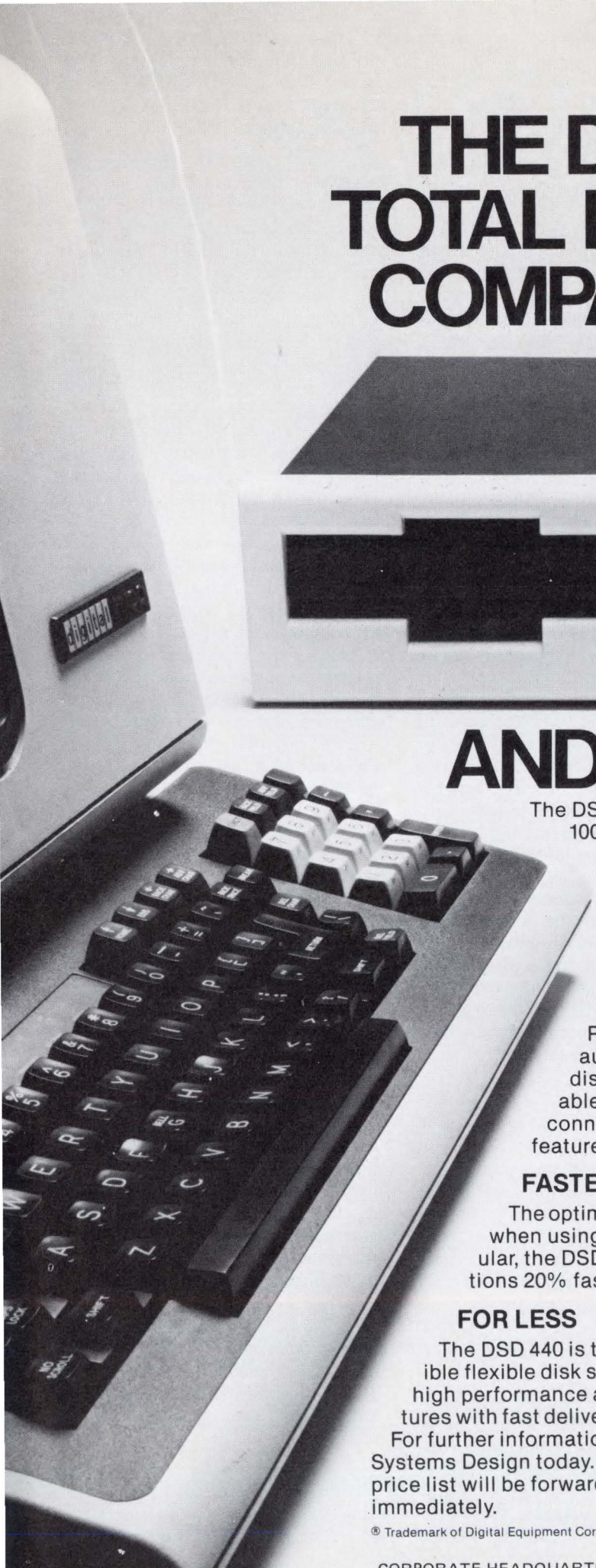

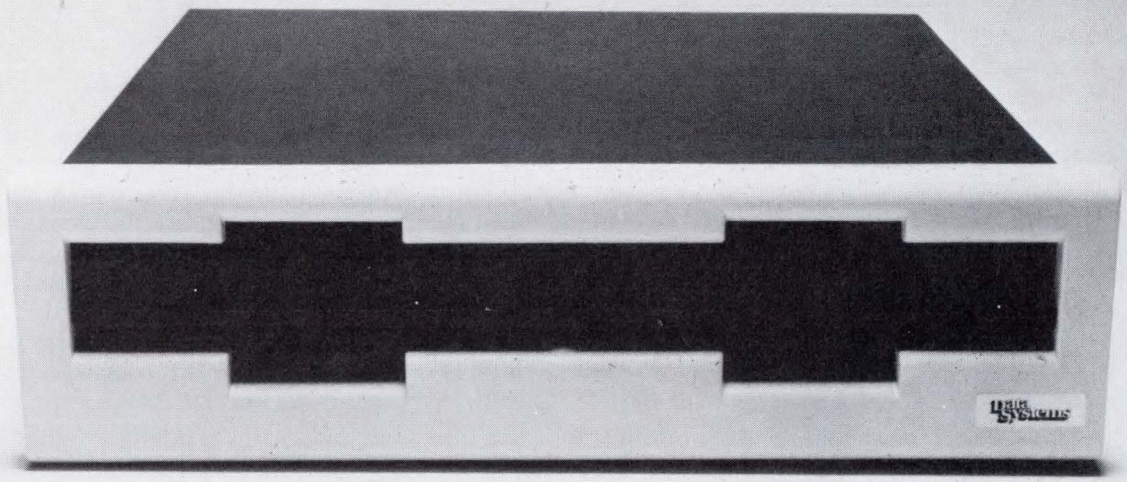

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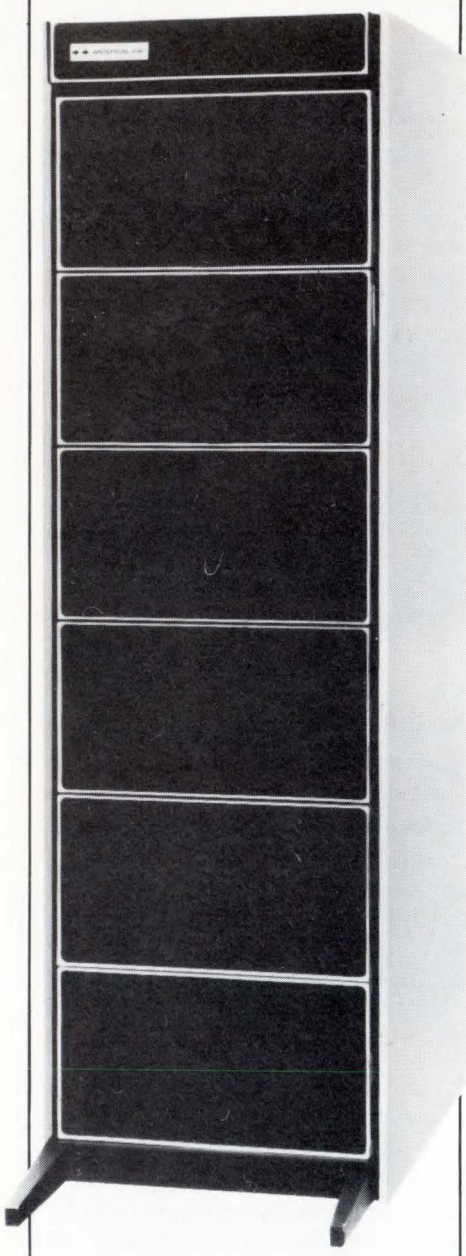


The 973 Cabinet replaces DEC's H960 rack. The appearance is identical to DEC units. But knock-down construction allows shipping in a small package size. Some of its features: AC power control/distribution, cooling fan; filter panels, custom logos, custom colors, fast delivery.

the DEC supplied software is incapable of detecting the difference. As the operating system is updated, the chances of rendering the controller unusable is less as the degree of transparency becomes greater.

Third, if it is a multiple device controller, like disk or tape, does it retain its transparency if you add additional devices? Those controllers that are transparent with a single device connected – but that require software patches if additional devices are used – can be an unfortunate surprise at some later date when you try to expand your system. This is not necessarily a reflection on the controller's quality or performance, since quite often the manufacturer must trade off some capabilities to meet his size or price goal.

Fourth, what are the physical and electrical specs? Determine if it is imbedded or rack mounted, and power required and size.

Fifth, what limitations does the controller have? This includes bus location, data rate, temperature, noise and number or range of devices.

An example of this may be found in μP-based controllers, where the micro's speed combined with the subroutine length may cause certain functions to slow the CPU bus. If this happens occasionally, it has little effect; however, it could happen during a status request. Everytime the controller completes a function, software requests status and the slow-down may become noticeable. Worse, the software may be looping on its own subroutine, continually requesting status to test for a specific occurrence. If the controller micro has to handle the status subroutine, as well as format and output data, time lost could be significant.

Another example is in very high data-rate devices, such as SMD disk controllers, where disk rate may be so high that the controller requires several drive revolutions just to write or read a single track. The resulting data rate slow-down could be a factor of three or four to one. A 1.2-Mbyte data rate 3600-RPM disk is transformed into a 0.3-Mbyte, 900-RPM drive. If you want storage capacity and not high data rate, that's okay. But, what if you are talking real time data?

Sixth, are there any competitive performance benchmarks? If so, look at the results. You won't find unfavorable information, but it may show weaknesses in other candidates' products. Since benchmarks are sometimes tailored to show particular advantages, do not select solely on benchmarks.

Reliability and maintainability

Determine controller reliability. Get MTBFs or failure rate data, and find out how they were derived. As an example, let's assume that there are 8,418 controllers in the field for 30 days or more and that there are eight hours/day, 21.7 days/month (52 weeks x 5 days ÷ 12 months = 21.666), or operation = 1,461,364 hours/month. For February, March and April, 1980, the average controllers per month returned for repair is 104.6. Assume 40% failures are unreported. Thus there are 174.3 failures per month. The total number hours (1,461,364) ÷ Failures (174.3) = 8,384 hours/failure. Note that in this sample of easily derived and usable failure data analysis, the resultant 8384 hours/failure doesn't meet the exact definition of MTBF; however, it gives a workable reference for comparative purposes.

Now, if the vendor has any field installed base, he should have failure rate analysis that is usable for this purpose. Also, find out about in-house quality control procedures, including elevated temperature burn-in or extended time reliability runs.

Next, ask about maintainability. (Murphy's Law states that "All controllers will ultimately fail and require service.")

Determine what kind of service is offered. Do they have their own field service force? Or is it third party service? Or, none? If you're lucky, they have their own field service group with worldwide offices in every major city. Larger companies generally have their own field service organizations (some supplemented by third parties); smaller controller houses may use third parties exclusively with potential pitfalls. You may want to buy some service on a time and material basis only to find that the third party arrangement is for fixed price maintenance contracts. Or, you may find yourself on a low priority that puts you behind anyone having a fixed maintenance agreement. The third party group in your town may not be trained yet. Sure, they will be trained eventually. But that's no help now. If the vendor has his own field service organization or a combination arrangement, you can always get serviced.

Examine documentation

What level of documentation will you get? "Documentation" can mean any-

thing from a basic plug-it-in, turn-it-on instruction list to a detailed package including installation, theory of operation, schematics, logics, flow charts, firmware and diagnostic listings. On one hand, you end up with barely enough information to connect the controller; on the other, information is detailed enough to maintain, field repair and possibly build your own controller. What's the reason? Rarely is it incompetence. It is generally due to shortsightedness or just plain "haven't got around to it yet". Remember, sufficient information about the controller can mean the difference between a maintainable, operating piece of hardware and a very expensive "state-of-the-art" piece of junk. If it doesn't work and the vendor can't (or won't) support it, and there isn't enough information to have your own people do the job, then it makes little difference how advanced the controller architecture is or how sophisticated the firmware or how little power it draws.

Check the manuals for installation instructions, theory of operation (detailed?), schematics, and firmware listings and flow charts. Can the manuals be used by themselves for maintaining and repairing the equipment? Do the manuals get the same kind of sustaining support as the controller, and is information supplied to users as controllers are revised and updated?

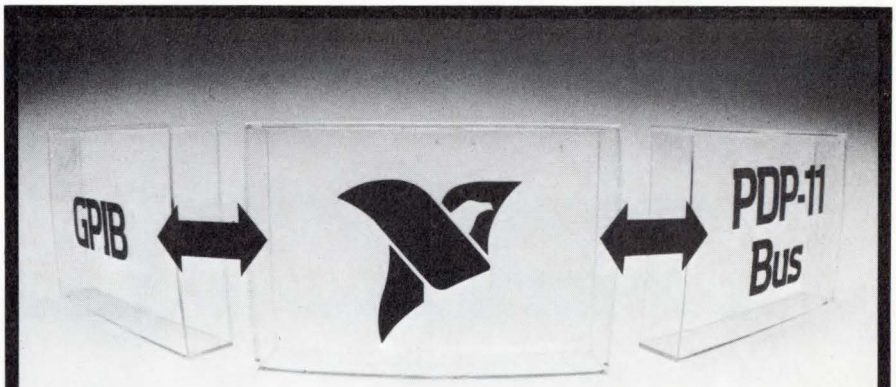
What about the company?

You are developing a long term business relationship; The nature and philosophies of their company operations will indirectly reflect upon your own. Determine their reputation among users and competitors. Ask for customer references. Determine the level of vendor experience in the product line. The answers will indicate how he conducts his business – from his customers' viewpoint.

Determine his financial condition. Insist on at least a brief written financial report on his latest completed quarter, check with his vendors, and get bank references. You don't want to get caught with a vendor who can't supply hardware beacuse he will be on credit-hold with his suppliers and can't correct his problem. Avoid the suppliers that may lose or dissolve their business because they lack staying power. This happens too often with garage shop operations. With new privately-held companies, check the backgrounds of company principals; a past record of failures or a rapid succession of company changes could indicate where the new one is going.

Although we could write a book on the subject of "The Philosophy of Product and Customer Support", a few questions may eliminate the more unpleasant surprises. Envision your system at the end users site in Cape Kennedy getting ready to take data on the next shuttle launch. The tape controller goes down. Your disk system can accumulate some data, but the tape system is required to get it all. A frantic service request to your controller vendor gets a response like: "Send it back to the factory and we will repair it. We don't have anybody to send." Or: "We use XYZ company for our service, but their Florida office hasn't been trained yet." Or, how about: "Return it to us for repair. For a little extra money, we will expedite it with a short turn around."

I'm sure the language you will hear on the phone from this customer at NASA won't differ from a customer in Fargo, North Dakota who is using his system to monitor the milk output of dairy cows. In either case, you're the



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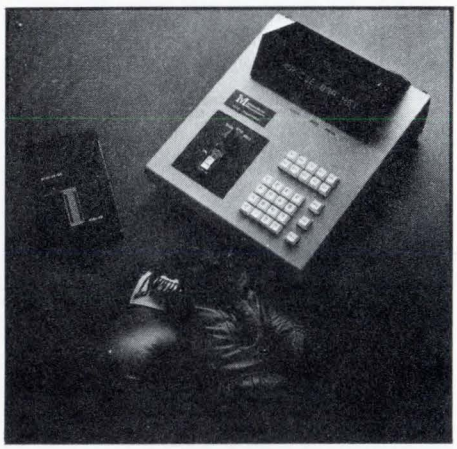

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bad guy, and your firm's reputation will get around. To protect your firm, ask questions now. What is their product support philosophy? Do they have a direct factory field service organization? Do you need a monthly maintenance arrangement to get service from him or his third party? Or is it available on a time and material basis? If you return the controller for repair, must you pay for an expedited return or is it offered as a complementary service? If loan controllers are available, what's the price? What are the warranty terms? Is there a dedicated engineer or engineering group for continuing product support? If a software driver is supplied, does this support extend to it as well?

DEC periodically updates its operating software and continually introduces new CPU models in all its family lines. How do you keep your product from being obsoleted by these software revisions or new CPU models? Through sustaining product support by your supplier and dissemination of update information.

Training is a must

If you assume service responsibility on someone else's product, your people must be trained on that product. Does the vendor offer training at his facility, at yours or at the end user's site? Is the training aimed at servicing or merely installing and operating? It's a good feeling, if you have your own service capability, to know you have a level of independence from your supplier should he not be able to support you.

Check manufacturing rights

Do you plan to use a lot of controllers? Maybe you wanted to design and build your own, but decided to buy a commercially available unit. Serveral manufacturers' arrangements provide controller manufacturing rights. So, even if you have no intention of building, the manufacturing rights may insulate you from a vendor business failure.

After you get answers to these questions, carefully weigh and tailor them for your specific application. You should be able to score each prospective supplier. Then ask the last question: What's the price?

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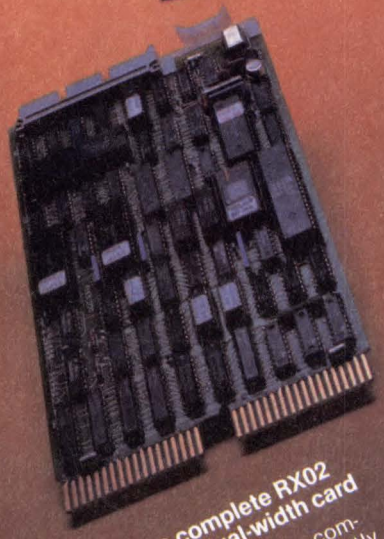
DEC (etc.)-Compatible Directory

We want to publish DEC (etc.)-compatible equipment directories and listings of firms that manufacture/service compatible memory and peripherals for DEC, Data General, Intel, Motorola, IBM, Varian, Interdata and other computers. If your firm manufactures such computer-compatible products, this is an excellent opportunity to be listed in a directory that will reach 65,000 direct (173,000 total) readers — computer system designers and integrators throughout the industry. Our readers are active purchasers and specifiers of such products — more so than any other publication in this field — and they want to hear about *your products.* Interested in helping our readers help you? Then turn to this issue's Speakout on page 21 and fill out our DEC (etc.)-compatible directory questionnaire.

DEC COMPATIBILITY



FLEX 02 offers complete RX02 emulation on one dual-width card

Media compatible and software compatible, the FLEX 02 card plugs directly into your LSI-11, 11/2 or 11/23. This low-priced controller has built-in bootstrap; handles single or dual-head floppy disk drives. Order now for 30-day delivery!

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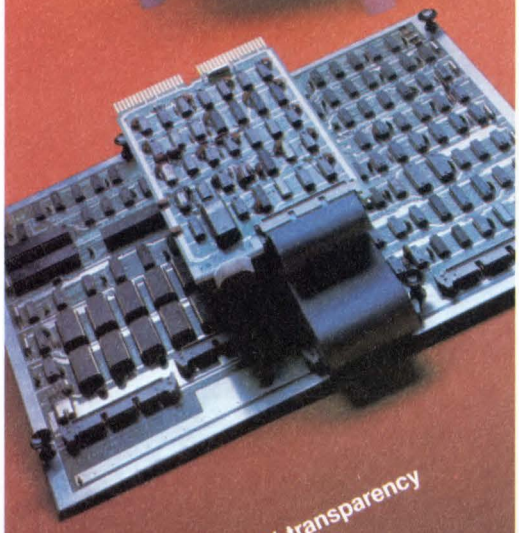

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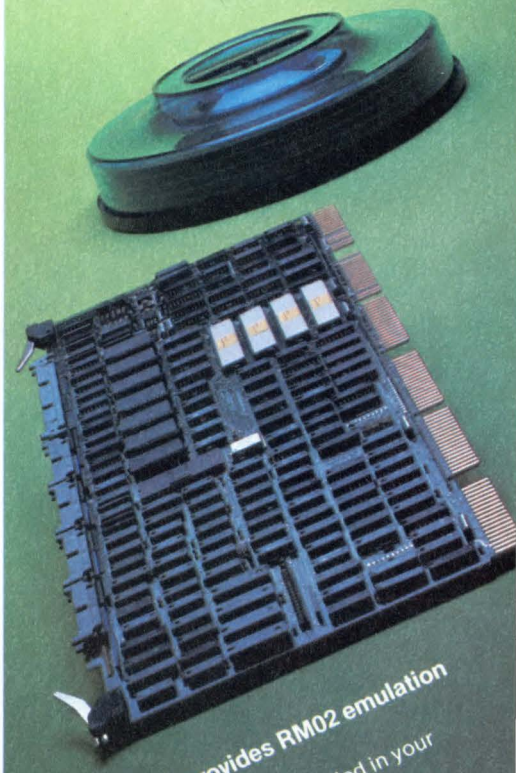

STORM 02 provides RM02 emulation for PDP-11 users

This single hex card, embedded in your PDP-11, runs under standard RM02 drivers. STORM 02 accommodates up to four 80 MB storage module drives and provides disk pack interchangeability with DEC. 30-day delivery and quantity discounts!

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How To Select DEC-Compatible Analog I/O Boards

Paul Severino
Data Translation, Inc.
Natick, MA

Computer users select compatible peripheral hardware from a different vendor for three reasons: (1) the manufacturer does not offer the desired peripheral, (2) high price and (3) long delivery times. DEC's leadership position has prompted several excellent peripheral add-on manufacturers to furnish a variety of DEC-compatible peripherals. Some of these units are needed, but not available from DEC; others outperform the comparable DEC unit. All are generally comparably priced and more readily available. However, if you're going the alternate vendor route, you must look at compatibility from the hardware and software side.

Compatibility: a first look

Compatibility can be described by an exact connector-for-connector replacement which is totally transparent to the system operating software. This enables the user to mix, match or replace peripherals without modifying system operation or requiring a programming change. In other words, full hardware and software compatibility exists.

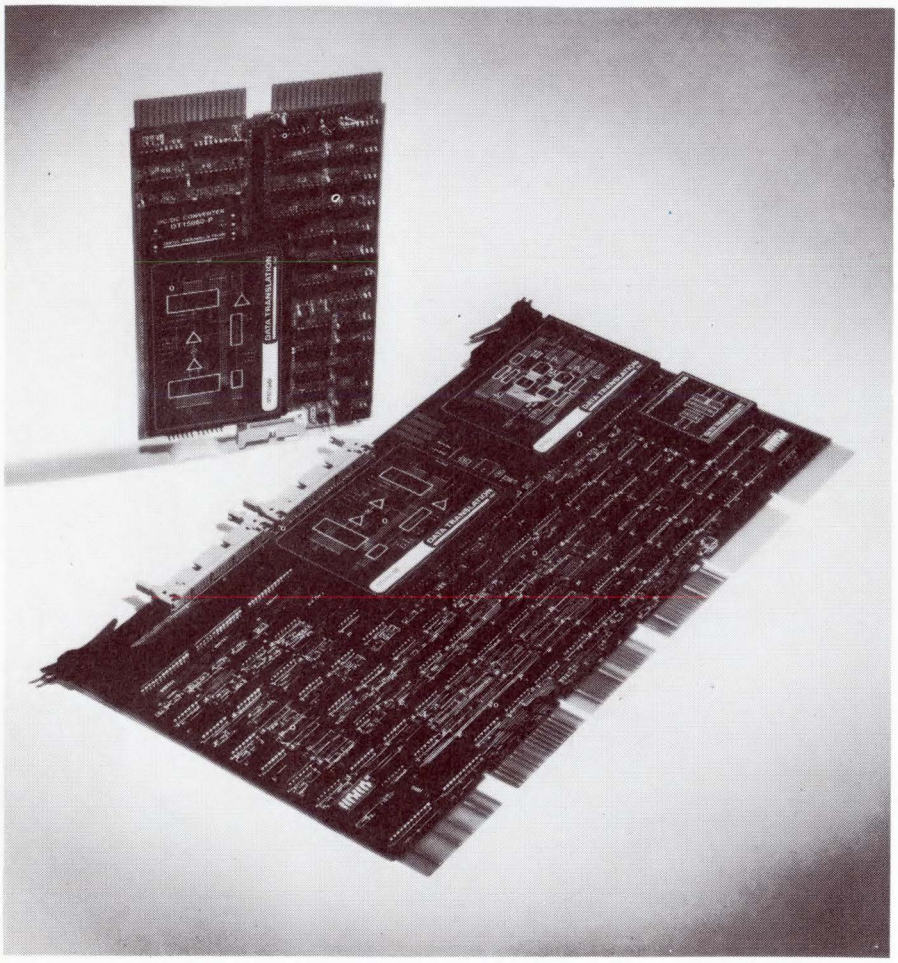

Fig 1 DEC-compatible analog interface board is by non-DEC vendor.

Hardware compatibility = E+M

For two peripherals to be hardware-compatible, they must be electrically and mechanically compatible. The units are electrically compatible when they comply with all bus protocols for both timing and loading, furnish I/O signals for user connections that are equivalent in loading and logic sense, and furnish equivalent analog inputs and outputs relative to impedance levels, resolution and drive capability.

Two mechanically-compatible peripherals will share matching physical dimensions, along with identical I/O user connectors and pin outs. Further, location of adjustment controls will be similarly placed. **Fig 1** illustrates two commercially available DEC-compatible, microcomputer analog interface boards. Here the board having two-edge connectors (a high performance analog input system) fully complies with DEC's "dual-height" format for LSI-11 and LSI-11/23 systems. The board showing six-edge connectors is an analog I/O system in the DEC "hex-height" format for the PDP-11.

Software compatibility

Peripherals configured to reside at the identical device address and to utilize the same interrupt vector address within a given computer system have met two requirements for software compatibility. A third criterion is for interface structure equivalence, in which control, data and/or status bit func-

ANALOG INPUTS	INDUSTRIAL	LABORATORY
# of Inputs	Up to 64	Up to 16
Voltage Ranges	10mV to 10V	5V, 10V Typical
Isolation	±250V Common Mode Voltage	Not Required
Sample Rate	Not Critical/100 Samples/Sec.	50 KHz Typical Up to 200 KHz
Resolution	12 Bits Typical 14 or 16 Bits Optional	12 Bits Typical 14 or 16 Bits Optional
ANALOG OUTPUTS		
# of Outputs	4 to 8 Typical	2 Typical
Voltage Out.	10V	10V
Current Loop Out.	4 to 20mA	Not Required
Point Plotter Control (Z Axis)	Not Required	Yes

Table 1 Typical analog I/O specifications for industrial and laboratory applications.

tions are identical between compared peripherals. Note that, in part, software compatibility relies upon hardware configuration.

Getting specific

With regard to DEC-compatible analog I/O boards, in certain areas, DEC compatibility is readily defined and absolutely required for proper system operation. This is especially true for mass storage peripherals – floppy disks, hard disks and magnetic tape drives – when utilizing DEC-standard RT-11 or RSX-11 software. The user of one of these storage peripherals is usually building a DEC-based system which he would like to run under standard DEC Operating System software. A growing trend finds many users obtaining non-DEC add-ons for these systems at lower cost, with shorter delivery and, often, with performance capabilities not available from DEC-manufactured products. For Operating System software to run unmodified, only 100% DEC-compatibility will do. Thus, the vendor of the floppy disk subsystem, given as an example, must fully comply with all DEC hardware and software standards.

When the user performs data acquisition via an analog input sub-system, a new set of needs can emerge. While still wishing to run on standard DEC Operating System software, the user may find that his required data acquisition performance is not available from a standard DEC product. Key specification differences may focus upon speed, resolution, dynamic range and high voltage isolation capability, to name but a few. Other such capabilities may include software programmable gain and on-card DMA.

The need for these assorted performance capabilities springs from the demands of innumerable real world applications, each imposing its own demands on accuracy, sampling rate, signal characteristics and many other parameters. Fortunately, broad categorization is possible.

DEC-compatible analog I/O boards serve in two basic technical areas: lab/scientific applications and industrial process control systems. **Table 1** lists the performance specs required within the two application areas and illustrates the difference in requirements.

Table 1 emphasizes this contrast by noting that while lab applications typically require high sampling rates – even to the point of using DMA for enhanced throughput capability, process control applications typically address low-speed, low-level measurements within harsh operating environments.

In contrast to the lab, industrial environments typically challenge the analog measurement system with large potentially-damaging electrical noise signals. The measurement system must reject and withstand these interference signals while accurately conditioning the outputs of low level transducers, such as strain gages and thermocouples. This requires effective isolation techniques for high common mode voltage rejection along with low-noise amplifier design.

The need for analog and digital peripherals places an additional product development burden on the mainframe manufacturer (and even more so when the accessory device is analog). User needs for peripherals are, in fact, so diverse that no single manufacturer would conceivably endeavor to fill them.

How DEC supports the LSI-11

One of industry's most popular 16-bit μCs, DEC's LSI-11, is utilized in both lab computer systems and industrial process control systems. Despite this, the depth of DEC-built, analog interface products runs suprisingly shallow. In large part, this is because a digital computer company must broaden its design and manufacturing capabilities to encompass the demands that attend the building of analog products. These demands require the addition of analog expertise at all levels of design, manufacturing and test, in terms of personnel, techniques and equipment.

DEC's analog interface product offering for the LSI-11 Q-BUS consists of the ADV11-A analog input board and the AAV11-A analog output board. Listed in **Table 2**, the specs for these devices impose severe limitations on the user.

A prime example of this is in the area of sampling rates. While the

ADV11-A ANALOG INPUT SYSTEM	
# of Analog Inputs	16 Channels Single Ended
Input Ranges	10.24V (–5.12V to +5.12V)
Resolution	12 Bits
Sample Rate	25KHz Plus Software Overhead
Board Size	Quad Size (8.430 X 10.457)
AAV11-A ANALOG OUTPUT SYSTEM	
# of Analog Inputs	4
Voltage Output Ranges	±2.56V, ±5,12V, ±10.24V 0 to 5.12V, 0 to 10.24V
Drive Capability	±6mA Per Channel
Rise & Settling Time to 0.1%	4μsec
Board Size	Quad Size (8.430 X 10.457)

Table 2 Key parameters for DEC analog boards for LSI-11 systems.

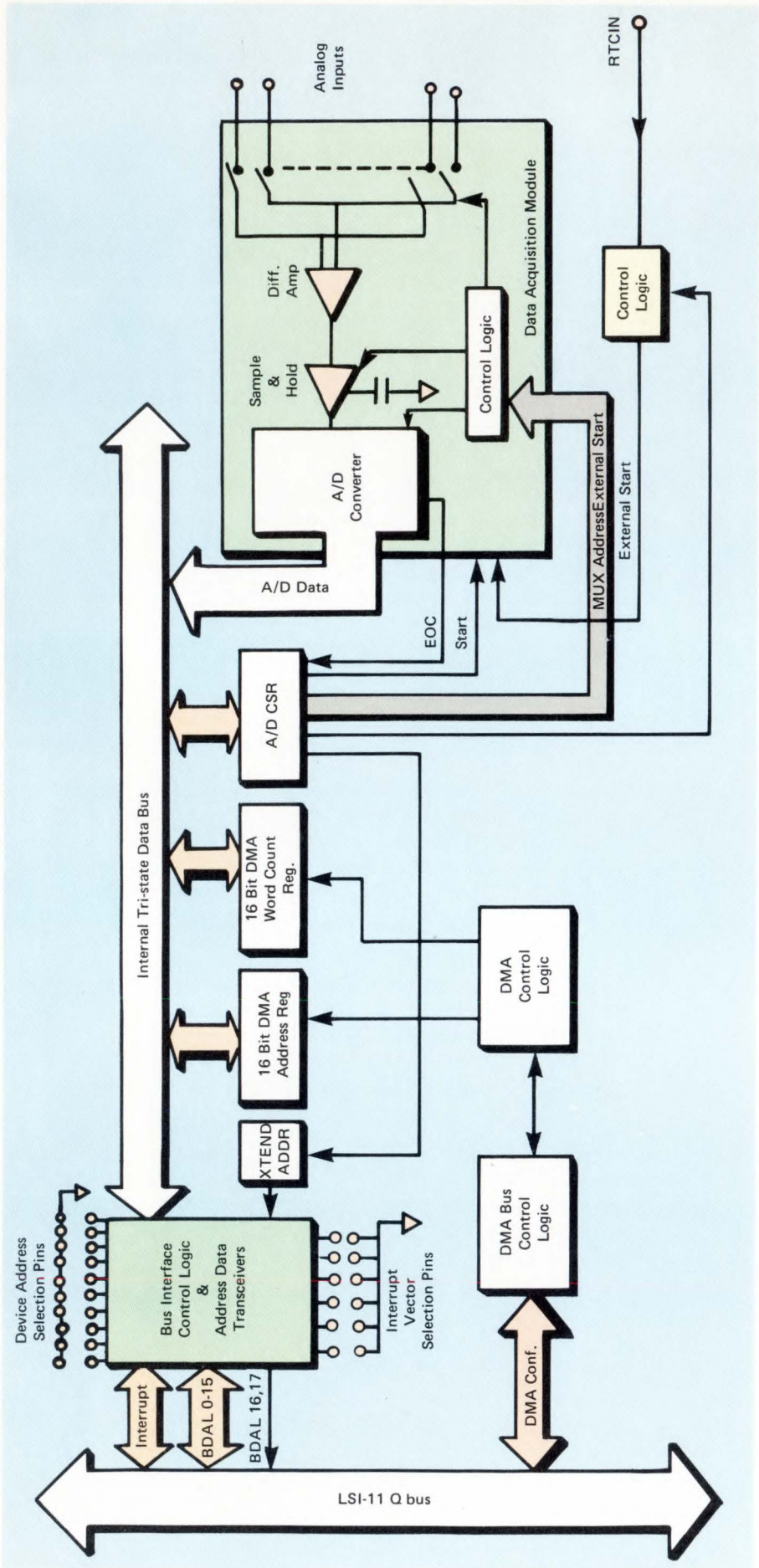

Fig 2 This diagram of enhanced, non-DEC analog subsystem shows A/D control and status register (A/D CSR).

ADV11-A can execute 25,000 samples per second, the device is a programmed I/O interface. This imposes a software penalty on the device-to-memory data transfer, which considerably reduces the effective throughput rate.

This is easily shown by assuming that the software overhead adds say, 20 μS to each sample. The effective sampling rate now decreases to 15,000 per second. From the Nyquist sampling theory, the highest frequency that could be sampled would be a mere 7.5KHz. Generally, the samples are taken at much higher rates than double the sampled-frequency period, so the limitation is very severe indeed.

Compare this to a commercially available, enhanced-performance outside-vendor equivalent system having on-card DMA. The enhanced unit performs device-to-memory data transfers at a 125 kHz rates. This unit performs 12-bit conversions at 125 kHz rate, and is available with 14- and 16-bit A/D converters with proportionately longer conversion times. The resolution and speed options are simply not available from DEC. Further, the enhanced analog input board manufactured by the non-DEC vendor is most favorably priced and is fully Q-BUS compatible.

If anything, the preceding example highlights the fact that we live in an age of specialists, where peripheral manufacturers are carving a niche. They are enhancing the capabilities of existing computer systems and giving users increased functional versatility. But the user must still assure himself that operational compatibility exists.

Key to DEC compatibility

All DEC LSI-11 Series interface boards are built around a control and status register (CSR) format. **Fig 2** illustrates the location interconnection of the CSR in a DEC-compatible DMA-enhanced analog input board. Here, the CSR monitors data conversion status while enabling either internal program or external interrupt commands to initiate channel selection and the onset of conversion. The CSR is formatted so that certain of its functional bits have the specific location in the register in order to achieve a standard interface structure capable of utilizing the LSI-11 instruction set. This minimizes software overhead by enabling efficient software routines to handle peripheral device service request.

Table 3 lists the CSR bit format of the DEC Model ADV11-A analog-to-digital converter (ADC) sub-system, while **Table 4** presents the same infor-

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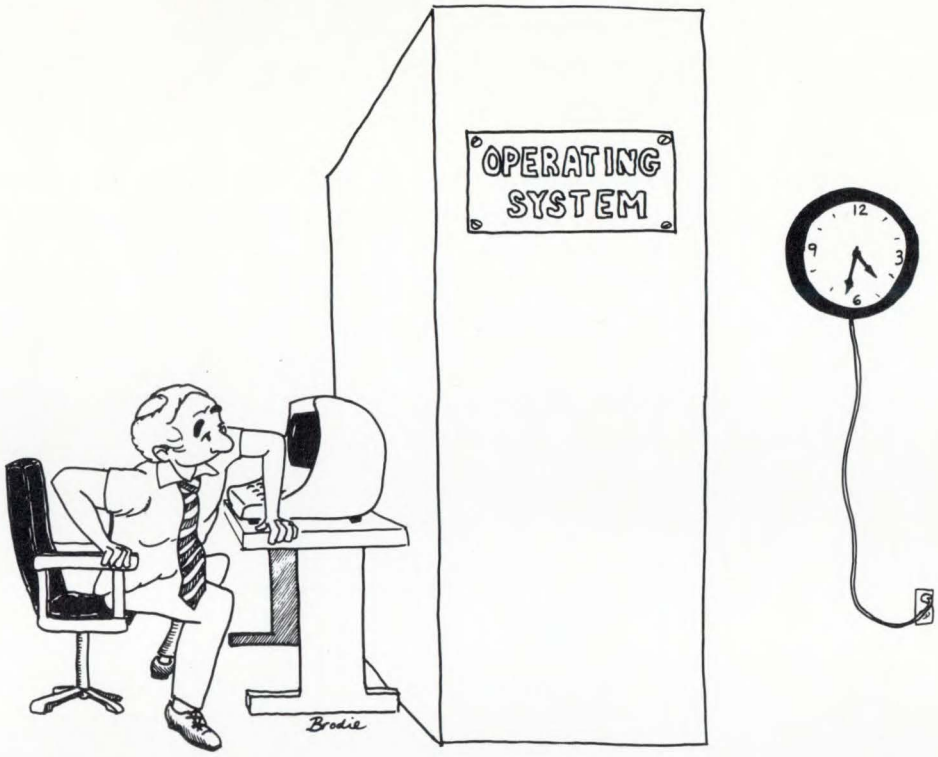

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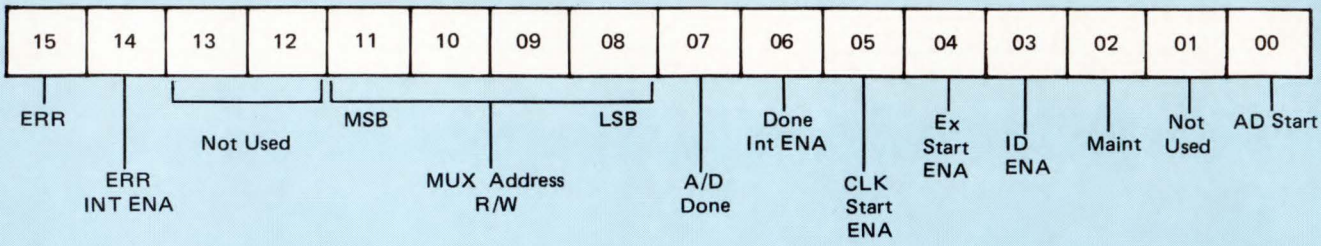

CSR BIT FUNCTIONS

BIT	DESCRIPTION
15	A/D Error (Read/Write) — The A/D Error bit may be programmed or cleared and is cleared by asserting BINIT L. it is set by any of the following conditions: 1. Attempting an external or clock start during the transition interval. 2. Attempting any start during a conversion in progress. 3. Failing to read the result of a previous conversion before the end of the current conversion.
14	Error Interrupt Enable (Read/Write) — When set, enables a program interrupt upon an error condition (A/D Error). Interrupt is generated whenever bits 14 and 15 are set, regardless of which was set first.
13-12	Not used.
11-8	Multiplexer Address (Read/Write) — Contain the number of the current analog input channel being addressed.
7	A/D Done (Read) — Set at the completion of a conversion when the data buffer is updated. Cleared when the data buffer is read and by asserting BINIT L. if enabled, interrupts are requested simultaneously by both 7 and 15; bit 7 has the higher priority.
6	Done Interrupt Enable (Read/Write) — When set, enables a program interrupt at the completion of a conversion (A/D Done). Interrupt is generated when bit 7 and bit 6 are both set, regardless of sequence.
5	Clock Start Enable (Read/Write) — When set, enables conversions to be initiated by an overflow from the clock option.
4	External Start Enable (Read/Write) — When set, enables conversions to be initiated by an external signal or through a Schmitt trigger from the clock option.
3	ID Enable (Read/Write) — When set, causes bit 12 of the data buffer register to be loaded to a 1 at the end of any conversion.
2	Maintenance (Read/Write) — Loads, when set, all bits are of the converted data output equal to multiplexer address LSI (bit-8) at the completion of the next conversion. Cleared by asserting BINIT L. Used for all 0s and all 1s = tests of A/D conversion logic.
1	Not used.
0	A/D Start (Read/Write) — initiates a conversion when set. Cleared at the completion of the conversion by asserting BINIT L.

Table 3 CSR bit format for DEC ADV11-A

mation for the enhanced-performance non-DEC analog input system; the latter unit is the Model DT2782 which is manufactured by Data Translation, Inc.

The expanded capabilities of the DEC-compatible sub-system are evidenced by a comparison between **Tables 3** and **4**. The CSR bit assignments show that the enhanced performance DEC-compatible analog input system is, in fact, a super set of the ADV11-A.

The performance differences between sub-systems demands that other differences exist. However, compatibility suffers little, because along with the addition of a DMA interface, the enhanced performance unit has a CSR which contains many of the ADV11-A CSR bit functions. Those bits which are not contained within the non-DEC system CSR relate to maintenance rather than functional operations. While, for example, maintenance bits and the ID enable bit have been replaced by DMA-related bits in the non-DEC system, the functional operation and compatibility remain unmodified.

DEC system compatibility

DEC systems have been supplied with high level language subroutines to allow the data acquisition functions to be controlled with FORTRAN or BASIC, utilizing calls to the subroutine. For example, an A/D conversion can be accomplished by using a FORTRAN callable subroutine titled IADS. This subroutine will input an A/D sample and store it into a memory location. Thus, if a user is writing a FORTRAN program he can utilize the set of FORTRAN callable subroutines for his data acquisition portion and many of the enhanced features and added specifications will become transparent. An example of this will be a user who requires a 14-bit resolution A/D convert-

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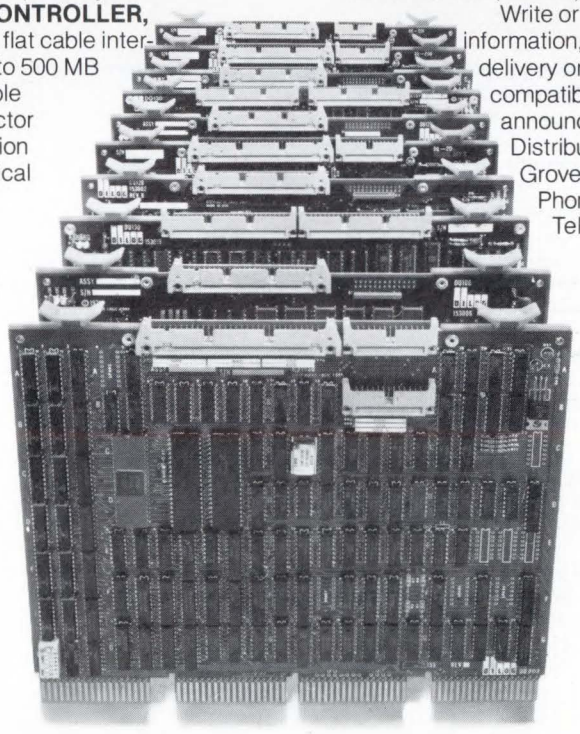

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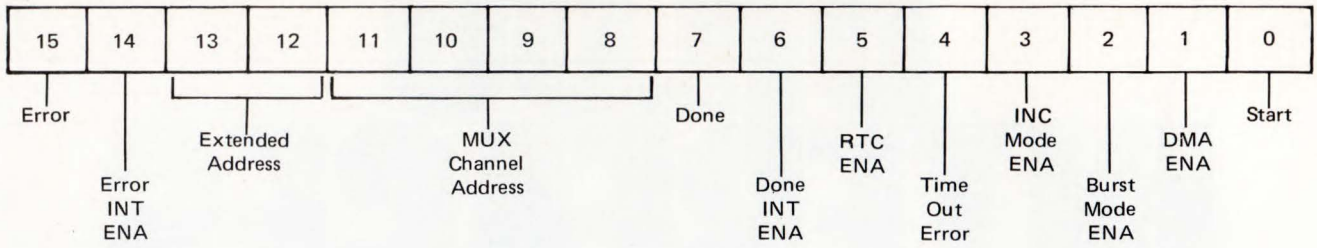
CSR BIT ASSIGNMENTS



CSR BIT DEFINITIONS

BIT	NAME	FUNCTION	SET BY	CLEARED BY
15	ERROR Read/Conditional Write	When set indicates that one of the following A/D errors occurred: i) A/D was triggered while MUX was settling. ii) A/D was triggered during a conversion iii) A new conversion was completed, before the previous conversion was read.	Occurence of any of the three error conditions or program control	Program Control and INIT
14	ERROR INT ENA R/W	When set will allow the setting of bit 15 to generate an interrupt request.	Program Control	Program Control and INIT
13-12	EXTENDED ADDRESS R/W	These bits from the upper two bits of the DMA address register to allow DMA transfers over the complete 18 bit address space. These bits will be incremented if the address overflows out of 16 bits, thus DMA transfers across 32K boundaries can be accomplished. Bit 12 appears as address line 16 and bit 13 appears as address line 17	Program Control	Program Control and INIT
11-8	MUX CHAN R/W	These bits select one of 16 SE (or 8 DI) analog channels from which data is to be taken.	Program Control	Program Control
7	A/D DONE Read Only	This bit is set when an A/D conversion is completed.	Completion of A/D	This bit can only be cleared by reading the A/D data buffer. This bit is also reset by INIT.
6	DONE INT ENA R/W	When set will allow the settling of A/D DONE (in NON-DMA mode) to generate an interrupt request. If the board is operating with DMA, then this bit allows the completion of the DMA transfer to generate an interrupt request.	Program Control	Program Control and INIT
5	RTC ENA R/W	When set allows a high-to-low transition on the RTC INL line to initiate an A/D conversion	Program Control	Program Control, INIT, and if a Bus Timeout error occurs during a DMA transfer.
4	TIME OUT ERROR	When set, indicates that non-existant memory was address by the DMA logic, and that the DMA process was aborted.	When non-existant memory is addressed during a DMA transfer	When the lower byte of the CSR is written to, and by INIT.
3	INCREMENT MODE ENABLE R/W	When set enables increment mode operation, when cleared disables increment mode operation	Program Control	Program control, INIT, or if a Bus Timeout Error occurs.
1	BURST MODE	When set allows the A/D to retrigger itself after every conversion during a DMA transfer, thus running out its max. speed. When cleared will disable the free running mode under DMA	Program Control	Program control, INIT, or where Bus Timeout Error occurs.

Table 4 CSR bit assignments for enhanced product with DMA interface.

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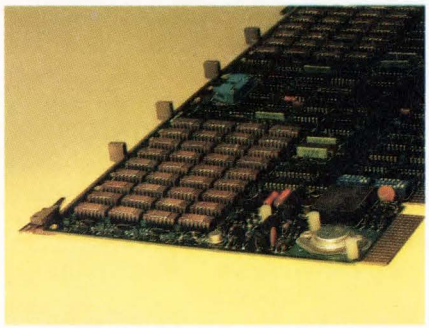

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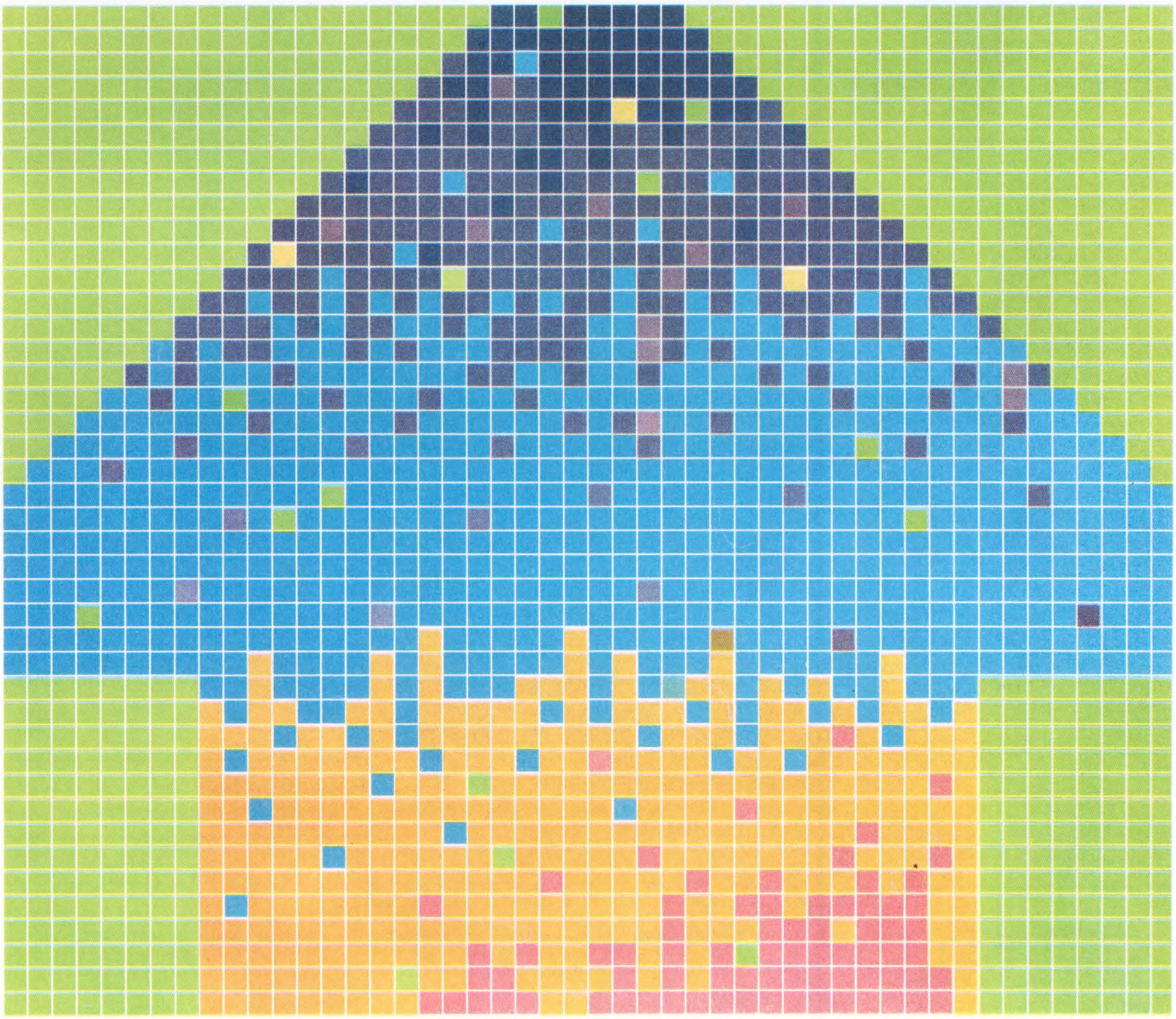

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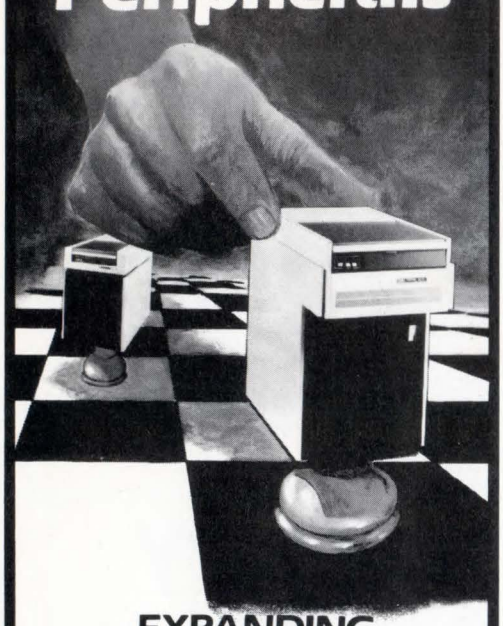

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er. He cannot obtain this product from DEC, however, an external vendor may have a 14-bit A/D converter which is compatible to the DEC system and a set of FORTRAN callable subroutines which would allow the user to utilize the same FORTRAN software that he would use with a standard DEC product. Thus, it becomes obvious that the FORTRAN subroutines can mask out the incompatibilities which exist in the hardware and still allow a user to take advantage of the enhanced features of these peripherals.

Table 5 shows a list of FORTRAN callable subroutines which are available for the DEC RT11 FORTRAN operating system. This library of subroutines contains exactly compatible calls that are utilized on a DEC library of subroutines, however, it provides enhanced performance features since the hardware that it will run on also provides enhanced performance features above the standard DEC peripheral offerings.

SUBROUTINES	FUNCTION
IADS	Single A/D conversion
RTS	Real-time sampling of A/D converter at up to 125KHz
SETR	Set Real Time Clock rate and mode of operation
HIST	Schmitt Trigger 2 driven real-time sampling of histogram time-data or memory locations
IDIR	Reading of a Digital Input channel or memory location
IDOR	Loading of a Digital Output channel or memory location
DRS	Real-time sampling of Digital Input channels or memory locations, clock-driven or event-driven
DINP	Clock-driven Digital Input polling and event latency measurements
IDAC	Loading or reading an Analog Output channel
CLRD	Scaling display data
DIS	Continuous display of data
DXY	Continuous display of XY data pairs
SDIS	Stop real-time data display
FSH	Display data once
KBCD2B	Convert 16 bit BCD to INTEGER*2
KB2BCD	Convert INTEGER*2 to BCD
LWAIT	Wait for event to occur
INT16	Convert REAL*4 into unsigned 16 bit integer
FLT16	Convert unsigned 16 bit integer into REAL*4

Table 5 High-level language subroutine calls.

In summary...

Like many other real world problems, the problem of data acquisition requires a variety of products to allow the end user to connect to an almost infinite variety of real world signals. It is much more important in this case to be able to acquire the proper data at the proper throughput rate with the necessary accuracy, so that either the computer-controlled experiment will be meaningful or the process can be controlled within proper limitation. Complete compatibility with DEC products in this area will not allow the end user to obtain this performance. Consequently, partial DEC compatibility is available, and use of higher level languages can lessen the impact and effort required by the user to account for the incompatibilities.

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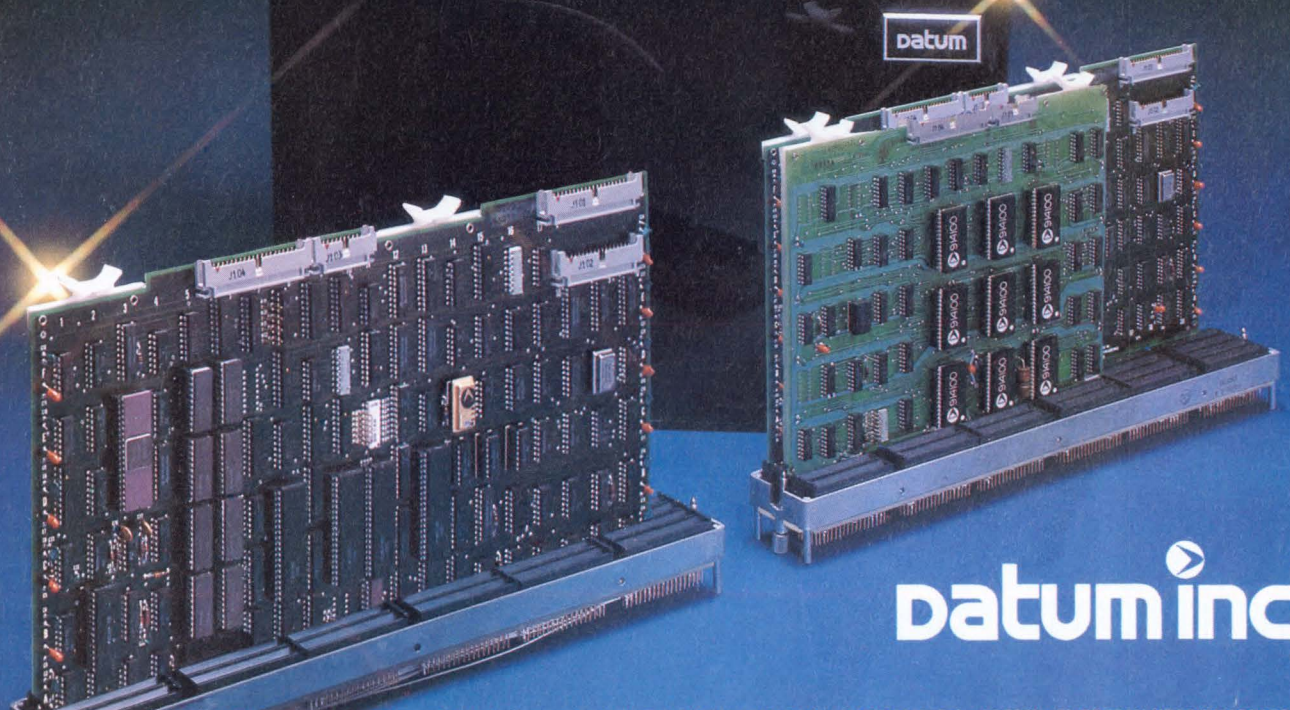

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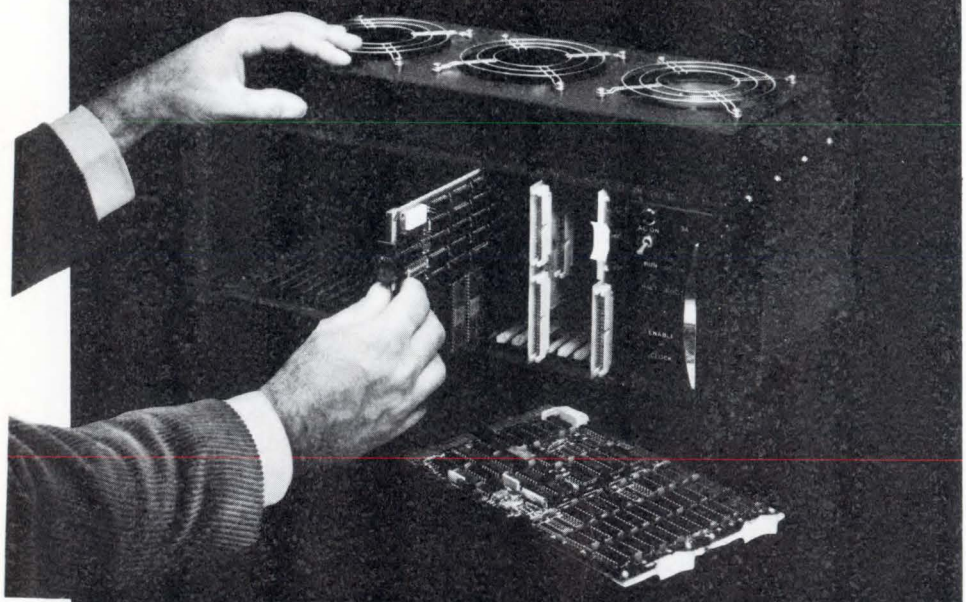

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Letters

Continued from page 8

TMS9900 Overlooked

Dear Editor:

I do agree with the article, "Foreign Intrigue and Satellite Spying Invade Silicon Gulch" (March, pgg. 22-26). The IEEE is wrong in abetting the transfer of high technology to China.

On another vein, it's hard to imagine that you completely overlooked the Texas Instruments' line of TMS9900 boards in the single-board computers special report. TI has one of the most expandable and complete lines of SBCs now available.

Louis Muller
Servo Corp.
Hicksville, NY

Random Number Generator

Dear Editor:

The article "A True Random Number Generator" (March 1980), apparently contains some errors and misconceptions. The statement is made in the article that pseudo-random sequences have the drawback that they are not truly random and that they repeat. Certainly this statement is true, however, it is not a drawback. Good pseudo-random number generators generally have extremely long periods and will provide sequences which are apparently random.

The method of generating random numbers presented in the article is questionable as to its randomness. There is a fairly good body of material which supports the fact that sequences generated by random means do not necessarily produce random sequences. For a discussion of this, I refer the author to D. E Knuth's "The Art of Computer Programming, Volume 2."

An important feature of random number generators also seems to be lacking in the author's method. In order for a random number generator to be useful in a generic sense, it is desirable to provide for reproducibility. This feature is provided for in most pseudo-random routines by allowing the programmer to set the initial seed value. This feature allows for the checking or debugging of computer simulations and other such programs which require random numbers.

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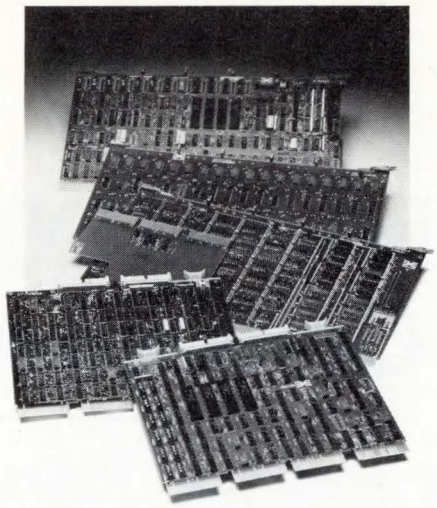

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Phillip Begich
Emulex Corp., Santa Ana, CA

Buying DEC Add-On Subsystems?

Consider Service

Why buy third party controller and storage peripherals for expansion of DEC computer system capacity? Lower cost, quicker delivery, wider range of product selection, more compact packaging and better performance – these and other reasons account for the widespread practice. But when a user considers adding third party controllers and storage peripherals, he should carefully examine a number of other concerns.

Other factors. . .

Controllers must be software compatible in terms of both operating system and diagnostics software to avoid becoming a slave to operating system drivers and sole source suppliers. They should work with virtually all makes of disk and tape drives to guarantee future product flexibility. They should not be general purpose in nature but should be designed specifically for a particular computer system (e.g., an LSI-11 is different from a PDP-11, a PDP-11/70 and a VAX-11/780) to obtain the most cost-effective product possible.

But perhaps the most important consideration the user should examine is whether he can get service for his complete computer system – including the third party storage subsystems – after it's installed. DEC, like most other computer manufacturers, will not provide service for non-DEC equipment that is attached to the system. And all too often, when a customer attempts to get service from a peripheral manufacturer or a controller maker, there's a lot of finger pointing as to the responsibility for that service. In the past, the customer has usually been the one who suffered.

A trend?

Today that's not true, and our case may be a precursor of future change. Can a peripheral manufacturer and controller company jointly arrange to provide service for third-party add-on equipment – and in many cases, even for the DEC computer system to which they're attached? We feel it can. With the agreement between us and Control Data Corp. (announced at NCC), Control Data's Engineering Services Organization provides nationwide maintenance service contracts covering most Control Data disk and tape peripheral equipment and Emulex controllers installed on PDP-11 and LSI-11 computers. Coverage includes our SC01, SC11 and SC70 large disk controllers and the TC01 and TC11 tape controllers; CDC's MMD, CMD, SMD and FMD Series disk drives and tension arm tape transports; and in selected cities, DEC's PDP-11/04 through PDP-11/70.

The last element is an important one because in addition to coverage of the third party storage subsystem, the agreement also provides that service contracts can include entire PDP-11 based systems, including CPU, memory and options. This **whole-system coverage** is available initially in 12 cities: Albuquerque, Boston, New York, Philadelphia, Washington, D.C., Atlanta, Dallas, Chicago, Denver, San Francisco, Los Angeles and Minneapolis.

Flexibility essential

Service may be purchased on a local, regional or national basis and it typically provides on-call service availability during particular periods plus defined preventive maintenance periods. Spare parts stocking/replacement for all equipment included in a service agreement will be handled by CDC on a local basis, with regional parts depot backup and further support from their world distribution center (St. Paul, MN). In the areas where mainframe service is provided, CDC stocks DEC parts and has its DEC specialists.

What about costs? Typical costs for an eight-hour, five-day service contract on a CDC9762 disk drive with an SC11 controller (identical to a DEC RJM02) is about $210/mo. A CDC9766 disk drive with an SC70 controller (comparable to a DEC RWP06 subsystem, but with an extra 75-MB capacity) costs about $310/mo.

The future

Whether or not many other peripheral makers and controller firms, or other manufacturers in a similar situation, will go the route we've selected is not certain. However, in view of the need for reliable service for third-party add-on equipment, the outlook seems positive.

Want more information on the maintenance service contracts? Then write to Emulex Corp., at 2001 East Deere Ave. in Santa Ana, CA (714/557-7580) or call Control Data's Worldwide Communications Center (800/328-3980).

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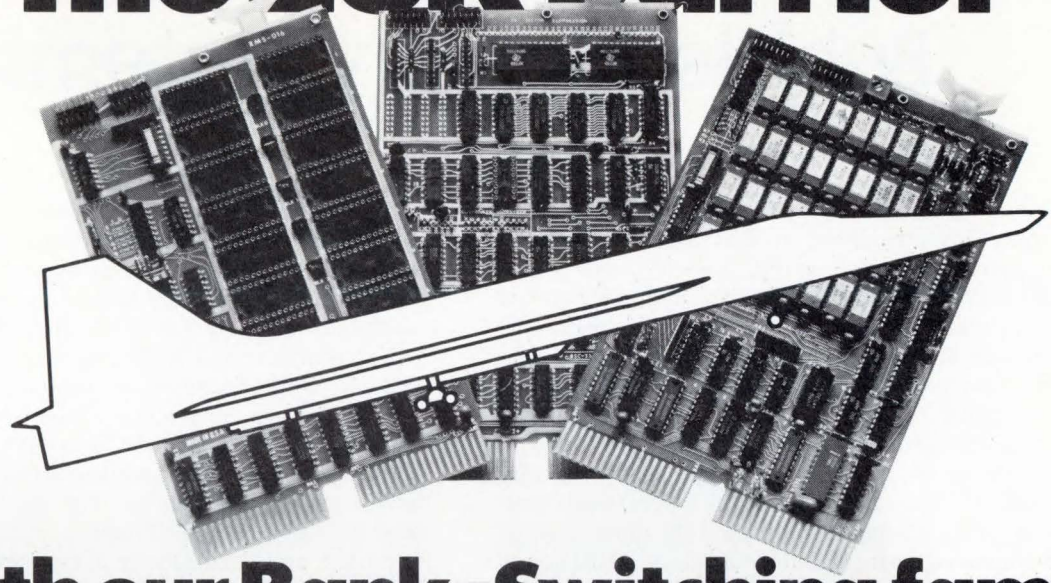

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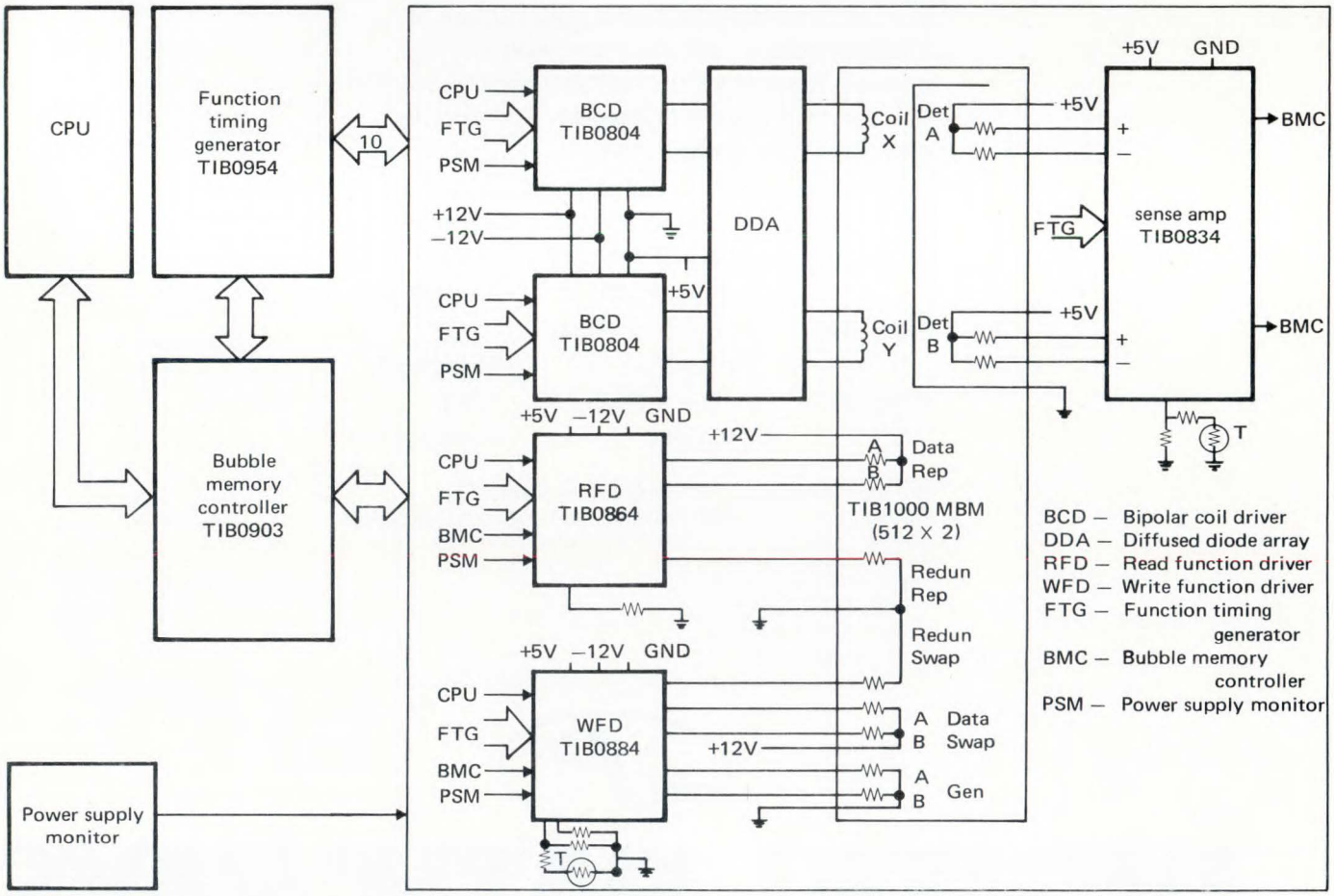
Roger Hagard
Texas Instruments, Dallas, TX

Designers' Guide To Magnetic Bubble Memory Systems

Since 1967 when the concept of magnetic bubble memories was first introduced by Bell Labs, the development and practical application has gone through several phases. The initial concept was that data could be stored in the form of cylindrical magnetic domains (magnetic bubbles) existing in a magnetic epitaxial film deposited on a nonmagnetic substrate. The presence of a magnetic bubble represents a digital "1" and the absence represents a digital "0". Because the diameter of the magnetic bubble is so small, as little as two microns in today's devices, a very large amount of data can be stored in a very small area. This was one of the driving forces behind the rapid development of commercial magnetic bubble memory (MBM) products. Others included the potentially very low cost per bit and the inherent reliability of solid state technology. Since those early days, practical ways to create (or generate) magnetic bubbles, to move them in shift-register fashion through the magnetic epitaxial layer, and to detect their presence or absence in order to read data out of the memory have been achieved. Much research was done to determine the best materials to use for the magnetic film and substrate, and several different architectures (the physical arrangements of the elements of a MBM chip necessary to generate, store and detect magnetic bubbles) were developed.

Today there are several different MBM products on the market, all of which have a magnetic garnet film grown epitaxially on a non-magnetic substrate. The architectures, however, vary considerably. The first bubble memory chips used a single serial shift-register architecture, but this had two basic problems. One is that a single defect in the shift-register chain (formed by depositing chevron-shaped patterns above the epitaxial film) results in a bad chip. This causes low processing yields and higher costs. The other problem is that data just entered must circulate through the entire



This simplified block diagram of the 256-K/512-K/1-Mbit bubble memory system uses the first family of interface circuits.

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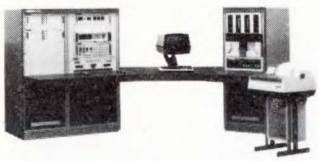

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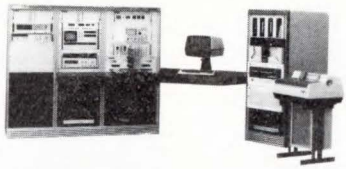

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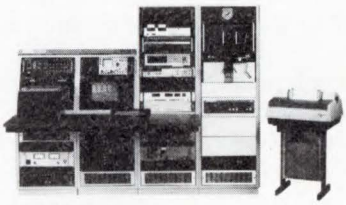

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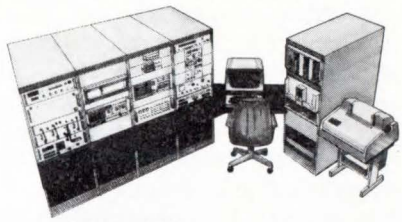

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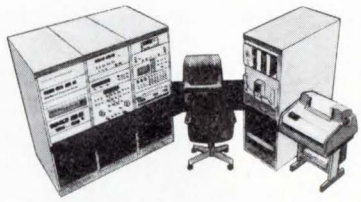

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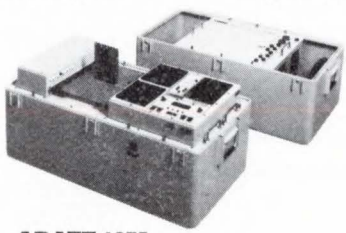

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shift-register chain before it can be read, which causes slow access to the data stored.

As bubble memory technology continued to evolve, new architectures were developed which had some definite advantages over the original single loop design. The first of these was a major-minor loop design used by Texas Instruments in its 92-kbit bubble memory. In this device data are generated in a major loop, serially shifted to align with the ends of a series of minor loops and then transferred for storage to the minor loops. The result is much shorter access time because the bubbles circulate through a much shorter loop before they are detected. The next improvement was aimed at achieving a higher speed device. A larger 256-kbit bubble memory chip, also from Texas Instruments, has two banks of minor loops with separate tracks for writing and reading data. Pages of data are separated into odd and even bits for storage and then during a read operation, the bits are merged to form the original page of data. This design has a data transfer rate that is twice that of the original major-minor loop design.

More recently, Texas Instruments has announced 1-megabit drives and two controller interface circuits. TI's product has a short access time, a high data rate and a great systems' expansion capability (a maximum of 32 channels can be operated in parallel producing a burst rate of 16 Mbytes per second).

The basic operation of today's magnetic bubble memories and their support and interface circuits is presented in this, the first of a four-part series on MBM systems. Part two explains the hardware interfacing of a bubble memory system to a μP or host CPU including sample circuits, types of operation and expansion capabilities. Part three examines software interfacing to microprocessors with specific discussions about the sequence of operations in a bubble memory system which includes flowcharts and corresponding assembly language code for some of the more important commands. Part four takes a look at PC board MBM subsystems, their primary features including a block diagram discussion, interfacing details and some applications.

Description of 1 Mbit MBM

The TIB1000 is a 1,122,852-bit, single-chip magnetic bubble memory. Nonvolatile data storage is in the form of cylindrical magnetic domains (magnetic bubbles) in an epitaxial film deposited on a garnet substrate. Wrapped around the chip are two orthagonal coils which produce a rotating magnetic field. The rotating field causes propagation of the magnetic bubbles in a shift-register fashion along a path determined by chevron-shaped permalloy patterns which are deposited on an oxide layer over aluminum-copper control elements. A permanent-magnet structure sandwiches the chip and the field coil assembly provides the static field necessary to retain data when power is removed. This whole assembly is then encased in a magnetic shield to prevent external fields from interfering with the operation of the chip.

The block replicate architecture of this new 1-Mbit MBM from TI has some interesting features. The chip has separate write and read tracks and the ability to transfer an entire page of data into or out of the minor loops in one operation. This improves the single page cycle time considerably. The memory is divided into two sections with 512 kbits per section and each loop contains 2049 bits. Twenty-six of the 300 loops are allowed to be defective which increases processing yields and reduces manufacturing costs. Of course, additional circuitry is required to keep track of which loops are defective and to control the chip's operation so that

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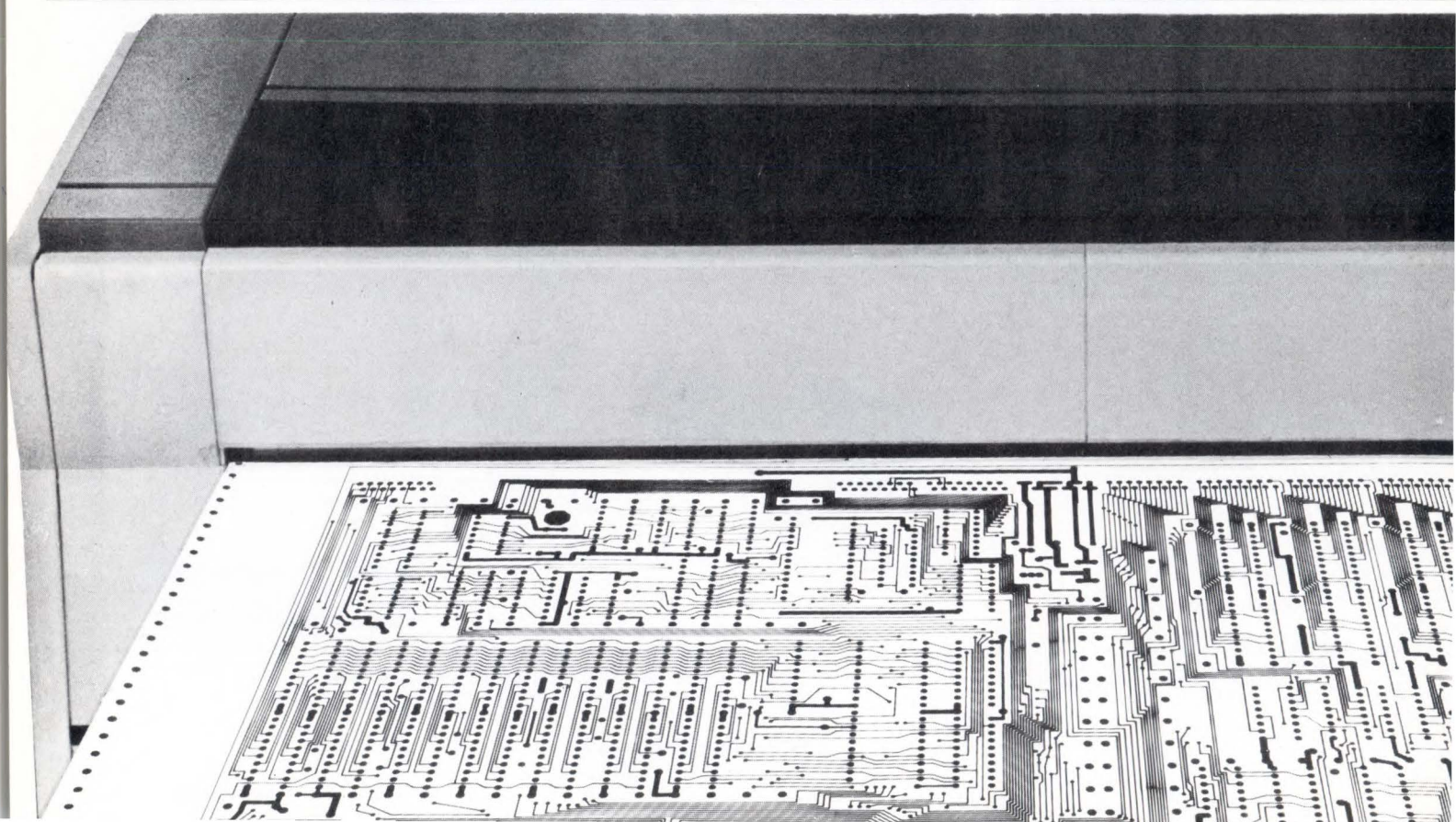

data is neither written into or read out of defective loops. The chip has dedicated loops which contain a map of the defective or redundant minor loops so that redundancy handling becomes transparent to the user. There are then 274 minor loops remaining for data storage, of which 18 are available for use in error correction. This leaves 256 minor loops so that with error correction a page of data consists of 256 bits. If error correction is not used, 272 loops are available for data storage and the remaining two loops store odd parity bits for the 272-bit page.

The area occupied by this chip is only 149,000 square mils which is less than one square centimeter. This results in the greatest bit density for any commerical MBM product; more than twice that of any other product. The cell size of 8 by 8 microns and a bubble diameter of only 2 microns was made possible by a truly planar process in which new limits of projection lithography have been reached. The small area of the chip significantly reduces manufacturing cost since a major factor in the cost of large capacity bubble memory chips is the garnet substrate – a smaller chip area means lower cost. Another important advancement in chip architecture is found in the TIB1000. This is the new double-period gate which moves the magnetic bubbles twice as far for each rotation of the magnetic field as in previous designs. In other words, when a bubble is moving under a double-period gate, it moves the same distance in one period of the field cycle that it would normally move in two periods of the field cycle. When these double-period gates are used in the write track, they allow data bits to be generated every field cycle. When these new gates are used in both the write and read tracks, the high speed of previous designs is achieved without the need to separate data into odd and even banks of minor loops.

The one megabit MBM has many features of the previous devices, including page swap and page replication of data. A primary difference in the operation of the chip results from using the new double-period gate in the write and read tracks. There is some space between the minor loops. Normally, this would cause an empty bit position to occur between every data bit entered in the write track or produced in the read track during page replication. However, the double-period gate effectively closes the normally present data gap between minor loops. During a write operation data bits are generated on every field cycle until a page of data has been generated and shifted by the double-period gates to align with the respective minor loops. Then a current pulse applied to the swap gates exchanges the old data in the top bit position to occur between every data bit entered in the write track or produced in the read track during page replication. However, the double-period gate effectively closes the normally present data gap between minor loops. During a write operation data bits are generated on every field cycle until a page of data has been generated and shifted by the double-period gates to align with the respective minor loops. Then a current pulse applied to the swap gates exchanges the old data in the top bit position of the minor loops with the new data in the write track. During subsequent field cycles, the old data in the write track is shifted to a guard rail and destroyed. During a read operation, a page of data is replicated (i.e., duplicated) and transferred from the bottom bit position of the minor loops to the read track. With double-period gates used in the read track, the page of data moves twice as far as it normally would for each cycle of the rotating magnetic field. The bubbles then pass under a detector element which is part of a balanced bridge circuit. Two legs of this bridge

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consist of two arrays of interconnected permalloy patterns connected externally to constant current sinks which are part of the sense amplifier. The current sinks complete the blanced bridge circuit and when a bubble passes under one leg of the detector element, the bridge is unbalanced and presents a small change in voltage to the sense amplifier. Before bubbles can pass under the second leg of the detector element, a guard rail placed between the two legs of the detector destroys the bubbles. The result is that common mode bubble signals are cancelled and are not amplified by the sense amplifier.

To complete the transfer of data from the bubble memory to the host system, the output of the sense amplifier is connected to a data corrector/formatter (DCF) circuit. The bits of data are serially shifted from the sense amplifier to the DCR for data buffering, redundancy handling, and, if desired, error correction. Redundancy handling is performed as data is being written and read. The redundancy RAM, which is internal to the DCF, is synchronized with the serial bit stream that is shifted to or from the bubble memory. During a write operation, zeros are inserted in the data stream for those loops or bit positions which are considered defective according to the redundancy map stored in the RAM. Then, during a read operation, these zeros are removed from the bit stream by gating the data into the DCF's buffer register according to the redundancy map.

The access time for the new 1-Mbit chip is the time it takes to write or read the first data bit to or from the bubble memory. This consists of the time it takes for a desired page of data in the minor loops to reach either the swap or replicate gates plus the delay time associated with the write or read track. For the TIB1000 with an initial specification of 100 kHz for the field frequency, the average access time is 11.2 ms, and when the design goal of 200 kHz is reached, the time will be reduced to half or 5.6 ms.

The data transfer rate for a bubble memory is determined by the number of bits per page, the frequency of the rotating magnetic field and the number of field cycles required to transfer a page of data into or out of the device. For the TIB1000 the average data rate per 512 kbit section or channel is 80 kbits/sec with error correction. When the two channels are operated in parallel, the data rate is 160 kbits/s; and if error correction is not used, the average data rate increases to 171 kbits/s. These data rates are normally slower than that for the host system. The DCF circuit, however, double buffers data between the host system and the bubble memory which allows the interface between the DCF and the host to be totally asynchronous. This interface can consequently be operated up to a 4 MHz burst data rate.

In summary, the architecture of today's magnetic bubble memories is becoming very sophisticated and the operation of the MBM devices is consequently becoming more complex. The need to make bubble memories easier to use, whether the memory consists of a single device or an expanded system, has been answered by the development of custom interface and support circuits. These integrated devices free the designer from the need to become intimately familiar with the electrical and magnetic properties of bubble memories which allows more time to concentrate on the systems aspect of the application. This is evident not only in the standard interfacing provided for μPs, but also in such features as transparent handling of redundancy and error correction.

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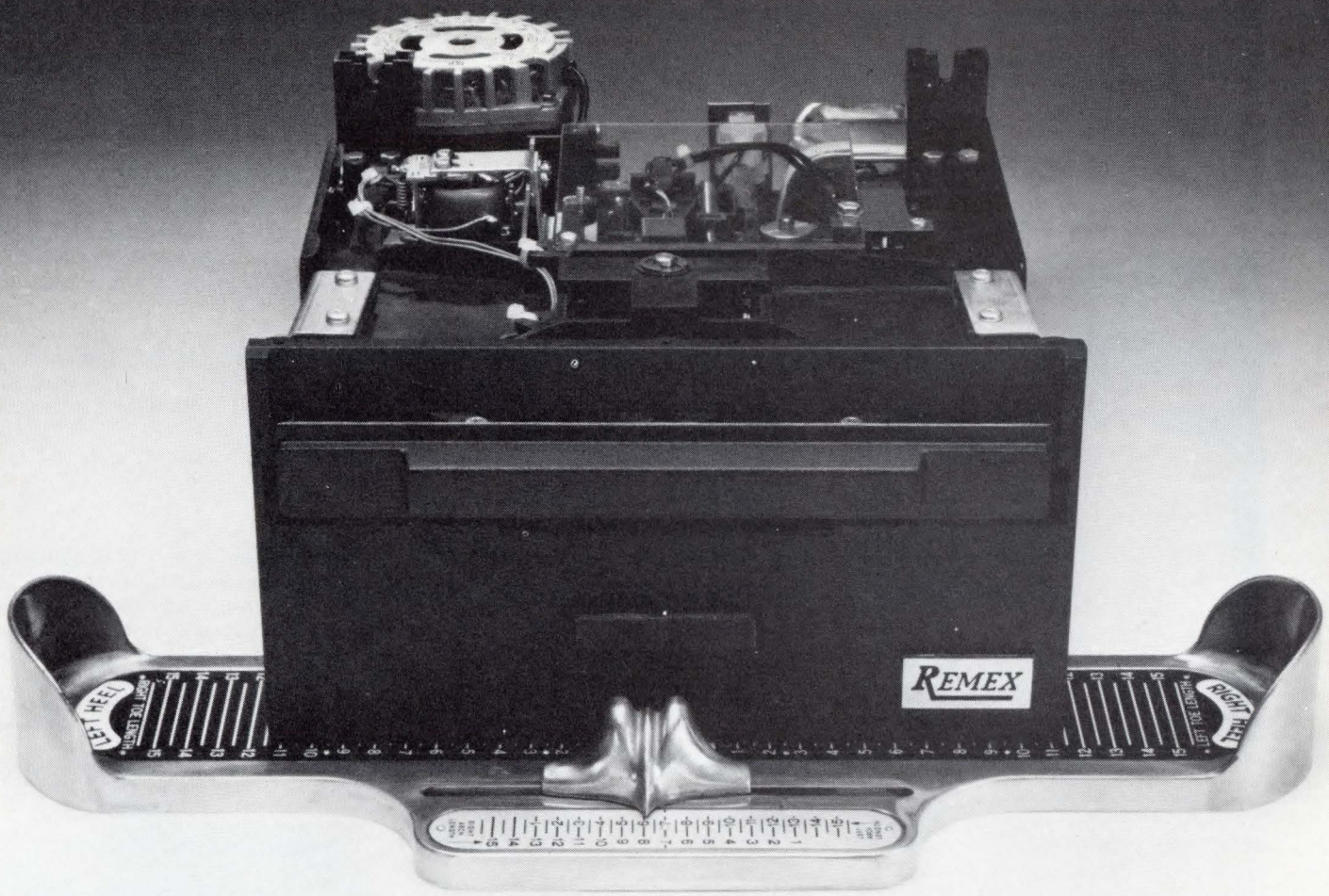

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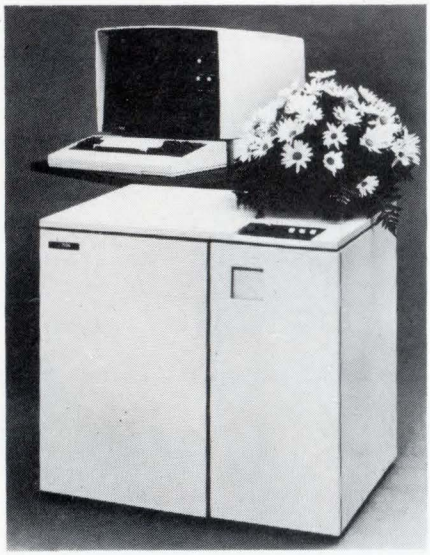
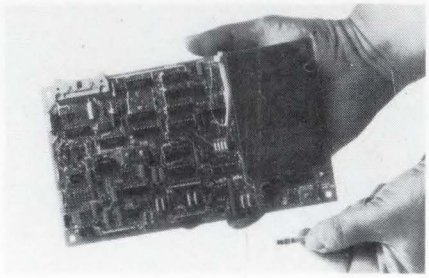


adapters in increments of eight. A program diskette provides ability to configure the cluster for initial requirements and later change those requirements based on future needs. Resident diagnostic programs are designed for immediate fault isolation, supplying information on all devices connected to the controller and controller-channel communications. **MDS Trivex, Inc,** 3180 Red Hill Ave, Costa Mesa, CA 92626. **Circle 217**

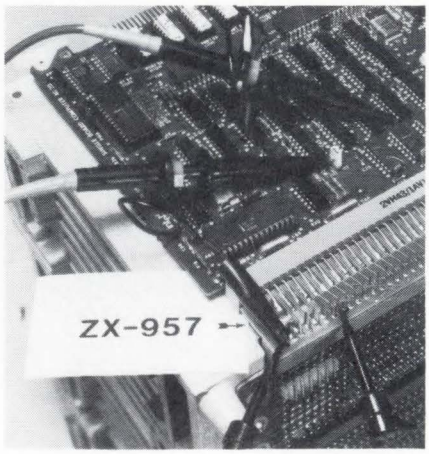
DEC-COMPATIBLE CONTROLLERS Two of these disk controllers (FLEX-02 and WINC-01) are designed for LSI-11, -11/2, -11/23 based systems. The third, (STORM-02) is for the PDP-11/04 thru PDP-11/60 series. The WINC-01 controller provides attachment of a 14 in., low-cost Winchester type disk drive to the DEC LSI-11 Q-Bus. The FLEX-02 has a single, dual-width controller card which plugs directly into an LSI-11 backplane and accommodates either single or double sided floppy disk drives. STORM-02 provides attachment of up to four (4) 80 MB storage module drives to the PDP-11 Unibus. STORM-02 provides emulation of the RM02 offering both software and media compatibility. **Advanced Electronics Design, Inc,** PO Box 61779, 440 Potrero Ave, Sunnyvale, CA 94086 **Circle 156**

COMPACT MODEM CARD. Designed for switched network 300 bps full duplex operation, Model VS300P is registered for direct-connect under FCC Rules, Part 68. Modem is fully compatible with Bell 103 and 113. All circuitry is contained on a 5″ by 6.35″ printed circuit board, which occupies less than 42 inches of space. The VS300P has the capability of pulse dialing with the dial-out pin and dial



tone detector. Modem also has force answer capability. Diagnostics include Local Test which connects the transmitter to the receiver, switches the receiver to the transmitter frequency, and busies out the line, isolating it from the transmitter and receiver. Model VS300P, $200 (100). Delivery 60 days ARO. **Racal-Vadic, Inc,** 222 Caspian Dr, Sunnyvale, CA 94086. **Circle 139**

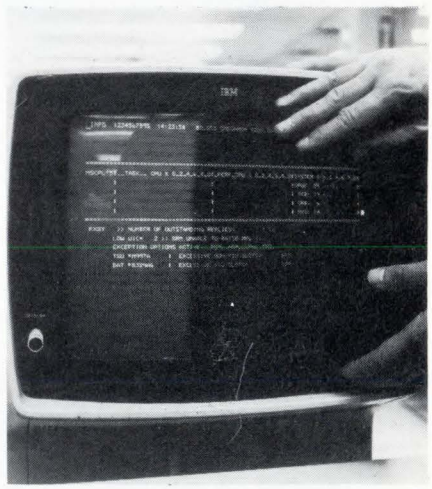
MULTIBUS EXTENDER SPEEDS DEBUG WORK. The ZX-957 MULTIBUS Extender Card plugs into the end of an SBC-604/614 Card Cage creating an extra slot outside the bus. The MULTIBUS card under scrutiny is then plugged into this new slot thereby



eliminating the obstruction caused by the card cage. Every test point on that board can then be easily & quickly reached with probes. Available from stock, $45 ea. **Zendex Corp.,** 6398 Dougherty Rd., Dublin, CA 94566. **Circle 129**

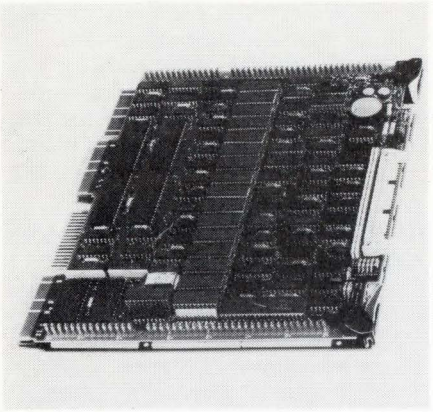
8048 SINGLE-BOARD μC. Based on the industry-standard 8048 single-chip μC, Concept-48 comes equipped with CPU, 28-position tactile feedback keyboard, seven-digit LCD display, ROM-based monitor, serial I/O port, and programming/debug capabilities. Two models are available: Model 6942 includes 2 KB of user program memory, and contains a serial I/O interface for upload and download of programs between Concept-48 and any computer with an RS232 or a 20 mA current loop; Model 6941 is a minimum system containing 256 bytes of external RAM and 256 bytes of user program memory. Model 6942, $995; Model 6941, $695. **Intersil, Inc,** 10710 N Tantau Ave, Cupertino, CA 95014. **Circle 149**

GLARE-CUTTING FILM SCREENS. Two film accessories to cut room glare and help ensure privacy for computer terminal readouts are now available; Panel Film selectively filters ambient room light, enhancing the CRT image by reducing glare; Formed Light Control Film has, in addition, a horizontal



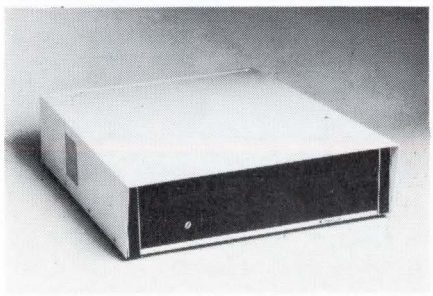
"microlouver" construction which limits the vertical angle from which the face of the terminal screen can be read. Glare reduction by both films, says the manufacturer, is equivalent to that of a 14-inch top hood on the terminal. Besides providing glare-reduction and privacy functions, the films are shatterproof and abrasion resistant. They may be cleaned with ordinary household solvents or detergents. Four standard diagonal-measure sizes are available: five, nine, 12 and 15 inches. Panel Film, $11.65 to $23.55, depending on size and quantity; Formed Light Control Film, $15.75 to $43.15. **3M,** Dept DR80-3, Box 33600, St. Paul, MN 55133. **Circle 127**

SMD CONTROLLER. This Storage Module Drive (SMD) Controller emulates DEC's RK611 Controller, which interfaces to DEC's RK07 SMD, and



operates under RT-11 and RSX-11M operating systems. Up to four 80 MB drives can be daisy-chained on the unit. A 2 kB bipolar buffer eliminates the possibility of data late errors and permits the controller to be assigned a low bus priority level. Internal self-test with appropriate LED displays is a standard feature. Error Correcting Code (ECC) logic is provided: 32-bit ECC for data (allowing correction for a single 11-bit error burst) and 16-bit Cyclic Redundancy Check (CRC) for header error detection. Model SO3/B, $5400. Delivery 30 days ARO. **Dataram Corp**, Princeton-Hightstown Rd, Cranbury, NJ 08512. **Circle 138**

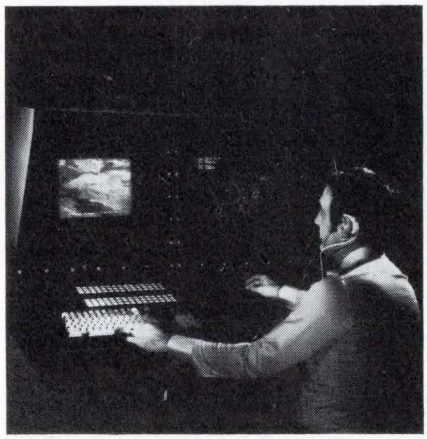
SLIM-LINE DISKETTE SYSTEM. This intelligent flexible disk system provides up to 3.2 MB of data in a space only 5-1/4″ high. It incorporates an RFS 4810 master drive with an on-board μP-based controller/formatter, a minimum-electronics RFS 4820 slave drive, and a DC power supply, all housed in a rack mountable chassis measuring 19″ wide, 5.22″ high and 21.32″ deep. Performance features include: multiple sector data transfer; fully automatic disk initialization; automatic diskette-to-diskette copy; and automatic density switching, allowing the drive to read single or double density diskettes



interchangeably without manual adjustment. Remex 48 Subsystem, $1997 (small OEM quantities). Delivery 90 days ARO. **Ex-Cell-O Corp, Remex Div,** 1733 E. Alton St, P.O. Box C19533, Irvine, CA 92713. **Circle 136**

MEGABYTE-SIZE FLOPPIES. Four new models of 5-1/4″ disk drives are now available with capacities ranging from 250 kB to 1MB, unformatted. Company claims highest capacity and fastest access time of any 5-1/4″ floppies on the market. Basic 250 kB model, under $200 (1000). **Tandon,** 9333 Oso Ave, Chatsworth, CA 91311. **Circle 148**

DUAL DISPLAY. With two CRTs of your choice built in, this color display terminal permits you to view graphic command and control applications in conjunction with a detailed alphanumeric interrogation or another color graphic display. Unit comes equipped with editing capabilities and permits full operator entry. Joystick provides independent cursor manipulation on either display by operator selection. Ninety user defined function buttons on a keyboard are standard. Interfaces



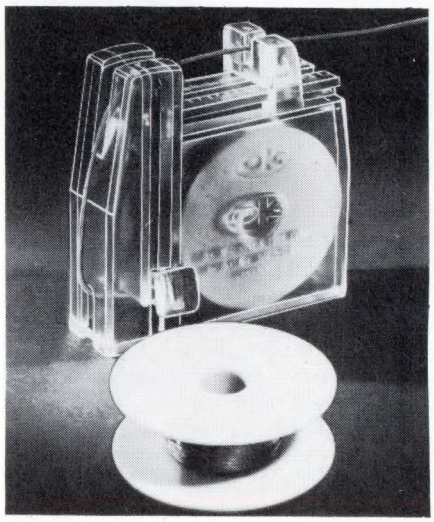
are available for off-line high speed DMA transfers to your host CPU. System supports 5 MB disk for local storage, hard copy devices and a graphic tablet for rapid graphic data base construction. **Aydin Controls,** 414 Commerce Dr, Fort Washington, PA 19034. **Circle 135**

STD BUS SERIES FEATURES 7888. The STD BUS series of industrial μC modules features the MSI 7888 CPU card based on the 8088 μP. The 7888, compltely compatible with the STD BUS, operates at clock frequencies up to 5MHz and accommodates 8K PROM and 4K RAM. Basic unit includes 2K RAM with sockets provided for the remaining memory. The 8088 is also socket mounted to facilitate emulation. The MSI 7550 I/O and Interrupt Card provides as programmable functions an RS232 or 20mA serial I/O (8251A), twenty-four digital I/O lines (8255A), three interval timers (8253), and eight vectored interrups (8259A). The MSI 7880 CPU card, based on the 8080A μP and structurally identical to 7888, is also included in the STD BUS series. **Microcomputer Sys-tems, Inc,** 1814 Ryder Dr, Baton Rouge, LA 70808. **Circle 150**

COLOR GRAPHIC ACCOUNTING. A new family of color graphic software packages is also available for use with CP/M-based graphic systems. "Execugraph" is a data base management program allowing users to create, update, or edit data files. System can be used to conduct analyses of sales, accidents, production, expenses, stocks, etc. "Execugraph" allows creation of bar charts, line charts, scatter graphs and filled line or area graphs utilizing information already existing in users' data files. Also allows overlaying of several data files for comparison. **Intelligent Systems Corp,** 5965 Peachtree Corners East, Norcross, GA 30071. **Circle 137**

WIRE DISPENSER. Heavy duty dispenser features precision ground steel cutters and die stamped stripping blade for easy and accurate cutting and stripping. Strip length of this AD series adjusts from 3/8″ - 2″ (9,5-51 mm) by loosening locking cam and sliding stripping blade to desired location. Interchangeable blades for 24 AWG or 30 AWG wire (0,5 or 0,25 mm). Available in either 24 AWG or 30 AWG version. The 24 AWG version includes 50 ft. (15,2m) of wire; the 30 AWG version contains 100 ft. (30,5m). Each AD dispenser is $1.98.

WIRE-WRAPPING KIT. The WK-4B Kit from OK Machine and Tool Corporation features a complete range of tools and parts for prototype and hobby applications. Kit includes a universal PC board, an edge connector with wire-wrapping terminals, two industrial quality 14-pin wire-wrapping



DIP sockets, two 16-pin sockets, a DIP inserter, a DIP extractor, a wire dispenser complete with 50 ft. of wire, and a new wire wrapping and unwrapping tool that wraps and unwraps 30 AWG (0.25mm) wire on .025 (0.63 mm) square pins, plus strips 30 AWG wire using a built-in stripper. Item WK-4B, $25.99. **OK Machine and Tool Corporation,** 3455 Conner St, Bronx, NY 10475. **Circle 131**

New Products

6MHz μP. A faster version of the 8-bit Z80 μP is now available. Made possible by a refinement in process technology, the new device runs at a 6 MHz clock rate, compared to the Z80A's 4MHz rate and the Z80's 2.5 MHz rate. Model Z80B, which is

completely pin- and software- compatible with the Z80 and Z80A, will allow users of systems based on the slower μP circuits to upgrade to a faster CPU. Model Z80B PS (plastic package), $20. (10-99); Model Z80B DS (cerdip package), $31.85. **Zilog**, 10340 Bubb Rd, Cupertino, CA 95014. **Circle 140**

6502 SOFTWARE DESIGN. This book by Leo Scanlon deals specifically with 6502 μPs and AIM μCs, but most of the material can be applied to any 6502-based μC. Provides instructions for your 6502 along with 89 subroutines and programs. Techniques for processing structured data, such as lists and tables, are included, as well as those needed to perform mathematical operations and data conversion. 6502 Software Design, 272 pp, softbound, $10.50. **Howard W. Sams & Co, Inc,** 4300 W 62nd St, Indianapolis, IN 46268. **Circle 147**

DEC-COMPATIBLE EXPANSION CHASSIS. The WP-919 Expansion Chassis is designed for DEC PDP-11 users who prefer to mount their controllers for tape and disk drives outside the computer. With capacity for two 4-slot system units or one 9-slot unit, the WP-919 allows addition of PDP-11 small peripheral controllers, extra memory, or embedded mass memory controllers. It also accommodates a full collection of LSI-11 boards and modules. The WP-919 unit measures 5.25 inches high and comes with standard 5 and 15 volt DEC-compatible power for up to nine hex boards (standard LSI-11 12 VDC power also is available). Separate fan forced-air cooling is provided for both the power supply and printed circuit boards. **Wesperline,** Div of Wespercorp, 14321 Myford Rd, Tustin, CA 92680. **Circle 210**

VIDEO CONTROLLER BOARD WITH SCREEN MEMORY Video controller board has 2K bytes of on-board screen memory that reduces central processor overhead. The V-100 displays 24 lines by 80 characters of data in 7 by 9 dot matrix. Fonts are available for standard ASCII, or German, French, or Japanese characters. The V-100 also provides 16 user-programmable graphic characters. The board accepts data at 2 MB/s. Data is transferred to the screen at about 300KB/s. $450 per board. **Piliceon Inc.,** OEM Computer Products, 2350 Bering Dr., San Jose, CA 95112. **Circle 153**

"CLEAR SIGNAL" ACOUSTIC COUPLER. Low-noise coupler has a sensitivity of −50 dBm, which exceeds standard telephone voice-service specifications. Bell 103A, the "Clear Signal" coupler interfaces with most EIA RS 232C computers and terminals at 0-300 baud. The coupler is packaged with choice of 34 standard Clear Signal cables for use with HP, DG, TI, and DEC hardware. Also available with cables to fit other hardware on special order. Operates in full and half duplex modes. Self-testing feature eliminates need for remote assistance in diagnosing most transmisssion problems. **Inmac**, 2465 Augustine Dr., P.O. Box 4789, Santa Clara, CA 95051. **Circle 169**

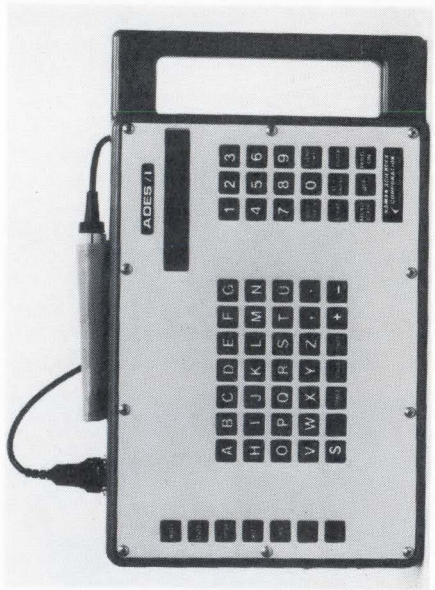
GRAPHICS ENHANCEMENTS There are two new enhancements available for Model 3400 Graphics Display Systems which, the manufacturer says, double the system's capability for high density displays. The first of these is a refresh buffer capable of handling 64K 16-bit words. Second is the system's integration with DEC's VAX 11/780 computer. Together, they allow users dealing with high-density displays to display all the needed vectors and attain both higher precision and faster response time. **Vector General,** 21300 Oxnard St., Woodland Hills, CA 91364. **Circle 155**

LSI-11 DISK-TAPE SUBSYSTEM This storage system features an intelligent, dual ported I/O processor capable of interfacing up to eight (8) Winchester disk drives and eight (8) 1/4″ cartridge tape drives. 32K of RAM is used for buffering and firmware execution. The I/O processor's firmware performs data caching. The I/O processor, for the DEC LSI/11 interfaces the Qbus through a single dual height DMA card. Winchester disk capacities for this CSS/11 subsystem range from 10 to 20 MB with 35μs average access time. Delivery, 30 days ARO. Prices start at $9500. OEM rates available. **U.S. Design Corp,** 100 Severn Ave, Annapolis, MD, 21403 **Circle 154**

1980-81 PRODUCT CATALOG. This 48-pg. short form catalog (SFC-6) lists a wide variety of semiconductor devices in 13 major product categories. Condensed specs include charts and tables for quick product selection. Several sections include schematics and dimensional drawings for many of the company's standard products. **International Rectifier,** Semiconductor Div, 233 Kansas St. El Segundo, CA 90245. **Circle 207**

DISPLAY STATION. Compatible with IBM's 5251-11, the Memorex 2051-11 is comprised of a CRT monitor and a separate keyboard. Monitor features a 1920-character display area using 24 80-character lines, displayed in an 8 X 16 dot character matrix. A 25th line provides line and column numbers of the cursor as well as system status information. Automatic dimming if there's no activity from the keyboard for 10 minutes extends CRT life. Lack of a cooling fan provides quiet operation. Model 2051-11, $2850 for purchase, $75/mo on a three-year lease; first shipments 3rd qtr 1980. **Memorex,** 3015 Daimler St, Santa Ana, CA 92705. **Circle 214**

PORTABLE DATA ENTRY DEVICE. Can be hand-carried anywhere, is intelligent, can store data, has own power source, and can be connected to host computer for data processing. The small package weighs less than 6 pounds and is approximately 15″ X 8″ X 2″. Up to 12K of ROM memory



for program storage is available. Also has 8K to 48K of low power RAM for storage. Powered by a rechargeable battery that will run for eight continuous hours. A portable voice option will be available in late 1980. **Kaman Sciences Corp,** 1500 Garden of the Gods Rd, Colorado Springs, CO 80933. **Circle 143**

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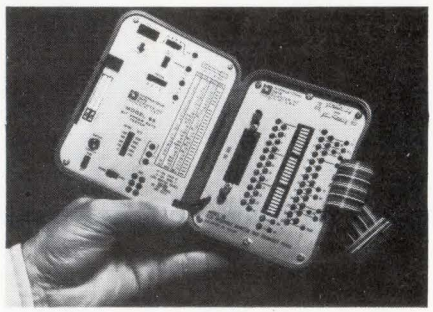
Circle 29 on Reader Inquiry Card

New Products

POCKET TEST SET. Model 65/60 is composed of two separate units packaged in a single, lightweight, hand-held carrying case. Model 65 is a complete miniaturized modem test set capable of performing bit error rate tests on any digital synchronous or asynchronous EIA modem communications link. Model 60 is the Blue Box EIA



Interface Monitor and Breakout Panel. Together they form a hand-held, battery-powered unit for completely testing and monitoring any data communications system at the EIA terminal-modem interface. Model 65/60, $850 (delivery 60 days ARO). **International Data Sciences, Inc,** 7 Wellington Rd, Lincoln, RI 02865. **Circle 145**

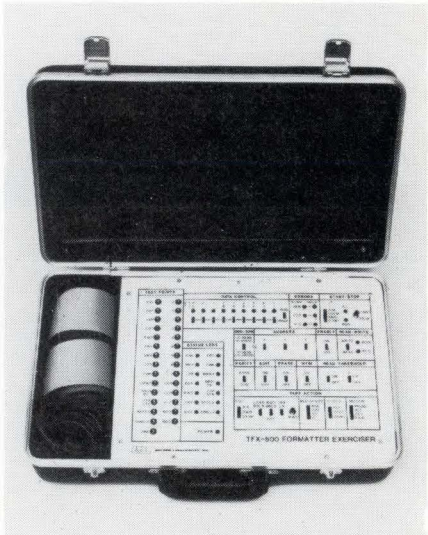
ADA SEMINAR. "Ada Introduction and Trends," a seminar for engineers, programmers and technical managers, will be held in Boston on Sept. 25-26 at the Sheraton Motor Inn, Lexington, MA. Providing detailed coverage of the latest developments in Ada language, the course will also cover features of the language, rationale for its design and implications for industry. Tuition is $300 and includes lunches, refreshments, evening reception and course notes. Contact Prof. Donald French at (617) 964-1412 or **Institute for Advanced Professional Studies,** One Gateway Center, Newton, MA 02158.
Circle 213

MAGNETIC DISK. The "Denka Magnetic Disk" is a high-density recording magnetic medium made by applying cobalt magnet-plating on aluminum disks. Using a magnetic thin film as a medium on a disk makes high density recording of video digital signals possible, and provides many excellent features which are not realized in VTR, thereby extending wide applications. Applications include: buffer memory for still picture broadcasting, slow motion analysis, buffer memory in X-rays, record moments through real-time recording and playback. **Denki Kagaku Industry Co. Ltd.,** Engineering Development Div, 1-4-1 Yuraku-cho, Chiyoda-ku, Tokyo 100, Japan. **Circle 167**

IMAGE PROCESSING HANDBOOK A new, 40-page handbook entitled "EyeCom II Picture Digitizer and Display," from Spatial Data Systems. Completely illustrated, easy to understand, overview of image processing – from initial scanning of images, through digitizing to ultimate display and all variations of display capability. Included are chapters on black & white displays and enhancement, graphics and alphanumerics overlays and pseudocolor and true color displays. Software programs compatible with PDP-II and other minicomputers are also discussed in the new handbook. Free. **Spatial Data Systems, Inc.,** P.O. Box 249, Goleta, CA 93017
Circle 166

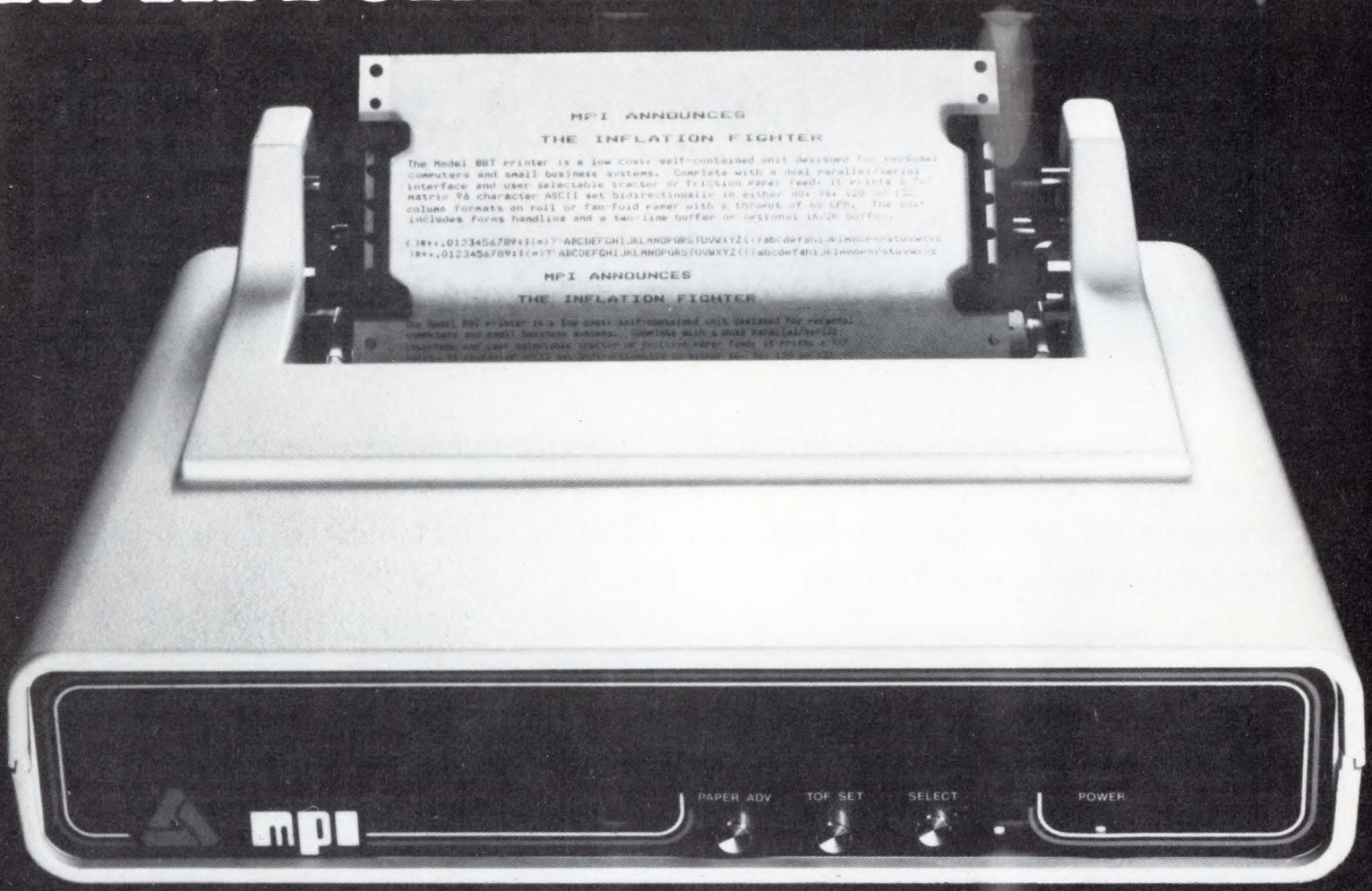
ARRAY PROCESSOR INTERFACES. The General Purpose Input/Output Processor (GPIOP) offers eight key features: 12 MB I/O throughput rate, programmable multiprocessor operation, universal device interface capability, easy-to use I/O channel language, data formatting library, FORTRAN-callable I/O functions, interactive data collection and run-time on-line debugger. $6800; 90 days ARO. **Floating Point Systems, Inc,** Box 23489, Portland, OR 97223. **Circle 212**

TAPE FORMATTER EXERCISER Complete testing/exercising of tape drive formatters is provided by this tape formatter exerciser. Cable-end adapters make Wilson's TFX-500 usable with all microstreamer-formatter interfaced drives, and dual-mode embedded formatters from Cipher, Pertec, Kennedy, Datum, Perkin-Elmer



and others. The TFX-500 has fifteen sections of test points and LED indicators for all signals from the formatter. From one to eight linked drives can be tested by the TFX-500. Price is $995. Delivery, 60 days. **Wilson Laboratories, Inc,** 2237 North Batavia St, Orange, CA, 92665. **Circle 211**

THE NATIONS LEADER IN AFFORDABLE PRINTERS



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*Suggested retail price, substantial OEM and dealer discounts available.

The first in series of new printers designed specifically for the general use computer market, the MODEL 88T DOT MATRIX PRINTER combines quality construction and attractive styling with capabilities generally associated only with more expensive printers. The Model 88T comes standard with a dual tractor/pressure-roll paper feed system and a serial/parallel interface. The tractor paper feed system provides the precision required to handle multi copy fanfold forms, ranging in width from 1 inch to 9.5 inches. The pressure-roll paper feed can be used with 8.5 inch roll paper. An optional sheet feeder is available for feeding single sheets. A long life ribbon cartridge gives crisp, clean print without messy ribbon changing. The microprocessor based controller has 80, 96, 120 or 132 column formating capability while printing upper and lower case characters bi-directionally at 100 characters per second. Write for complete specifications, pricing and distributor list.

mpi

MICRO PERIPHERALS, INC./2099 WEST 2200 SOUTH/SALT LAKE CITY, UTAH 84119/(801) 973-6053

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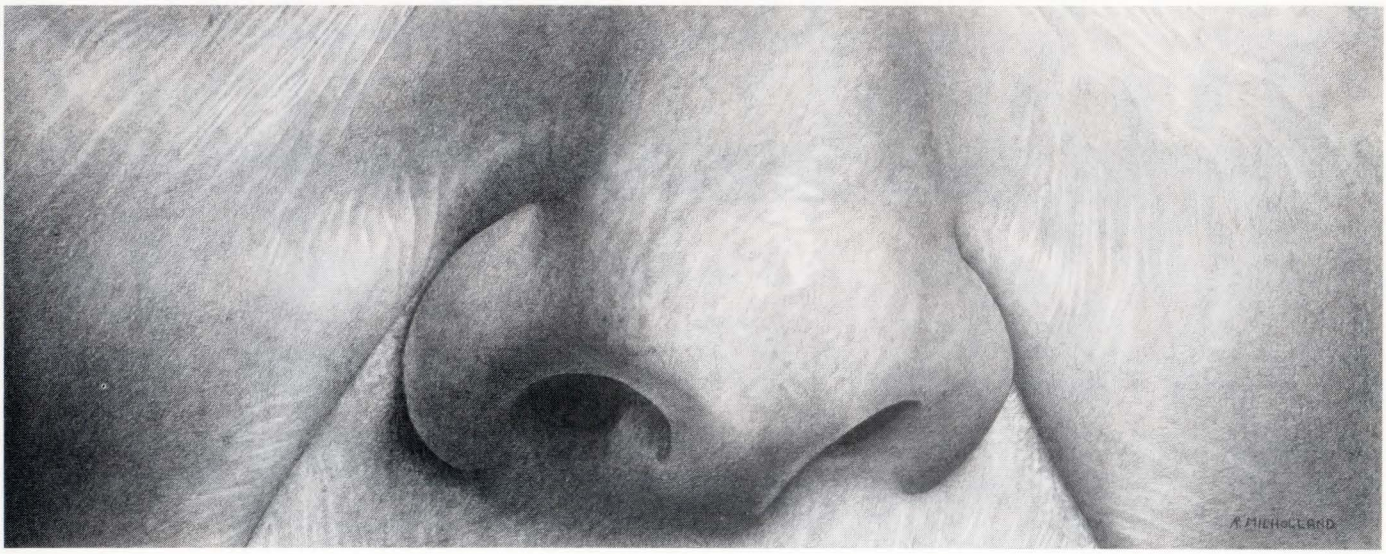
Nosey, nosey, nosey.



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Circle 53 on Reader Inquiry Card

New Products

MODULAR 8″ WINCHESTER. XYLOS is a modular, rack-mountable system that allows users to combine a choice of disk capacities up to 40MB, a tape cartridge and a complete LSI-11 in a powered chassis 10.5″ high. System features single-card microprogrammed peripheral processors for software transparent emulation of DEC I/O handling protocols. Three configurations are available: XYLOS-1 has one 24MB 8″ Winchester drive, XYLOS-2 includes two drives, and XYLOS-3 includes two drives and a 17MB cartridge tape for disk backup and program loading. XYLOS-1, $6250 (OEM quantities). **Xylogics, Inc,** 42 Third Ave, Burlington, MA 01803. **Circle 151**

FIRST, DUAL DENSITY, SINGLE BOARD TAPE CONTROLLER FOR PDP-11/VAX-11 The TFC-822 supports up to 8 transports and allows mixing of two tape speeds as well as mixing of both NRZI and dual density drives. Other features include internal diagnostics on power-up, on-the-fly read/write, software controlled byte swapping for IBM and DEC packing and optional read/write of gapless tape. Delivery, 30 days ARO. $3000 in OEM quantities. **Aviv Corp,** 6 Cummings Pk, Woburn, MA 01801. **Circle 159**

ANSI-COMPATIBLE CRT TERMINAL. Implementing most of the ANSI X3.64-1979 standard, the Ambassador operates KSR or Block mode and is standard with editing, erasure, cursor movement and transmission commands. It can also set up qualified areas (protected, guarded, numeric, security) and five graphic renditions (blink, bold, reverse, underline, blank). Setup Mode allows selection of baud rates from 110 to 19,200, send and print parameters, cursor rendition, bell and keyclick controls, and local mode controls. Terminal's memory is 60 lines of 80 characters; display format ranges from 18 to 60 lines. The Ambassador is standard with 15″ non-glare screen and 940-key detached keyboard. Prices start at $1300. **Ann Arbor Terminals,** 6175 Jackson Rd, Ann Arbor, MI 48103. **Circle 202**

EMBEDDED FORMATTER. This formatter, though specifically designed for use with TDX Series II magnetic tape drives, utilizes an industry standard controller interface. It uses a bipolar μP handling 800 bpi NRZ, 1600 bpi PE, or 800/1600 bpi Dual Density formats. Low cost is made possible by the unit's small parts count, says the manufacturer; formatter uses only 25 ICs for the NRZ, and only 89 ICs for PE or Dual Density designs. Software utilizes an industry standard type of command structure. 800 bpi NRZ Model, $995; 1600 bpi PE or Dual Density Model, $1495 (single unit). **TDX Peripherals,** 150 New York Ave, Halesite, NY 11743. **Circle 216**

NEW COST-EFFECTIVE UPS LINE SHOWN AT WESCON A new Utility Power Storage (UPS) will be introduced by Elgar at WESCON, September 16-18. Unlike conventional UPS', which have the battery charger and inverter constantly "on line", the new series incorporates a voltage regulator and noise filter with adequate energy storage to maintain output power continuity through a one-half cycle interruption of power. This storage provides a 100% safety margin while a static switch transfers the load to the output of the off-line inverter. Normal power flow bypasses inverter. Continuous operating efficiencies in the 90% range offer considerable savings in energy cost. **Elgar,** 8225 Mercury Ct, San Diego, CA 92111. **Circle 208**

Bit-Slice NIGHTMARES

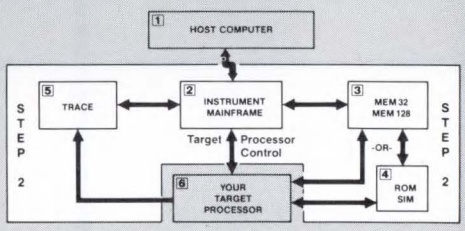
Microprogramming Nightmares . . . That STEP-2 Has Banished

NIGHTMARE #		NIGHTMARE COST*
#1	We only used up $50,000 worth of PROM's during development. What do you mean, Production is short of them?	$50,000 + Late Product
#2	Our bit-slice system almost works.	Bankruptcy?
#3	Real-time testing wasn't important. Of course Charlie's still "tightening" code.	Maintainability + $100,000?
#4	Charlie's home built simulator didn't break down until after he left for Germany.	Project Delay + $32,000?
#5	How can they scrap the project? We have only been debugging for six months.	Market Share + $250,000?
#6	It is just another 2 hour assembly	Frustation

Get Rid Of Your Nightmare . . . Wake Up To STEP-2

Not just another bit-slice development system . . . a complete solution to your microcoding problems:
- Microcode development in-circuit
- Real-time memory simulation
- Fast word-oriented microcode editing
- Real-time trace of processor activity

STEP-2 surrounds your processor, giving you the flexibility needed to turn your nightmare into a sweet dream. With STEP-2, you spot a bug, track it, recode, kill it . . . and sleep nights.



1 Use **any** computer to develop microcode: STEP will provide the meta assembler if you need one. Advantages: less startup time—no new operating system to learn—faster code development—quicker assemblies, simultaneous hardware and software development—less cost using existing computer. No computer? In many cases STEP-2 *plus* a computer costs less than our nearest competitor!

2 STEP-2 is a standalone interactive development instrument with: integral CRT, keyboard, word oriented microcode editor, communications facility with upload/download routines, control port for target processor, reconfigurable memory, and simple, fast-learn command routines. All in the base price.

3 Real-time reconfigurable memory simulation from 8 to 192 bits. You configure STEP-2 array size for each new project. Choose from both memory families:
- MEM 32 for fast controller applications: depth to 2k, worst case access time to **36ns**
- MEM 128 for processing applications: depths to 48k, worst case access time to **50ns**

Bonus: STEP-2 handles one memory array or several, pipelined or not.

4 ROM simulation cable family allows you to plug into existing PROM sockets on any target processor.

5 Real-time Trace for synchronous capture of processor states at cycle times to 90ns. A selection of triggering equations and modes from self-teaching menus simplify complex setups.

6 Your processor/controller under development is supported by STEP-2 *regardless* of configuration. Doubt it? Call Curtis at (408) 733-7837.

***Good equipment pays for itself. STEP-2 is priced from $4,950 to $49,500. Call STEP today for a quote.**

STEP ENGINEERING
P.O. Box 61166, 757 Pastoria Ave. Sunnyvale, CA 94088 • (408) 733-7837

Circle 79 on Reader Inquiry Card

SINGLE OUTPUT IC REGULATED OEM SERIES EAPS U

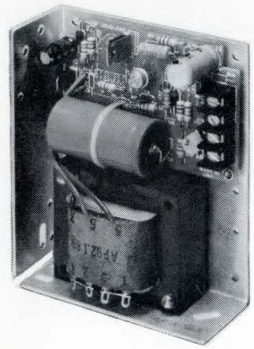
MEETS U L AND C S A REQUIREMENTS

Not available through distributors contact the engineering sales office near you. Minimum sales order 50 units.

FEATURES

- 3 way barrier block output terminals screw, solder connection or fast on tabs
- Higher efficiency cooler operation 45% efficiency at 5VDC, 60% at 15VDC
- Better noise immunity dual input electro-statically shielded transformer
- High reliability over 100,000 hr MTBF (5V 6A per MIL-HDBK-217B at 40°C ambient, full load, nominal line)
- Metal Cased Hermetically Sealed Pass Transistors used on all units over 25 watts
- 85°C 10 yr life computer Grade capacitors
- Meets UL and CSA requirements
- Full 5 yr warranty
- Metal Cased Hermetically Sealed IC regulator
- Fully enclosed, dustproof, insulated Potentiometers
- Wider input line voltage range 103-130V/206-260V 47-63Hz
- Thinner profile 3 plane mounting

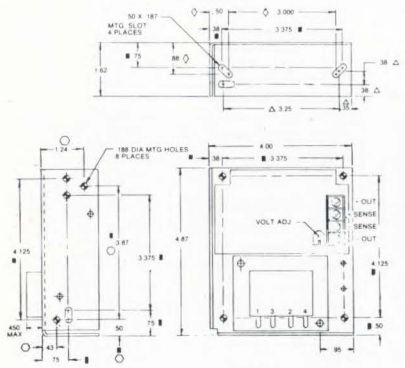
$22.25



10-15 Watts

HB Case Series
Meets U.L. and C.S.A. Requirements
5 Vdc @ 1.2 Amps to 24 Vdc @ 0.6 Amps
Optional OVP available for 5V to 24V units

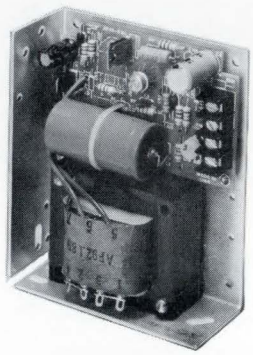
MODEL NUMBER	RATING		REGULATION		RIPPLE
	Vdc	Amps	Line	Load	(Pk/Pk)
EAPS 5-1.2U	5	1.2	±0.05%	±0.10%	3mV
EAPS 12-0.5U	12	0.5	±0.05%	±0.10%	3mV
EAPS 15-0.5U	15	0.5	±0.05%	±0.10%	3mV
EAPS 24-0.6U	24	0.6	±0.05%	±0.10%	5mV



Weight: 2 lbs

115V INPUT 1-4 JUMPER 1-3 & 2-4
230V INPUT 1-4 JUMPER 3-2 ONLY
NOTE UNLESS OTHERWISE SPECIFIED

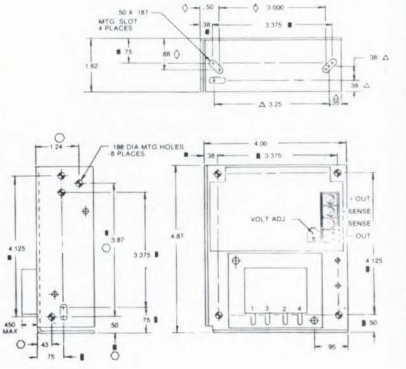
$23.25



15-24 Watts

HB Case Series
Meets UL and CSA Requirements
5VDC @ 3 Amps to 24VDC @ 1.0 Amps
Optional OVP available for 5V to 24V units.

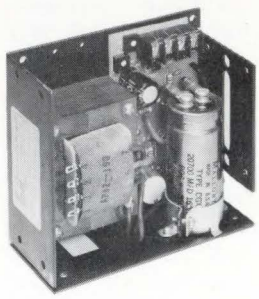
MODEL NUMBER	RATING		REGULATION		RIPPLE
	Vdc	Amps	Line	Load	(Pk/Pk)
EAPS 5-3.0U	5	3.0	±0.05%	±0.10%	5mV
EAPS 12-1.6U	12	1.6	±0.05%	±0.10%	5mV
EAPS 15-1.5U	15	1.5	±0.05%	±0.10%	5mV
EAPS 24-1.0U	24	1.0	±0.05%	±0.10%	5mV



Weight: 2 lbs

115V INPUT 1-4 JUMPER 1-3 & 2-4
230V INPUT 1-4 JUMPER 3-2 ONLY
NOTE UNLESS OTHERWISE SPECIFIED

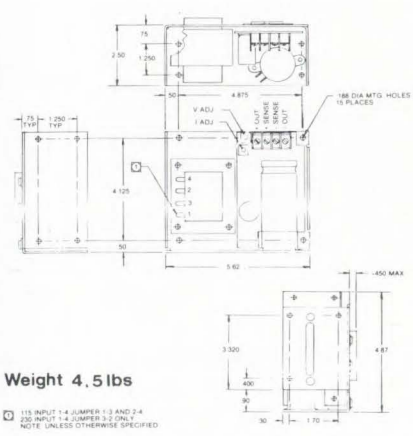
$44.95



30-50 Watts

HC Case Series
Meets UL and CSA requirements
5VDC @ 6 Amps to 24VDC @2.4 Amps
Optional OVP Available for 5V to 24V units

MODEL NUMBER	RATING		REGULATION		RIPPLE
	Vdc	Amps	Line	Load	(Pk/Pk)
EAPS 5-6.0U	5	6.0	±0.05%	±0.10%	5mV
EAPS 12-3.4U	12	3.4	±0.05%	±0.10%	5mV
EAPS 15-3.0U	15	3.0	±0.05%	±0.10%	5mV
EAPS 24-2.4U	24	2.4	±0.05%	±0.10%	5mV



Weight 4.5 lbs

115 INPUT 1-4 JUMPER 1-3 AND 2-4
230 INPUT 1-4 JUMPER 3-2 ONLY
NOTE UNLESS OTHERWISE SPECIFIED

NOW! Call Toll Free (800) 854-8288)

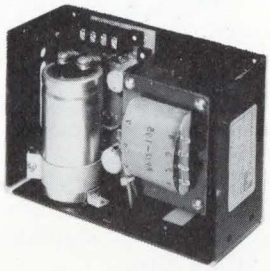
See Page 79 for List of Local ADTECH Field Offices . . .

Specifications:

AC Input: 103-130V/206-260V AC 47/63Hz
Derate 10% at 50Hz
DC Output: See tabulation of models
Line Regulation: ±0.05% for ±10% line change
Load Regulation: ±0.1% for ±50% load change
Ripple: Less than 5Mv peak to peak
Transient Response: Less than 50 microseconds
Short Circuit and
Overload Protection: Automatic recovery foldback current limiting
Reverse Polarity Protection: Standard
Remote Sensing: Standard with open sense lead protection
Output Adjustment: ±5% minimum
Operating Temperature Range: 0°C to +50°C at full power rating. Derate linearly to 40% at 70°C or -20°C
Storage Temperature: -30°C to +85°C
Stability: ±0.1% for 24 hours after warm up
Temperature Coefficient: ±0.01% typical ±0.03% maximum
Vibration: Per MIL-STD-810B method 514, procedure 1, curve AB (to 50Hz)
Shock: Per MIL-STD-810B method 516 procedure
Overvoltage Protection: Optional
Efficiency: 5V units 45%; 12V units 55%; 15V units 60%; 24V units 62%
Line Noise Suppression: Electrostatically shielded transformer

ALL MODELS WARRANTED FOR 5 YEARS

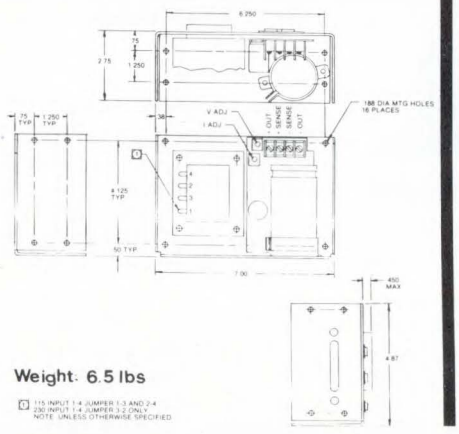
$59.45



50-84 Watts

HN Case Series
Meets UL and CSA Requirements
5 Vdc @ 9 Amps to 24 Vdc @ 3.6 Amps
Optional OVP available for 5V to 24V units

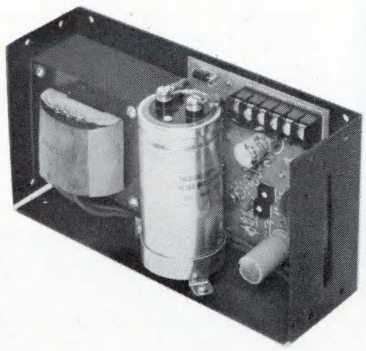
MODEL NUMBER	RATING		REGULATION		RIPPLE
	Vdc	Amps	Line	Load	(Pk/Pk)
EAPS 5-9.0U	5	9.0	±0.05%	±0.10%	5mV
EAPS 12-5.0U	12	5.0	±0.05%	±0.10%	5mV
EAPS 15-4.5U	15	4.5	±0.05%	±0.10%	5mV
EAPS 24-3.6U	24	3.6	±0.05%	±0.10%	5mV



Weight: 6.5 lbs

115 V INPUT: 1-4, JUMPER 1-3 AND 2-4
230 V INPUT: 1-4, JUMPER 3-2 ONLY
NOTE: UNLESS OTHERWISE SPECIFIED

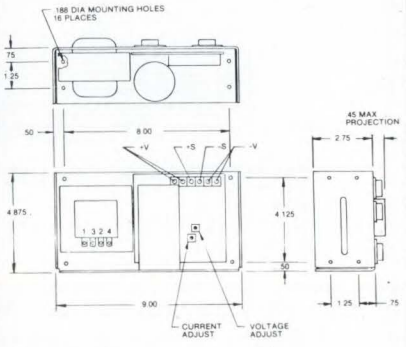
$71.05



60-100 Watts

HD Case Series
Meets UL and CSA Requirements
5 Vdc @ 12 Amps to 24 Vdc @ 4.5 Amps
Optional OVP available for 5V to 24V units

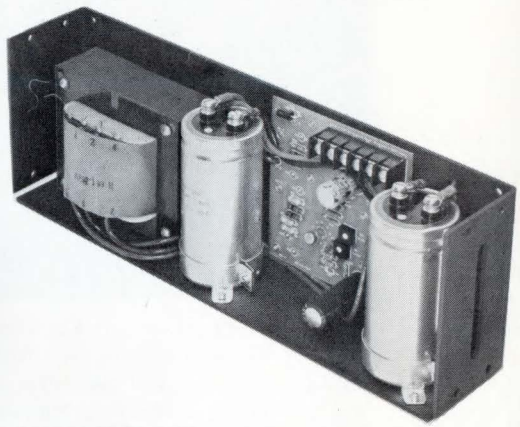
MODEL NUMBER	RATING		REGULATION		RIPPLE
	Vdc	Amps	Line	Load	(Pk/Pk)
EAPS 5-12.0U	5	12.0	±0.05%	±0.10%	5mV
EAPS 12-6.8U	12	6.8	±0.05%	±0.10%	5mV
EAPS 15-6.0U	15	6.0	±0.05%	±0.10%	5mV
EAPS 24-4.5U	24	4.5	±0.05%	±0.10%	5mV



Weight: 7 lbs

115 V INPUT: 1-4, JUMPER 1-3 & 2-4.
230 V INPUT: 1-4, JUMPER 3-2 ONLY

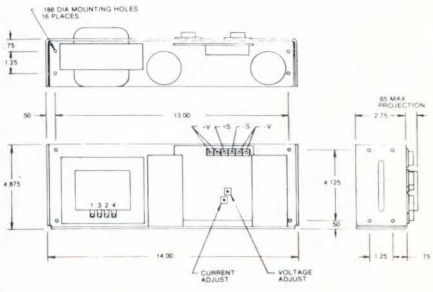
$98.85



90-168 Watts

HE Case Series
Meets UL and CSA Requirements
5 Vdc @ 18 Amps to 24 Vdc @ 7.0 Amps
Optional OVP available for 5V to 24V units

MODEL NUMBER	RATING		REGULATION		RIPPLE
	Vdc	Amps	Line	Load	(Pk/Pk)
EAPS 5-18.0U	5	18.0	±0.05%	±0.10%	5mV
EAPS 12-10.0U	12	10.0	±0.05%	±0.10%	5mV
EAPS 15- 9.0U	15	9.0	±0.05%	±0.10%	5mV
EAPS 24- 7.0U	24	7.0	±0.05%	±0.10%	5mV



Weight: 9.5 lbs

115 V INPUT: 1-4, JUMPER 1-3 & 2-4
230 V INPUT: 1-4, JUMPER 3-2 ONLY

ADTECH POWER SUPPLIES

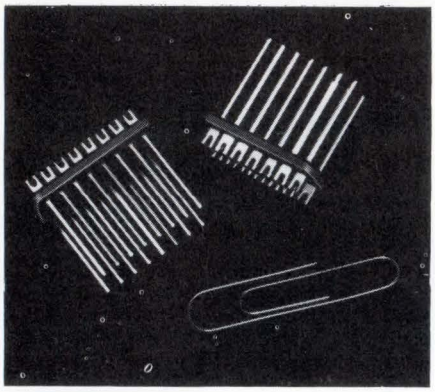
ADTECH POWER

1621 S. Sinclair St., Anaheim, CA 92806 (714) 634-9211 • Telex: 68-1498 • Outside Calif. (800) 854-8288

Circle 54 on Reader Inquiry Card

New Products

COMPONENT CARRIERS. These 14- and 16-pin component carriers, with 3 wrap .025" sq pins, are designed for adhesive mounting to any Cambion wire-wrappable or general purpose board. By mounting components directly to these carriers, discrete components may be soldered into a wire-wrappable array, thereby eliminating



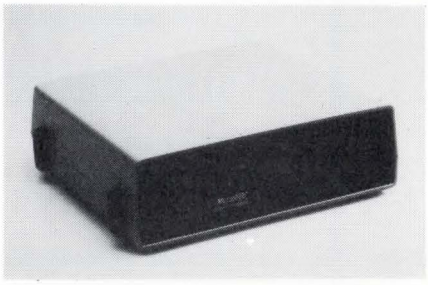
both DIP sockets and socket adapters. Carriers are available in two finishes: hard gold commercial plate over nickel and electrotin plate over copper plate. Models P/N 702-3525 (14-pin) and P/N 702-3526 (16-pin). **Cambion**, 445 Concord Ave, Cambridge, MA 02238.
Circle 215

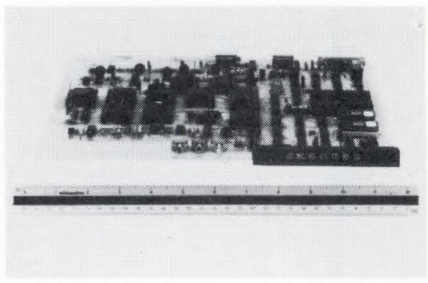
ADDRESSABLE BOARD FOR LOCAL POWER INTERFACE. Parallel addressable multiplexer for local job site monitoring and control. It features Opto 22's optically coupled power I/O modules for industrial interfaces. Power I/O modules can be in any mix of AC/ DC INPUT/OUTPUT to match the job site requirements. The addressable nature of "PAMUX" with on-board switch selection of the address allows one host computer I/O port configuration to be multiplexed by up to 64 PAMUX units via a 50 conductor daisychain cable. Opto 22, 15461 Springdale St., Huntington Beach, CA 92649. **Circle 165**

SINGLE-BOARD DISK CONTROLLER FOR PDP-11 This is the single-board version of Emulex's two-board SC11 with added features, including the ability to mix drives of different capacities and configurations on the same controller without changing any microcode. Also, any number and type of drives can go on any of the four ports without reconfiguring the controller. Via Adaptive DMA Throttle, the controller measures duration of pending NPR requests and adjusts its own DMA activity to insure that other system devices aren't locked out. SC21, approx $3500 (50). **Emulex Corp**, 2001 E Deere Ave, Santa Ana, CA 92705.
Circle 205

RACK-MOUNTABLE LSI-11 COMPUTER SYSTEMS. Complete LSI-11/2 or LSI-11/23 computer systems, (32K to 128K words of MOS memory) featuring fully-compatible DEC software, are now available as packaged systems from Charles River Data Systems beginning at $16,000. A typical system is described as containing an LSI-11/23 processor with 64K words of MOS memory, dual floppy disk system (RX02 equivalent)1 DLV-11J Quad serial interface, and 8 quad slot backplane, plus a 21MB Winchester disk drive. As an option, a fail-safe tape back-up can be ordered in place of the dual floppy system. Software offered as part of the package gives users the choice of RT-11, RSX-11, or UNIX (U/V6). Delivered as completely enclosed housing ready for rack mounting in 30 days ARO. **Charles River Data Systems, Inc.**, 4 Tech Circle, Natick, MA 01760.
Circle 168

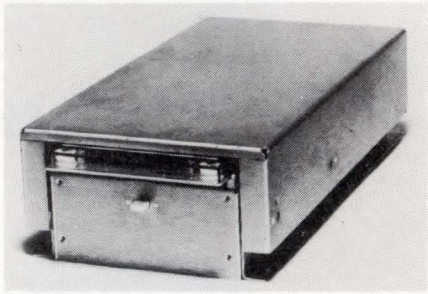
CONCENTRATOR MODEM. Micom Systems claims this high speed modem series with built-in data concentrator and automatic retransmission-on-error is the first of its kind. For DEC and other miniC users, the Micro8000 operates as a cluster controller with built-in modem. Unit operates at 4800 or 9600 bps on standard, unconditioned leased telephone lines and permits 2, 4, 8, or 12 asynchronous data termi-





nals to share the line without changing existing hardware or software. Designed for do-it-yourself installation and troubleshooting by untrained personnel, the Micro8000 weighs only 12 lbs in an 8-channel configuration. Micro-8000 4800 bps modem with 4-channel concentrator, $4750; 9600 bps modem with 8-channel concentrator, $7000. Qty and OEM discounts; Delivery 60 days ARO. **Micom Systems, Inc**, 9551 Irondale Ave, Chatsworth, CA 91311.
Circle 204

LOW-POWER CARTRIDGE-SYSTEM BACK-UP New fully-integrated cartridge-tape system, has both transport and formatter in one compact package that dissipates less than 40 watts. Designed to back-up 8" Winchester drives, Kennedy Model 6450 uses 6400-bits-per-inch recording density and serpentine serial recording. The unit has an unformatted capacity of 17.3MB,



with a 450 DC-300 cartridge and 11.5MB with a 300 cartridge. Transfer rate is 192 K-bits/s. Read/write speed is 30 ips and fast-motion speed is 90 ips. $1700 with OEM discounts available. Delivery, 60-90 days ARO. **Kennedy Co**, 1600 S. Shamrock Ave, Monrovia, CA 91016. **Circle 209**

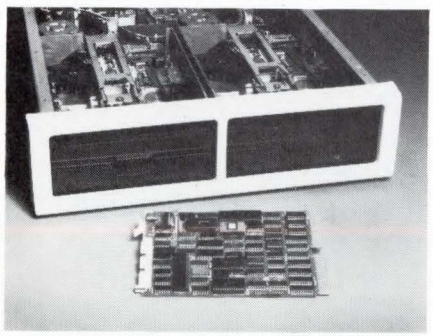
QUAD-SIZE TAPE COUPLER FOR PDP-11. Using a single PDP-11 SPC slot, this intelligent magnetic tape coupler interfaces up to 8 dual density (NRZI/PE) formatted magnetic tape drives (including streamer drives). Model DU-130 μP-based coupler is completely contained on one quad printed circuit module including on-board LED indicators for display of coupler status. Coupler handles 9-track 800/1600 bpi industry standard drives at speeds of 12.5 to 125 ips and features FIFO buffer for DMA latency, automatic test, and software or switch selectable density control. Model DU-130, $1695 (single qty); delivery, stock to 30 days ARO. **DILOG Corp**, 12800-G Garden Grove Blvd, Garden Grove, CA 92643.
Circle 206

NEW FLOPPY DISK-DRIVE PRODUCTS. Two new models utilize LSI Architecture, and a simplified spindle drive mechanism featuring a direct drive DC motor. MTBFs for both models (FDD-403A and FDD-403B) are in excess of 80,000 hours. The models offer a storage capacity of 985 KB in an IBM 26 sector format. With a recording density of 6816 BPI, and a data transfer rate of 500 Kbits/s, the 403 series accepts MFM recording methods. Utilizing IBM Diskette II or equivalent media the units record on 154 tracks. In operation the new models offer track-to-track access times of 3 ms, settling times of 35 ms, and head loading times of 50 ms. **Hitachi America Ltd.**, 100 California St., San Francisco, CA 94111. **Circle 170**

NEW LINE OF MAGNETIC MEDIA. Two new data cartridges and a new special mini-data cartridge provide rugged construction for new applications. Special roller-and-hub retaining systems reduce skew and bit-to-bit jitter. Endless drive bands provide

smooth bi-directional motion to 1/4" tape. ECTYPE DC-300 data cartridge is designed for standard data-processing applications. DC-300Z claims superior performance, high-capacity and high reliability. Up to 2.8 MB capacity for 30-ips read/write and 90-ips search/rewind operations (ANSI format). 204,000-character capacity in IBM format. **Syncom**, PO Box 130, Mitchell, SD 57301. **Circle 144**

FLOPPY DISK CONTROLLER. This controller card has two features: it can identify a drive as either one or two-headed and thereby establish correct control signals; and it automatically recognizes single or double density (DEC RX01 or RX02) formats. The F02CTR emulates a DEC RX02 with the LSI-11, LSI-11/2 or the LSI-11/23 microcomputer and runs DEC RX02 diagnostics as well as on-board, self-test diagnostics. The Controller also has a built-in bootstrap and uses DEC provided hardware. It is 100% media and software compatible with the DEC RX02 floppy. The controller card is configured as a single 5" x 8" dual-width printed-circuit card assembly that plugs directly into the backplane of an LSI-11 Series Microcomputer. A Z-80 microprocessor serves as the central control element and executes self tests by means of internal firm-



ware at power up. Diagnostics consist of a ROM check-sum test, a RAM test, plus interface register and drive bus access tests. $1,170 in single lot quantities. Delivery, 30 days ARO. **Advanced Electronics Design, Inc**, 440 Potrero Ave, Sunnyvale, CA 94086. **Circle 134**

ASSOCIATE PROCESSOR FOR PDP-11 A 250nS instruction execution time for this computer and a 10 megaword/sec DMA rate, enhances the processing ability of PDP-11. I/O between the MIPROC-16 and the PDP-11 is accomplished on a DMA-DMA basis. A general purpose PDP-11 DMA to MIPROC-16 AP DMA software handler is also included. A series of I/O devices including A/D and D/A modules are available. For 32 bit floating point abilities, fast three-card sets for the MIPROC-16 AP are offered. Prices start at $13,750 with CPU, 16K RAM, Program Loader, and MIPROC-PDP-11 DMA (DR11-B) system. Delivery, 60 days ARO. **Plessey Microsystems**, 1954 Clubhouse Rd, Gaithersburg, MD 20760 **Circle 157**

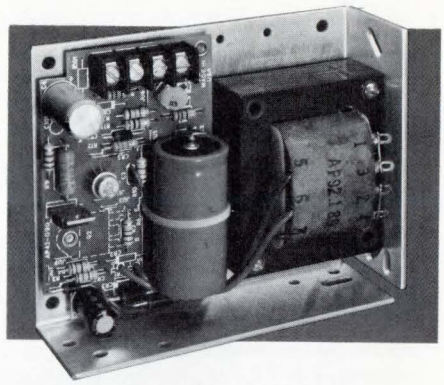
"SUPER" MINIDISK FOR ALL MINI-DISK DRIVES. This flexible 5.25" minidisk is claimed to be compatible with virtually every minidisk drive. The MD 577 Super Mini is certified for 40 tracks and then recertified for 77 tracks to ensure compatibility with virtually any disk drive currently produced. The disk functions with 48, 96 or 100 tpi drives, including the MICROPOLIS MOD II. The MD 577 has a 250 Kbit/s data rate capability, a capacity of 481.3 KB (unformatted), a maximum recording density of 5223 fci ("double density") and track density of 100 tpi. **Verbatim Corp.**, 323 Soquel Way, Sunnyvale, CA 94086. **Circle 164**

40MB 8" FIXED DISK DRIVE. In addition to 8- and 24MB models, **BASF** now manufactures 40MB 8" fixed disk drives. Latest member of the 6170 Series, the model incorporates three disks. Like the rest of the family, it offers data transfer rate of 800 kB per second, and a data access time of 50 ms. MTBF is calculated at 10,000 hours. The actuator and drive motors are located outside the sealed air flow environment, preventing heat buildup and lengthening motor life. A brushless DC motor directly drives the disk spindle. **BASF Systems**, Crosby Dr, Bedford, MA 01730. **Circle 183**

TAPE SYSTEMS FOR VAX-11/780. By using a newly developed VMS driver, you can now interface the VAX-11/780 to a TC-130. The systems handle up to eight industry-standard tape drives. Complete TS-130/VAX tape subsystms, including a single 45-ips dual density 800-1600 bpi drive, start at $7600. VAX users can purchase a VMS driver/TC-130 controller package for their industry-standard drive for $3500 (unit qty). **Western Peripherals Div, Wespercorp**, 1100 Claudina Pl, Anaheim, CA 92805. **Circle 203**

Adtech EAPS"U" Series Power Supplies

See Ad Pages . . . 76, 77



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INTERFACE PROVIDES 1 MEGABAUD DMA TRANSFERS BETWEEN PDP-11'S This Unibus compatible interface permits DMA block transfers between as many as 255 PDP-11 processors at a one megabaud rate over a single coaxial cable up to 32,000′ long. The 11-0016 is packaged on standard 8-1/2″ × 12″ quad board and plugs directly into the PDP-11 back plane. The communications protocol is synchronous data link control (SDLC). Implemented in hardware on all Megalinks, the protocol and control functions require no program intervention. A standard one megabaud Computrol Model 30-0078 coaxial cable modem is incorporated in the communication module. Model 11-0016 is $4,520 in quantities of 10. Delivery, 30 days. **Computrol Corp,** 15 Ethan Allen Hwy, Ridgefield, CT 06877 **Circle 189**

FIRST 11MHz 8048 CHIP The industry's first 11MHz 8048, one-chip microcomputer, offers the user an economical way to upgrade speed performance in 8048-based systems. The 11MHz speed advantage is a result of the company's innovative XMOS processing (high-speed, low power technology.) The company now supplies a full line of both 6 and 11MHz 8048 family devices, ranging from the INS 8048 with 1Kx8 internal ROM to the INS 8050 4Kx8. **National Semiconductor Corp,** 2900 Semiconductor Dr, Santa Clara, CA 95051 **Circle 192**

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Circle 55 on Reader Inquiry Card

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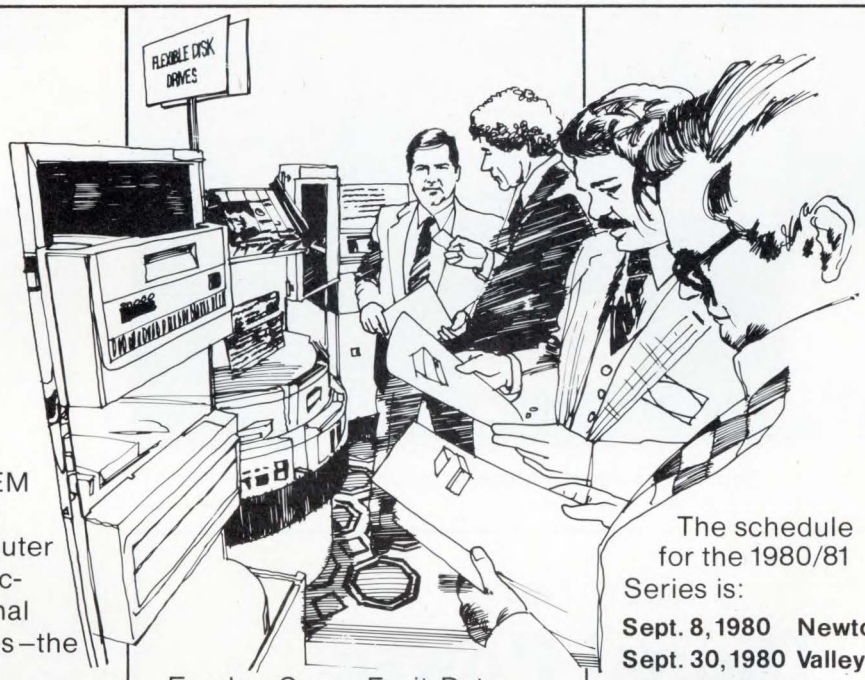

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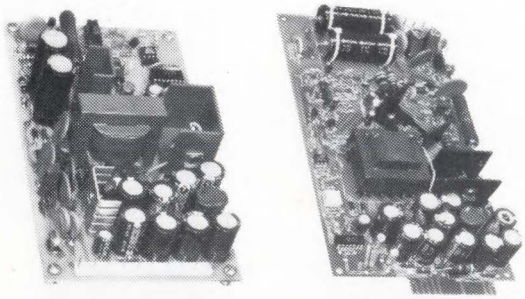

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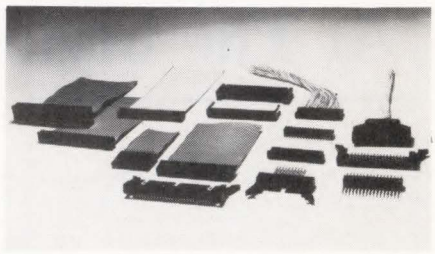

plated over nickel to ensure purity of the solder bath. The FCN 730 connector is part of the FCN 700 series connectors developed by Fujitsu for mass termination of flat cables with AWG #30 solid wire. They are available in a variety of types permitting neat, simplified assembly and interwiring of PC boards. **Fujitsu America, Inc.**, Component Sales Div., 910 Sherwood DR-23, Lake Bluff, IL 60044. **Circle 132**

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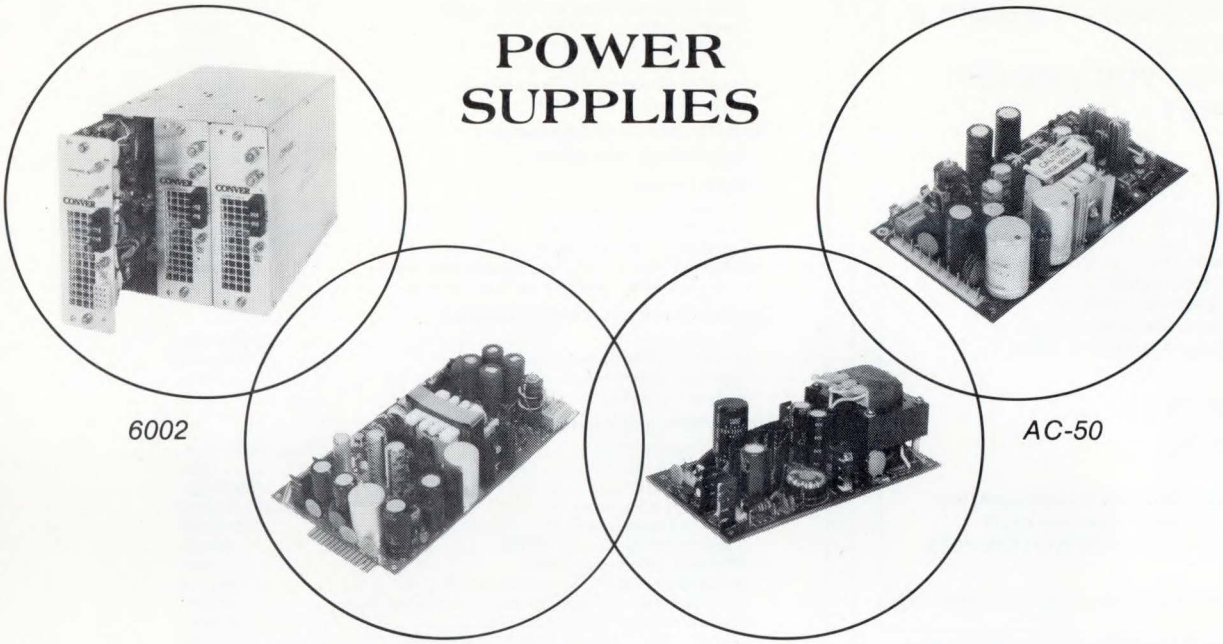

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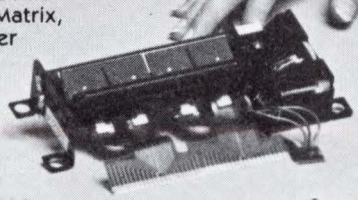
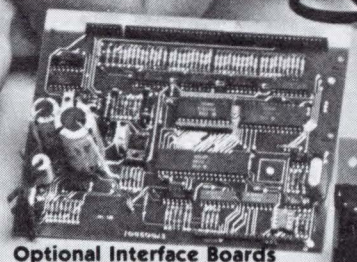
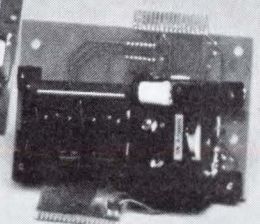
Dot Matrix,
Plotter



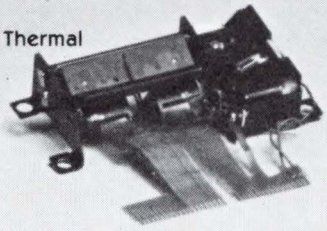


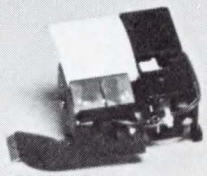
Optional Interface Boards



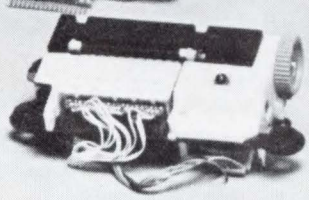
PU1800—
20 Column Thermal,
120 L.P.M.

PU1828—
28 Column Thermal
240 L.P.M.
Dot Matrix,
Plotter





PU1808—
16 Column Thermal,
120 L.P.M.



PU1100—
20 Column
Impact,
120 L.P.M.

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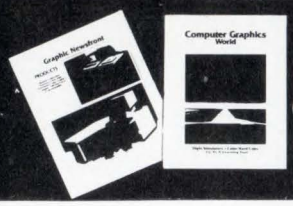

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New Products

TOP-LOADING CARTRIDGE FOR LOW-COST DEC DRIVE A new servo technology controls signals which are interspersed on both data surfaces of this disk. The embedded servo signals position read-write heads to provide increased data integrity. Each surface of the #4443 Cartridge contains 256 tracks. Recording density is 3725 bpi, density is 125 tpi, and operating speed is 2400 rpm. The removable 4443 weighs approximately 5-1/4 pounds and contains a recording disk 14″ in diameter that is 0.075″ thick. Nashua 4443 disk cartridges are compatible with DEC's RL01 drive. All 4443 cartridges are factory-formatted. **Nashua Corp,** 44 Franklin St, Nashua, NH 03061 **Circle 171**

GRAPHICS INTERFACE A high-resolution graphics interface (SDI) is designed for use in Cromemco computer systems. The SDI, can be used to display color or black-and-white images with up to 756 by 484 point resolution. Features include high point resolution, color map selection, dual page windowing function, automatic area fill mode, and NTSC broadcast compatibility. The two-board SDI graphics interface is $595. **Cromemco, Inc,** 280 Bernardo Ave, Mountain View, CA 94043 **Circle 181**

HIGH CAPACITY CARTRIDGE TAPE SUBSYSTEM This cartridge tape subsystem (for DG microNOVA) features a 14 MB storage capacity with a .9 MB/min. recording rate. Useful for Winchester back-up, tape spooling, or other storage requirements, it emulates the NOVA 4030 mag/tape system. The 8085 based DMN-1 Cartridge Tape Subsystem operates at 20K cps DMA transfer rate. Using 1 controller slot, the unit requires only 5 1/4″ of vertical mounting space. $2600 in quantities of 25 including controller, tape drive, power supply, and software license. **Alloy Engineering Co, Inc,** 85 Speen St, Framingham, MA 01701 **Circle 182**

SINGLE-BOARD, 8-CHANNEL 12-BIT D/A CONVERTER FOR PDP-11 Industry's first single-board, 8-channel 12-bit (D/A) converter system features full backplane and software compatibility with PDP-11 series and associated UNIBUS. Mounted on a DEC-standard quad-height board, the DT1716 has 8 independent channels of 12-bit D/A conversion. Each channel operates solely under PDP-11 program control and includes an individual, 16-bit data input register. Registers are organized to appear as 8 consecutive read/write locations in the I/O address page and to allow full use of all read-modify-write commands in the PDP-11 instruction set; the base address is jumper selectable. The converter is especially ideal for 8-channel point-plotting applications under command of the PDP-11 instruction set. $1695 in 1-9 quantities. Delivery, 5 days ARO. **Data Translation, Inc,** 4 Strathmore Rd, Natick, MA 01760 **Circle 190**

HIGH LEVEL LANGUAGE FOR MICROCOMPUTER A high-level system-implementation language, (PL/65) is available for Rockwell's AIM 65 microcomputer. The software is designed to improve the productivity of the programmer and to increase program reliability. Control statements such as conditional execution (IF-THEN-ELSE), conditional looping (FOR-TO-BY), coupled with simplified block capability, support structured program design techniques. The PL/65 compiler generates R6500 assembly language source code. In addition, PL/65 allows assembly language instructions to be incorporated in-line in portions of programs. The AIM 65 PL/65 compiler is contained in two 4k byte ROMs which plug directly into the AIM 65 master module. The price, with user's manual, is $125. **Rockwell International,** Electronic Devices Div, 3310 Miraloma Ave, PO Box 3669, Anaheim, CA 92803 **Circle 194**

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LSI-11/23 systems 30 days! a.r.o.

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Your choice of:

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- **RSX-11M**
- **U/V6 (UNIX*)**

MF-211/411

- **LSI-11/2 with 32K words or LSI-11/23 with 64K, 96K or 128K words**
- **RX02 Equivalent Dual Floppy Systems, Single-Sided or Double-Sided, Dual Density**
- **Quad Serial Interface**
- **8 Quad Slot Backplane**

HD-11/HD-11T

- **Shugart Winchester Drive with 21 Megabyte Capacity, Software Equivalent to Four RL01's**
- **DEI Cartridge Tape Back-up (HD-11T)**
- **Controller Card with RL01 Instruction Set Compatibility**

When you plug in to Charles River Data Systems you plug in to innovative, practical solutions to your system design requirements. Solutions like our double-sided, double-density floppy disk systems—offering one megabyte of RX02 equivalent storage per drive. Or our Winchester drive with cartridge tape back-up for fail-safe reliability—in a single enclosure, with a common controller card.

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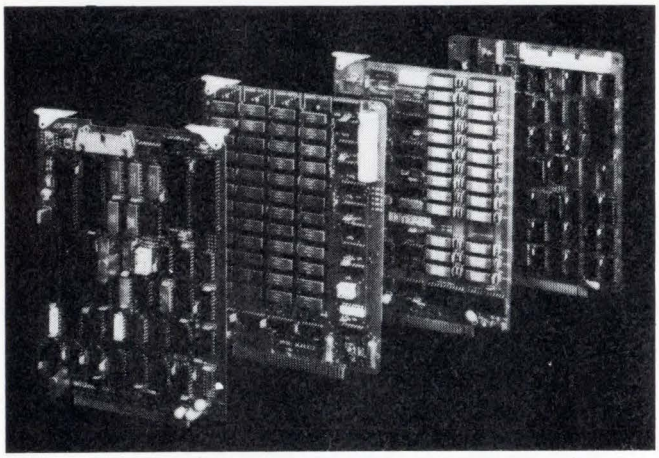
New Products

HARD DISK OPTION FOR LM-80, LM-25 SYSTEMS Hard disk package consists of a 10 MB capacity disk, a controller and a new LOMAC DOS. Cartridge consists of two five megabyte platters, one fixed and the other removable. The removable cartridge readily transfers programs to other systems and system backups. It also provides ability to process collected data on other computers (IBM, DG, DEC, HP, etc.) The hard disk controller will support up to four hard disk drives, for a total of 40 MB storage capacity. The package includes diagnostics and utility programs. Delivery, 90 days ARO. **Lomac Corp,** 3052 Orchard Dr, San Jose, CA 95134 **Circle 172**

LOW-COST ALTERNATIVE FOR PDP-8 An immediately-available alternative to the PDP-8 is this new LSI-8 microcomputer priced at $1500 each in 25-unit quantities. It is claimed to be ideal for medium and high-volume general-purpose applications which require a powerful, reliable and easily-serviced computer. The $1500 price is for a complete 32K system with rack mount chassis and power supply.



Hardware is available at all levels of system configuration from individual boards, card cages, and chassis to complete systems, including flexible disk systems. Typical system boards contain CPU with dual-serial I/O, 32K RAM, 4K battery-backed-up CMOS RAM, and a DMA flexible disk controller. Software available from Intersil for the LSI-8 microcomputer includes operating systems, special handlers, utilities, and cross-assemblers. Other software, such as operating systems and a variety of specific applications are available from Digital Equipment Corporation and DECUS. **Intersil Inc,** 10710 North Tantau Ave, Cupertino, CA 95014 **Circle 173**

MICROHYBRID 2-QUADRANT DIVIDERS Microhybrid dividers are designed to interface with micro-processor based systems. Small modules include a transconductance dividing element, a stable reference and an output amplifier with specified accuracy internally trimmed for feed-through, output zero and gain trim. Models 503 through 506 divide in two quadrants with a transfer function of 10X/Y; dividing errors (at 25°C) range from 1.0 to 0.1% Accuracy specifications include the effects of offset voltage, feedthrough, scale factors and nonlinearity. $65 to $160 in 1-9 quantities. Delivery from stock. Quantity discounts available. **SGR Corp.** Neponset Valley Industrial Pk, PO Box 391, Canton, MA 02021 **Circle 175**

SBC. The PCU-6800 series include the CPU, power-on restart circuitry, system clock and timing circuitry, provisions for mounting RAM and ROM/PROM memory, four parallel programmable I/O ports, a serial RS-232C communications port, optional monitor/debugger firmware, 3 programmable counter/timers, bus drivers and receivers for system expansion and capability to work with slow and dynamic external memory. $525 – $775. **Phoenix Digital Corp,** 3027 N 33rd Dr, Phoenix, AZ 85017 **Circle 177**

SEVEN NEW SPINWRITER FONTS Seven additional new fonts from this company include first-time-offerings for the medical, pharmaceutical, chemical and publishing industries. The new multilingual fonts print over 30 different languages. Typical offerings include the Scientific/Times Roman font, which was specifically designed for the chemical, pharmaceutical and medical industries. The Super Courier/Publishers font was tailored for the newspaper and publishing industries. The Greek/Times Roman font combines both conversational English and Greek. **NEC Information Systems, Inc,** 5 Militia Dr, Lexington, MA 02173 **Circle 178**

TRANSACTION MONITORING FACILITY TMF is a system-level capability that simplifies the task of designing transaction oriented data management applications on a Tandem system by providing a number of facilities to maintain data base consistency during concurrent transaction processing. The data base can reside on a single Tandem system or can be distributed over multiple nodes of a GUARDIAN/EXPAND network. In either case, TMF ensures that the data base remains consistent in the event of a program failure, a single component failure or even the total loss of communications between nodes. **Tandem Computers, Inc,** World Headquarters, Cupertino, CA **Circle 179**

COLOR VIDEO TERMINAL This new color raster scan display is offered as part of a graphics workstation. Also included are an alphanumeric keyboard, and choice of tablets with electronic pens. The 19-inch display has a bright, high-contrast picture with eight colors (red, blue, yellow, green, magenta, cyan white and black.) A selective erase capability allows an operator to remove selected components without repainting the entire screen. The display is designed for use with the company's Video PCB and Super VLSI interactive graphics systems. Prices of the color workstations begin at $51,300. Delivery of the first system with color video workstations was scheduled for July 1980. **Applicon Inc,** 32 Second Ave, Burlington, MA 01803 **Circle 191**

PASCAL AT 'BASIC' PRICES: $175 SORCIM has lowered the price of its PASCAL/M release two product (compiler, emulator, runtime library and ninety page user manual) to $175. Release two has been improved to support long integers, full random input and output, and Boolean output. Pascal/M runs under the popular CP/M operating system and supports the full Pascal Language plus extension for assembly language externals, ADA syntax random I/O, a complete run time recovery system plus over forty additional built in procedures. The product is available to run on either the 8080-85 or Z80 with additional versions supporting the AMD 9511 and GODBOUT 8085-8088. **SORCIM,** 2273 Calle de Luna, Santa Clara, CA 95050 **Circle 195**

PASCAL LANGUAGE SUPPORT FOR Z-80 The new product (Pascal/8002) is said to simplify the process of programming Z-80 based equipment in the Pascal language using any 8002 development system. The new package solves many problems which were previously barriers to Pascal programming of microprocessors. It provides him with a simple yet flexible set of tools for configuring Pascal programs to meet the machine-dependent constraints of his end product. **Pascal Development Co,** 10381 So. De Anza Blvd, Suite 205, Cupertino, CA, 95014.

Circle 196

VECTOR CAPABILITIES IN A RASTER DEVICE. This new color raster graphics system has 10 times increased speed and offers dynamic line drawing capabilities. Whizzard 7250's high speed digital vector generator has an average pixel writing time of 160 nanoseconds. This speed allows complex pictures to be updated and manipulated at standard 30Hz frame rates on a 512 x 512 color or black-and-white raster monitor screen. The 7250 supports up to four red/green/blue color monitors of 16 colors each; or up to 16 black and white monitors. Wide variety of interfaces available for most popular 16-bit minicomputers. The WHIZZARD 7250 system will be available for deliveries beginning late Summer. Black and white monitor systems will start around $20,000. Color systems will start below $25,000. **Megatek Corp.**, 3931 Sorrento Valley Blvd., San Diego, CA 92121. **Circle 130**

DISK CARTRIDGES, both front- and top-load designs, now are available with features designed to enhance data protection, according to 3M. Top-loading cartridges have a single-action handle which seals the cover to lessen the chance of debris entry. A bottom-cover twist lock centers and locks hub and disk in the cartridge. Front-loading cartridges have a hinge-action access door; the absence of warping and distortion

ensures positive door closure, keeping debris off disk surface. Air doors use the 3M "living hinge" door stop, which has a soft, flexible, folding construction that limits the potential for damage to disk surfaces during handling and shipping. The cartridges come in a variety of sector notch configurations to provide compatibility with virtually any cartridge drive. **3M**, Dept. DR80-9, Box 33600, St. Paul, MN 55133. **Circle 128**

DOS CONVERTER. ISIS, CP/M, or polyFORTH can be run on the SBC-80/20 CPU Board by use of the SW-800 conversion kit. Package includes an instruction manual that describes the required hardware modifications to the board. A cold boot loader, monitor, and disk modifying program come on a single 2716 EPROM that plugs into the SBC-80/20 Board. Full use of the Disk Operating System implies the addition of 64K BYTE RAM and a Diskette Hardware Subsystem; also, a standard CRT terminal is a necessity. Model SW-800, $450. **Zendex Corp**, 6398 Dougherty Rd, Dublin, CA 94566. **Circle 126**

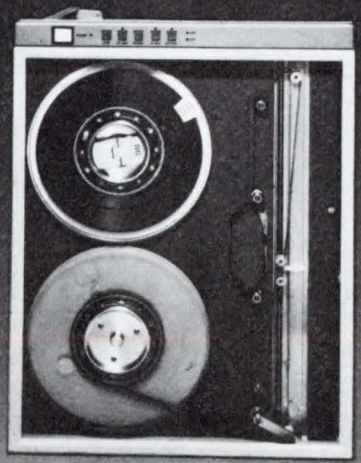
DISK STORAGE SYSTEMS FOR DATA GENERAL Single-board controller emulates Data General's ZEBRA (6057/6060/6061) disk systems. The 3100 Controller is designed for large data base environments, and permits daisy-chaining up to four CDC Storage Module Drives for a total capacity of up to 2,700 MB. The emulating 3100 single-board Controller mounts within the minicomputer; uses a single, resident I/O slot; employs a fast 2901 bit-slice μP; and offers an optional dual-CPU capability for configuring redundant, non-stop systems where downtime is intolerable. **System Industries**, 525 Oakmead Pkwy, Sunnyvale, CA 94086. **Circle 158**

$3550.

The new 75 ips TDX Series II Tape Drives – Priced from $3550 in OEM quantities.*

Fully IBM compatible. No program restrictions. Industry standard interface. Patented low inertia tape tensioning system.

*Includes complete 800 or 1600 bpi tape drives in 100 per year quantity. Dual Density 800/1600 bpi version — $3750. Contact Tad Richardson for additional details.



TDX PERIPHERALS
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150 New York Avenue, Halesite, NY 11743
(516) 423-3232

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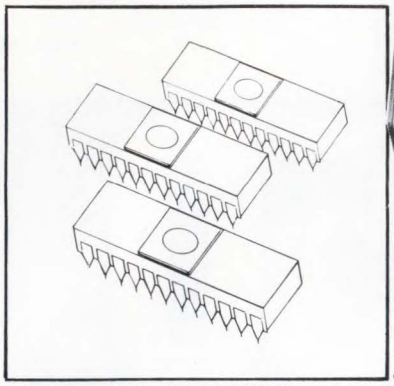
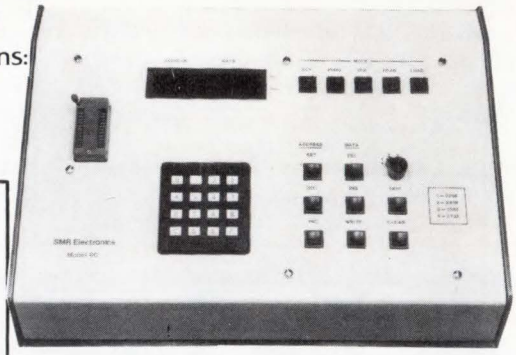
A Low-Cost EPROM Programmer: $1345

The Model 80 Programs These single supply EPROMS to manufacturer's specifications:

- 2758
- 2532
- 2516
- 2732
- 2716





The Model 80 is a versatile, stand-alone EPROM programmer. Because it is self-contained, it doesn't tie up your development system. The Model 80 allows program entry via paneled keyboard or serial interface RS232, and features true hexidecimal display of address and data with editing capabilities allowing data insertion, deletion, and resequencing. The Model 80 has a bi-directional ASCII-Hex Serial Interface with Intel and Motorola among its standard formats and others available as specials. Get more information today.

SMR Electronics, Inc. P.O. Box 275, Sharon, MA 02067

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Clifton's brushless dc motors for Winchester drives offer you these important advantages:

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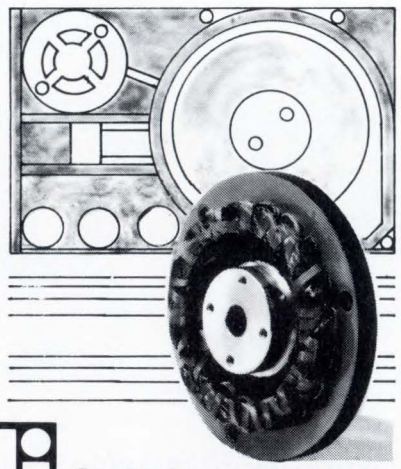
Clifton has the capability to provide a wide range of brushless dc motor packages to meet virtually any set of requirements. To review your needs, call Carey Walter at (215) 622-1000 today.



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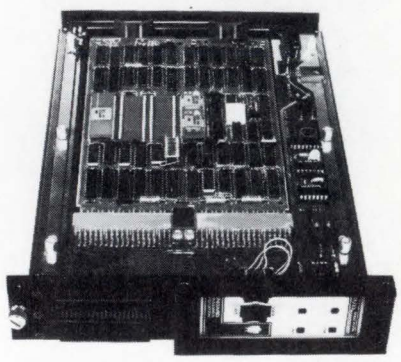
Circle 142

HALF-SIZE DISK DRIVES. At 2.1 inches high, these 8" floppy disk drives are half the height of other models. By installing two of these drives in the same cabinet space presently occupied by one drive, storage capacity of word processors and small computers can be doubled. Both dual and single headed models are available. Storage capacity is 800 kB for the single headed model, 1600 kB for the dual. Both models accommodate FM, MFM, or M^2FM encoding. **Micro Peripherals, Inc**, 9754 Deering Ave, Chatsworth, CA 91311.

Circle 146

LSI-11/23 BASED μC. MIK-11/23 μC system adapts the LSI-11/23 processor to the Computer Automated Measurement and Control (CAMAC) standard for data acquisition, process control and software development. Unit is two to four times faster than LSI-11/2 based models, and features 400-plus PDP-11 instruction set, asynchronous



serial port for interfacing RS-232C and 20 mA loop terminals, and a controller board to interface the processor to the CAMAC data bus. Also, this model supports RT-11, RSX-11M, and all DEC PDP-11 software, and has memory management for addressing 128K words of resident memory. **Standard Engineering Corp**, 44800 Industrial Dr, Fremont, CA 94538. **Circle 152**

FORMATTER, EDITOR, PROCESSOR (some new items from Perkin-Elmer.)

EMBEDDED TAPE FORMATTER. Mounted in the rear of the tape drive, this formatter provides control for up to four tape drives from a single controller. When daisy-chained with a second formatter, up to eight drives are controlled. IBM/ANSI compatible, it operates at data densities of 1600 bpi in PE and 800 bpi in NRZI, and also provides all the necessary logic for writing and reading in either PE or NRZI formats. Models are available for use with NRZI, PE, or dual density 9 track tape drives. Additional control features include continuous read or write (on-the-fly) operations; writing and reading of file marks; edit updating of any record on a previously recorded tape with a new record of the same or shorter length; and special low threshold data recovery circuit. Model 700, $1475 (100). Availability is 60 days.

SUPER OWL EDITING TERMINAL. This device offers compactness, choice of two detachable keyboards, light pen, and communications modes to minimize host computer loading and maximize host control. Configuration details and the 12 (shiftable to 24) function keys are programmable from keyboard (in response to English menus) or downline from host. Information is stored in a nonvolatile EAROM. Field attributes include half intensity, inverse, blink, protected, numeric only, non-display, light pen selectable and most combinations. Model 1250, $1990.

INTEGRATED TRANSACTION PROCESSING SOFTWARE. Reliance II runs Perkin-Elmer's 32-bit Megamini computers and controls up to 128 transaction processing terminals on each minicomputer. Perkin-Elmer also offers a new Interactive Query System, IQ/32, which provides simple user interface for ad hoc queries to data base files. Using IQ/32, management and other user staff can fulfill onetime requests for information without programming. New versions of COBOL and RPG II compilers have also been announced. The COBOL compiler offers performance improvements of 30 to 50% over prior releases. Reliance II is $12,500 (U.S.) , and is available under license immediately. Includes three weeks of training, installation, and maintenance for one year. IQ/32, COBOL, and RPG II are also available under license immediately. $3,000 for IQ/32 (U.S.,) $5,000 for COBOL (U.S.,) and $2,500 for RPG II (U.S.) Additional software copies are available under company's licensing plan at about 10% of the first copy price for multiple system buyers. **Perkin-Elmer,** Computer Systems Div., 2 Crescent Pl, Oceanport, NJ 07757.

Circle 133

magnet wire

FINE AND ULTRA FINE

INSULATIONS AVAILABLE - SINGLE

INSULATION	TEMP RATING	SIZE RANGE	NEMA SPEC.
POLYURETHANE	105°C	AWG 31-56	MW-2C
Vinyl Acetal FORMVAR	105°C	AWG 31-46	MW-15C
SELF-BOND (POLY)	105°C	AWG 31-56	MW-3C
Polyurethane-Nylon POLY-N 130	130°C	AWG 31-56	MW-28C
SELF-BOND (POLY/NYLON)	105°C	AWG 31-56	MW-29C
SELF-BOND (Polyamide) (Polyamide Outercoat)	120°C	AWG 31-56	N.A.
*SOLDERABLE Modified POLYURETHANE 150	150°C	AWG 31-56	N.A.
*SOLDERABLE POLYESTER 170 ESTERMIDE 170	170°C	AWG 31-56	MW-26C
Modified Polyester ESTERMIDE 180	180°C	AWG 31-56	MW-30C

*UL & MILITARY SPECIFICATIONS
NOTE: POLYURETHANE 150 - Solderable in 2 to 3 seconds at 370°C.
ESTERMIDE 170 - Solderable in 2 to 3 seconds at 450°C.

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30-44 AWG available in many insulations-
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(213) 882-8311

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Kentron International, Inc.

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LIKE ATLANTA *OR* PHOENIX *OR* DENVER BUT
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Ken O'Mohundro and **Ray Bell**
Able Computer, Irvine, CA

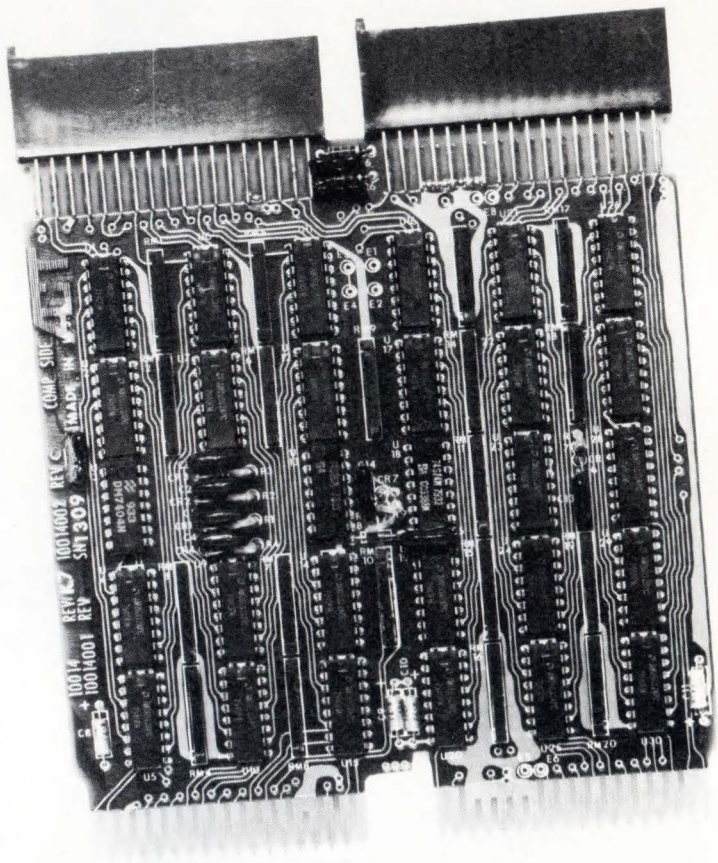
Designers' Guide To DEC Add-In/Add-On Products

There are three kinds of users in the add-in/add-on business: those who *should not* try to use add-in/add-on products, those who should use add-in/add-on products and those who *must* use add-in/add-on products.

When not to buy

Do not buy from an add-in/add-on vendor if you need someone to take service responsibility for your entire system. Add-on vendors usually do not take responsibility for a system, but provide a telephone-support-only service – typically for hardware with little or no software consideration. Those users who work well with this type of telephone support usually have a working knowledge of this computer and can isolate problems. One who simply uses the computer, but is not involved in installation, maintenance, running diagnostics, board replacements, etc., will need on-site support from his system vendor's service group to perform those functions.

You should not buy from an add-in/add-on vendor if you are relying totally on the mainframe house for installation and maintenance of your computer system's hardware and related software. The field service person may or may not provide service for your machine if there are products operating on it that are not his. You may choose to place the add-on item so that it can be easily removed from your system. This may not necessarily be optimum or electrically correct, but it is one solution to continue service by your mainframe house. If you can learn to install and remove your add-on equipment, then you shoulld have no problems in buying those products. But, if you are reluctant to perform these type of operations, you should avoid purchasing the add-on product.



REBUS[tm] (Bus repeater – DB11 replacement). Installs in: All PDP-11's; without using additional backplane space.

When you should buy

Most mainframe houses offer hourly, on-site service to their customers. However, the typical add-in/add-on vendor, limited by his size, does not supply this type of service. Instead, he provides service via a telephone support person. Add-on vendors have found that most problems can be solved, or at least isolated with this type of support. The client who should buy from an add-in/add-on vendor, then, is one who operates comfortably with this level of support from his vendors. Two types of users fall into this category: the OEM and sophisticated end-user.

An OEM is, you might say, an add-on vendor himself. He assumes the responsibility of becoming the computer system supplier for his customers. As such, the OEM's expertise is also in the servicing of such systems. He should be equipped to give the proper on-site support, as well as be the central support source for his customers. He brings together all the different add-on or add-in items of his customer's computer system, and in being equipped to provide this service, he is an excellent candidate to buy from the add-in/add-on vendor himself. He can provide support to his own customers who are not knowledgeable enough to buy directly from the add-in/add-on vendor.

The "sophisticated end-user" is one who is knowledgeable enough about his own computer system to perform the basic range of operational and remedial tasks. This end-user can usually be taught to isolate a probable faulty interface. This includes running diagnostics, removing the device, rerunning diagnostics effecting systems, and being prepared to discuss the type of hardware or software problem (in reasonable detail) with a telephone support person from the add-on vendor. The end-user's needs and the add-on vendor's capabilities are balanced so that they productively compliment one another.

If you are an end-user and are considering buying from an add-in/add-on vendor, you need to determine whether you are both capable and willing to perform the following tasks: (1) install and remove the product from the system; (2) run diagnostics to isolate a problem interface (board level) and (3) be able to provide problem detail and accept and understand corrective instruction via telephone support.

When you must buy

Here is a list of situations in which a user must buy from an add-in/add-on client . . .

- There are times when the product you need requires more space in your system than you have available. Some add-on vendors develop products with the same capabilities as those offered by the mainframe house which take up less space in your system.
- If you find yourself in a financial corner and the alternatives open to you are too expensive to institute, an add-on vendor can often offer you a similar alternative at a lower cost than the mainframe house.
- If it is time for you to move up to the next largest CPU because your needs have outgrown your present computer system and budgetary restrictions will not allow the purchase of an entirely new computer, add-on vendors can provide enhancements which extend the capabilities of your system, thus allowing you to continue using your current system to meet your increased workload.
- In situations like the above one, you need a proven, dependable product, one which can reliably provide the capabilities you need. Certain add-on vendors specialize in these types of reliable products.
- Oftentimes, your computer manufacturer simply does not make the product you need. Add-on vendors, because of their size, tend to spend more time developing these unique products, and also tend to have the capacity to respond more quickly to changes in needs within the market.
- Because of their smaller size and more specialized emphasis, add-on vendors can take the time to solve your individual problems, and satisfy your unique computer system needs.
- You need the product now. An add-on vendor can often supply the required product in a much shorter delivery time than the computer manufacturer can. Again, because of the smaller size, the add-on vendors can work more quickly in responding to your individual needs. For example, in the memory market, a 128K word add-in memory for the PDP-11/45 is not available from DEC. We offer such a memory that upgrades the PDP-11/45 to an equivalency of 1.5 times the internal processing speed of a PDP-11/70. This add-in increases the power of currently-installed PDP-11/45, -11/50, -11/55 systems for those users who cannot or choose not to spend the money to replace those systems.

In the cache memory field, 8-kbyte caches upgrade the throughput of PDP-11/34, -11/34A, -11/35 and -11/40 minis. These caches help make the present system viable for a little bit longer, provide a capability which is not offered by the computer manufacturer, and are backplane-resident and fully software-transparent.

In communication devices, a 16-line multiplexer, which operates at twice the speed or within half the bandwidth required by the DEC DH 11, allows the user to support more communication channels on his system while realizing economies of space, power, bus loading and cost. The DMAX/16, for example, emulates a similar DEC product yet it requires only one-third the amount of standard backplane space in the system as opposed to a dedicated backplane required by the "DEC equivalent."

Sometimes a product is designed by the mainframe manufacturer out of "market necessity", as a "courtesy" to customers or convenience rather than out of a planned development of the product. Such a "necessary" product may only be "timely" – not the best product – and most likely may not reflect a state-of-the-art design. Add-on/add-in vendors take these "necessary" products and make them more efficient and reliable, not just adequate. For example, the REBUS bus repeater fits in line with the UNIBUS cable and replaces a complete system unit, saving considerable space (four full backplane slots) and installation time and maintenance. Also, the design is installed at *any* point in the system where a UNIBUS connection is made.

These are just some of the necessary-type products. Our market strategy was to aim our 20 products primarily at the user who MUST use add-on/add-ins. We appeal to all classes of add-on/add-in product users because they all "add-in" with full software transparency to the diagnostic level and do not associate with any other product that rotates, snaps, pops, slides or moves in any fashion. Such solid state devices lend themselves readily to quick and simple "board-swap" support responses with minimal system impact.

Users must know their specific needs as well as the real capabilities of any add-on vendor because there are so many such vendors in the market to choose from. Serious things to remember when choosing an add-on vendor are to be sure that they know your CPU well enough to work with it, that they can work well with you and the field service group supporting your computer, and that they take an interest in your system, and have sufficient computer-system expertise to assure that they are not going to be careless in working with it. While it is difficult to make a judgement on these things without actually working with the vendor, these are a few things to look for when choosing the vendor, and they may help you to avoid negative encounters which are always overly costly in terms of time, confidence, system integrity and reputation as well as money.

If you find a vendor who has specialized in one mainframe for over three years, you can safely assume he will know that product fairly extensively. The vendor who deals with four or five different computers probably will not be as knowledgeable about your CPU as the one who works specifically with your type of CPU. The add-on/add-in vendor should know your computer well enough to help you in deciding how to make it operate most efficiently and effectively for your specific needs.

What is the future?

Where is the add-in/add-on market going? At this point there are numerous possibilities, almost unlimited vectors of interest to pursue relative to DEC alone. There is the LSI, PDP-11, Mini-Vax, communications, controllers, peripherals, memories, and backplane resident system enhancements.

No matter which computer system application the user implements, the key is choosing the kind of bus he can really build upon. In this area, also, there is a lot of confusion. DEC has introduced the SBI bus, mass bus, mega bus, Q bus, UNIBUS, fast bus. How do you decide which one to choose? The main thing to remember in choosing your bus is how far it can grow with your needs, how much it can expand before it becomes inefficient for you.

Besides needing a bus with expansion capabilities, you need to avoid major software changes. If you need to upgrade so extensively that you need a new system, you will

probably need an entirely new software system as well. But, if you choose a bus that is versatile and thus viable for a long time, you will be saving both time and money by avoiding those major computer system changes.

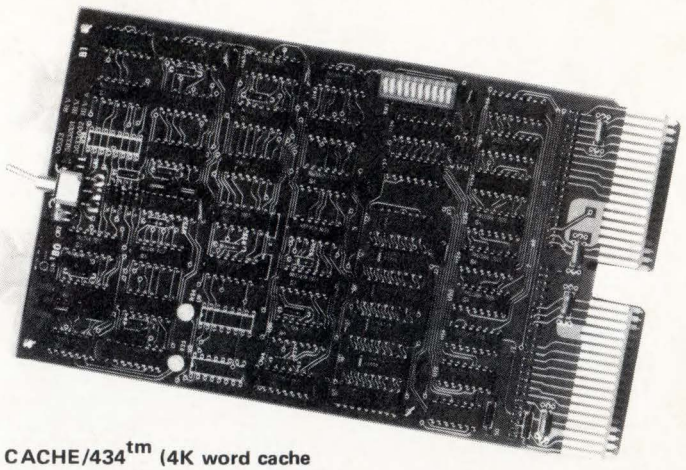
There are a lot of solutions to the question of where to head for the future. People are talking about microprocessors, the Q bus, performance, speed, scurrying about for the newest, latest, and greatest thing. But the truly universal solution to the problem of where to grow is still best served by the DEC UNIBUS. It was in the beginning, is now, and always will be. The UNIBUS is used throughout the DEC line even though there may be other busses as well. The VAX has a UNIBUS. The System 20 provides a UNIBUS. The KL10 mainframe has a UNIBUS. Any peripheral which operates on one of them will operate on all of them. The versatility of the UNIBUS makes people willing to wait for it, and to continue investing in it. The result is a very broad and extremely deep "investment addiction" to the UNIBUS;

For example, compare the UNIBUS and the Q bus, both from the dollars standpoint and the technical standpoint. The Q bus is cheaper. It is cheaper because of computer volumes, if you want to or can handle those kind of volumes. You save money with the Q bus, but you lose the speed of the UNIBUS. The UNIBUS runs at a speed of 300 ns, while the Q bus runs at 600 to 800 ns.

The UNIBUS products are supported by DEC field service, while the Q bus product is handled by distributors. Therefore, Q bus devices are not supported on the system level. With the money you save on the Q bus, you lose the specialized system service of the UNIBUS.

The Q bus can do a lot of things, but its expansion capabilities are limited. If you are looking to grow in the future, and we can assume that you will grow, it is best to look to the UNIBUS or else all that money you saved on the Q bus will have to be used to buy all UNIBUS devices.

What does all of this mean? It means you had better have a number of very sound reasons to invest your confidence in any add-in/add-on vendor. You can profit by such associations – if you pick such a vendor who has established a long and demonstrably good record of *both* product reliability and product support for a very broad base of customers throughout the world.



CACHE/434^{tm} (4K word cache memory). Installs in: PDP-11/34 and -11/34A without using any additional backplane space.

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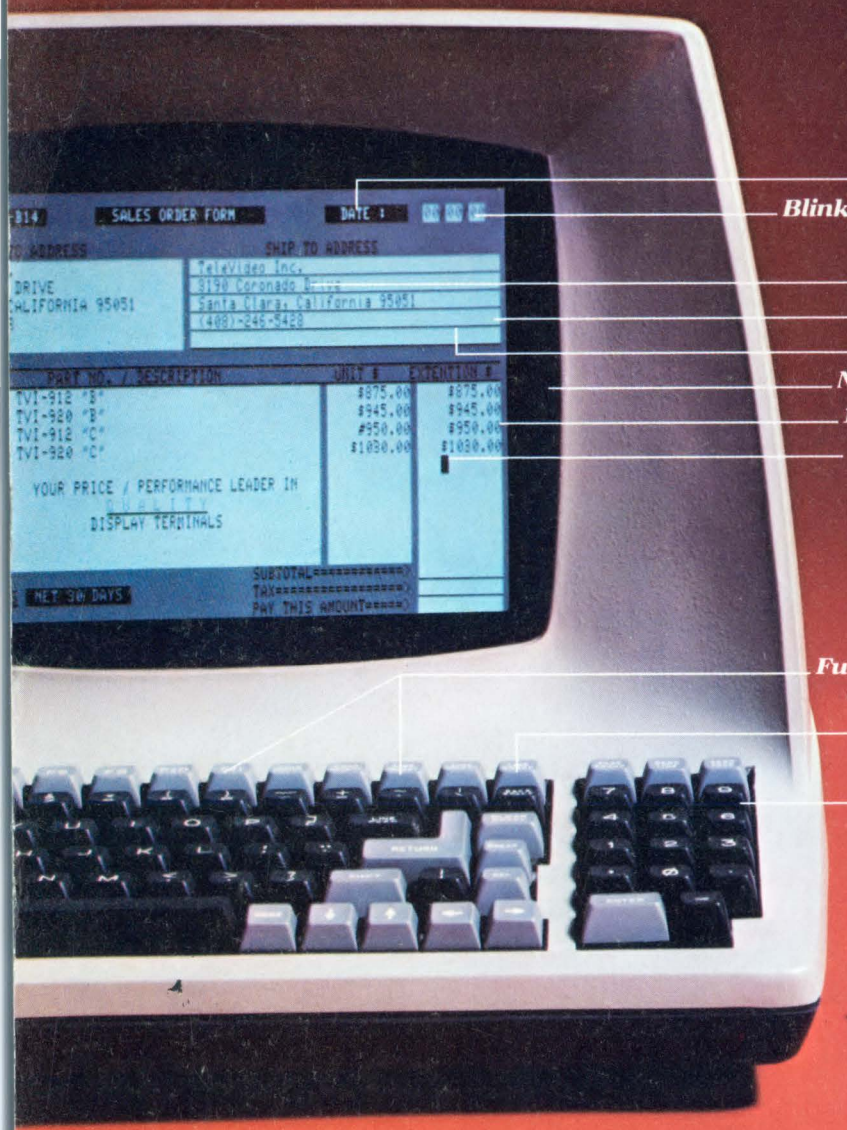

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