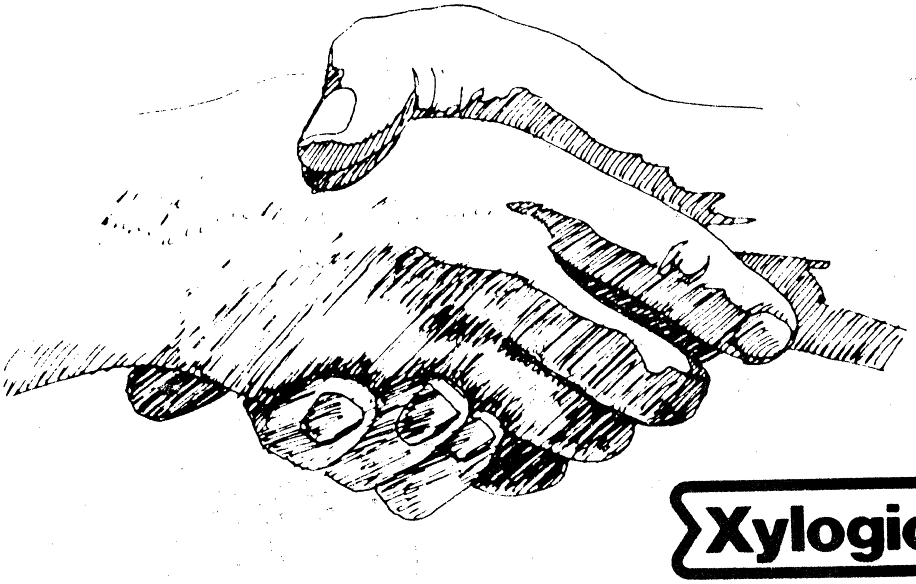
Xylogics

Model 772
User's Manual



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166-772-001
Revision B
August 15, 1987

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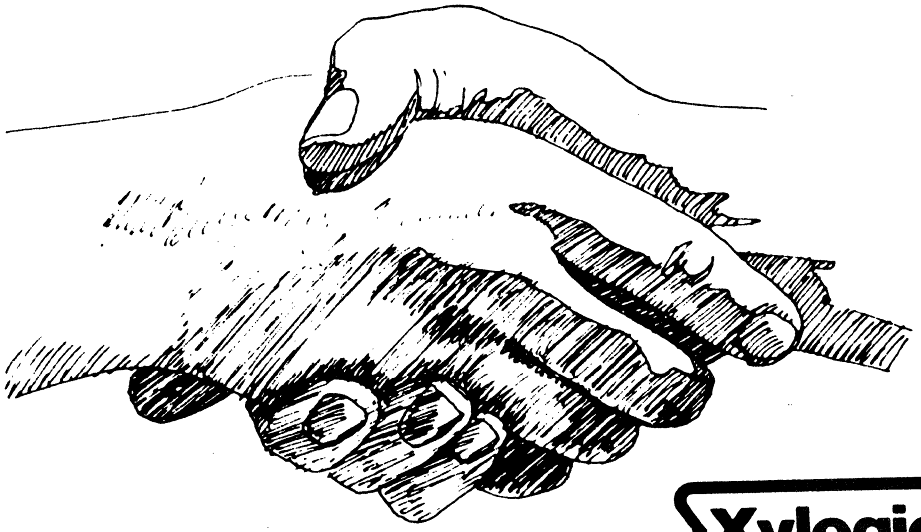

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772 Revision Level History

Revision	Description
A (7/23/86)	Initial release.
B (8/15/87)	Added Byte C (EPROM Release Level) to the Controller Parameters IOPB, and removed Byte 13 (EPROM Subrevision Level).

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SECTION 1: SPECIFICATIONS

1.0 GENERAL

The Xylogics Model 772 tape controller couples up to eight Pertec-formatted Interface 1/2-inch tape drives to VMEbus[1] systems.

1.1 USING THIS MANUAL

Section 1 describes the 772 specifications; Section 2 details how to install the controller; Section 3 describes the 772 registers; Section 4 describes the IOPBs; and Section 5 describes the 772 commands. Section 6 describes error processing; Section 7 is a programming tutorial; Section 8 explains the 772's special functions; Section 9 details the 772 theory of operation; and Section 10 includes drive interface information.

1.1.1 Abbreviations

This manual uses the following mnemonics:

AIO	Add IOPB
AIOP	AIO Pending
AIOR	AIO Response Time
AM	Address Modifier
ASS	Auto-streaming Select
AUD	Auto-update
BHT	Black Hole Transfer
CHEN	Chain Enable
CRIO	Clear Remove IOPB
CRBS	Clear Register Busy
CTYP	Controller Type
DFLT	Drive Fault
DRRDY	Drive Ready
ERRS	Error Summary
FERR	Fatal Error
FIFO	First In/First Out Buffer
H	Notation for Hexadecimal Values
ICS	IOPB Checksum
I/O	Input/Output
IOPB	Input/Output Parameter Block
IRAM	Battery Backed-up RAM
LED	Light Emitting Diode
MMA	Maintenance Mode Active
MM	Maintenance Mode

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[1] VMEbus is a trademark of the VMEbus International Trade Association.

1.1.1 Abbreviations (continued)

NPRM	Non-privileged Register Mode
PNUM	Prom Number
PRIO	Priority IOPB
RBS	Register Busy Semaphore
RIO	Remove IOPB
RMM	Register Maintenance Mode
ROR	Release On Request
SGM	Scatter/Gather Mode
TDT	Throttle Dead Time
THRO	Throttle
TMOD	Transfer Mode
WPT	Write-protect
64KB	65,536 Bytes

1.2 DESIGN RELIABILITY

Xylogics implements the following features to minimize the likelihood of product failure:

- Design for worst case voltage and temperature.
- Extensive evaluation testing.
- Low parts count through extensive use of custom LSI.
- Buffer parity for continuous error checking.
- Low-stress design on all components.
- All components burned-in.
- One card; resides in backplane or expansion chassis.
- Controller is power-cycled under thermal stress during test.

1.3 PHYSICAL

PACKAGING — The 772 resides on one printed circuit board.

DIMENSIONS — The 772 is a 2 by 2 Eurocard standard; it measures 9.2-inches high by 6.3-inches deep (233.35 mm by 160 mm). The 772 is identical in form-factor to the standard VME (dual high-dual wide) printed circuit board.

SHIPPING WEIGHT — 3 pounds (1.4 kg).

CONNECTORS — There are two 50-pin connectors on the edge of the board facing out; they protrude through the optional front panel.

FRONT PANEL — Xylogics offers the 772 with an optional front panel.

1.4 ENVIRONMENTAL

The 772 environmental requirements are 0 to 55° C, with a maximum relative humidity of 90% (without condensation). Air flow across the board must maintain a maximum temperature differential of 7° C to prevent hot spots.

1.5 ELECTRICAL

POWER -- The 772 uses 4.2 amperes at +5 volts DC (VDC).

TOLERANCE -- Voltages must be within plus or minus five percent (4.75 to 5.25).

GROUNDING -- Common earth ground must be established between the tape drives and the CPU chassis, backplane, and expansion cabinets.

1.6 SYSTEM RELATED SPECIFICATIONS

DATA TRANSFER MODES -- The 772 transfers data in Word or Longword mode. The 772 may use byte transfers to align subsequent transfers on word boundaries.

I/O ADDRESSING CAPABILITY -- The 772 decodes byte addresses for its on-board registers.

DATA BUFFERING -- The 772 has a FIFO buffer that is 8k-bytes long and incorporates parity error detection. Data can be put into one end of the FIFO and simultaneously removed at the other end; there are no delays associated with filling and emptying the buffer.

COMMAND BUFFER -- The 772 reads commands into a separate buffer that holds up to fifteen full commands (IOPBs); this minimizes processor intervention and optimizes controller decode overhead. The 772 also stores up to fifty IOPB addresses.

STATUS LEDs -- The 772 implements two status LEDs. L1 (BSY) indicates the controller is active; L2 (ERR) indicates the on-board diagnostics did not complete successfully, or a fatal error occurred.

MULTIPROCESSOR SUPPORT -- The 772 has a built-in register control semaphore. This flag allows multiple processors to share the 772 register set. See Section 8.2 for more information.

SCATTER/GATHER -- The 772 supports Scatter/Gather Read and Write commands. The controller can gather data from various memory locations and transfer it to the buffer for use in a Write command; it can scatter the data out from the tape drive to the appropriate memory locations with a Read command. To execute a scatter/gather, software issues a normal Read or Write command along with a DMA list that contains a memory address and the number of 16-bit words to transfer to/from that location. The smallest granularity of scatter/gather is one 16-bit word.

PRIORITY IOPBs -- The 772 executes priority IOPBs over all IOPBs in its command buffer, except for the one in process.

BLACK HOLE TRANSFERS -- The 772 may transfer all the DMA data into the same bus address without incrementing the address at each DMA.

1.6 SYSTEM RELATED SPECIFICATIONS (continued)

SOFTWARE SUPPORT — Sample software driver supplied for use in UNIX[2] based systems (source included).

SOFTWARE CONTROL — Software can program the 772 for use with various drive configurations, controller parameters, and controller options.

1.7 TAPE DRIVE RELATED SPECIFICATIONS

TAPE INTERFACE — Pertec-formatted Interface.

TAPE DATA TRANSFER RATE — The 772 supports tape drive transfer rates from 20 kilobytes per second (KBS) to 2 megabytes per second (MBS). The tape data transfer rate is a function of tape speed, density, and in certain cases the tape cache speed.

NUMBER OF TAPE DRIVES — The 772 supports up to eight tape drives, including mixed speeds, densities, and types.

DRIVE PARAMETER PASS THROUGH — The 772 supports any tape drive manufacturer's command set via a special command. The 772 allows software to directy manipulate the tape command lines with this special command.

READ/WRITE CONTINUOUS DATA — The 772 can read or write continuous streams of data, up to the the entire tape length, by linking the data addresses together with a special command. This feature is extremely useful in all applications requiring a large amount of data collection.

AUTOMATIC STREAMING CONTROL — To successfully maintain Streaming mode, software must provide commands and data to the 772 within the tape drive's prescribed reinstruct window. If software does not meet this time, and the drive is set for Streaming mode, the drive repositions (causing a performance loss). The 772 automatically shifts the tape drive into Non-streaming mode if software does not meet the reinstruct window, reducing the performance loss to a minimum. If software meets the reinstruct window, the 772 switches the drive back into Streaming mode.

ERROR DETECTION AND RETRY — The 772 allows a great deal of flexibility in dealing with errors, depending on the application. Available options include multiple error reporting, automatic retry on Read or Write operations, and Ignore Read or Write errors. The 772 reports the actual number of bytes transferred, file marks skipped, records spaced, or retries attempted, during Read, Write, and Position operations.

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[2] UNIX is a trademark of AT&T.

1.8 VMEbus RELATED SPECIFICATIONS

VME COMPLIANCE NUMBER — IEEE P1014/D1.0.

TRANSFER MODE — Direct Memory Access (DMA).

DMA THROTTLE CONTROL — Each time the 772 becomes bus master, it executes DMA transfers to or from the buffer up to the max throttle parameter or the number of bytes/spaces available in the buffer.

DMA DATA TRANSFER RATE — The 772 transfers data at a rate of up to 10 MBS; this rate requires Longword mode transfers and a system memory that responds within 200 nanoseconds.

DMA PROCESSOR — The 772 has a custom DMA processor that allows dual channel operation (speeding up the DMA by reducing the inter-transfer overhead).

DMA DEAD TIME — The 772 supports a programmable DMA dead time between throttle bursts. This prevents the 772 from taking over the bus and allows time for other DMA devices to access the bus.

DATA TRANSFER LIMIT — Data transfer length, from 1 to 65,536 bytes. The 772 supports unlimited data transfer lengths via a special command.

BUS COMPATIBILITY — The 772 is compatible with the standard VMEbus.

ADDRESSING CAPABILITY — Full 32-bit support. The 772 supports Master A32, and Slave A16, as per the VMEbus Specification. As a slave, the 772 responds to Address Modifiers 29H and 2DH.

DATA WIDTH — The 772 supports D16 and D32 as per the VMEbus Specification. The 772 transfers data one byte, one word, or one byte and one word at a time until the transfer aligns with a word or longword boundary.

RELEASE ON REQUEST — The 772 releases the bus at the request of other peripheral devices.

RELEASE WHEN DONE — The 772 releases the bus after each bus access.

BUS REQUEST LEVELS — The 772 supports four bus request levels.

INTERRUPT PRIORITY — Software programmable interrupt level and vector.

1.9 SOFTWARE RELATED SPECIFICATIONS

CONTROLLER I/O PARAMETER BLOCK (IOPB) LENGTH — 26 bytes.

CONTROLLER REGISTERS — Seven 8-bit I/O Registers; byte or word addressable. Only eight bits respond during word access.

DIAGNOSTIC SUPPORT — Comprehensive set of stand-alone diagnostics written in 'C' are available.

SOFTWARE INTERFACE — The 772 supports a high level software interface that allows system software to use the same method to add IOPBs to a chain while the controller is busy or while it is free.

1.9.1 Software Interface

The software interface includes seven byte-wide registers. Four of these bytes comprise the VME Address Register, the fifth byte is the Address Modifier Register, the sixth byte is the Control and Status Register (CSR), and the last byte is the Fatal Error Register (FER). The CSR includes two bits that are very important to IOPB processing: Add IOPB (AIO) and Remove IOPB (RIO).

The IOPB is a block of command and status information; it includes the bus address, and the requested operation. The software driver sets up the IOPB in user memory, sends the IOPB address to the VME Address Registers, and sets AIO. After the 772 receives the IOPB address, it resets AIO. The 772 then executes the IOPB and, upon completion or error, updates the IOPB status and sets RIO. The VME Address Registers point to the complete IOPB; the software driver reads the address, and resets RIO.

Software may add IOPBs to the queue, providing AIO is reset, by writing the IOPB address to the address registers, and setting AIO (regardless of the 772's busy status).

1.10 PROGRAMMABLE FEATURES

- Software Controlled Interrupts or Polled operations.
- Software Programmable DMA Parameters.
- Software Controlled Register Response.
- Software Controlled Transfer Retry/Correction.

SECTION 2: INSTALLING AND TESTING THE 772

2.0 GENERAL

Section 2 describes how to unpack, configure, install, and test your 772 controller.

2.1 UNPACKING AND INSPECTION

2.1.1 Inspect the Shipping Carton

Inspect the carton for possible shipping damage. If you determine there is damage, do not unpack the unit. Notify Xylogics and the freight carrier immediately.

If no damage is visible, carefully unpack the 772. Save the carton and other packing material for possible later use.

2.1.2 Contents

The 772 is a single printed circuit board. Optional items include a manual and/or software on a floppy diskette, or 1/2-inch magnetic tape.

If any items are missing or damaged, please contact Xylogics at one of the following telephone numbers.

United States:	(617) 272-8140
United Kingdom (Milton Keynes):	44-908-569444

2.1.3 Handling Precautions

Observing proper handling precautions minimizes the risk of damaging the 772 with electrostatic discharge. When transporting the 772, use an antistatic bag, antistatic bin, or the original shipping carton and packing material. Personnel handling the 772 should observe proper grounding methods including, but not limited to, wrist bands, heel straps, and antistatic mats.

The 772 has a non-volatile memory circuit that employs a lithium battery (at location F6). Do not expose this device to excessive heat (greater than 125° C) as it may ignite or explode.

2.1.4 Inspect the 772

Inspect the 772 for socketed parts that may have loosened during shipment. Make sure all parts are firmly seated in their sockets. If any parts must be reinserted, observe proper orientation.

2.2 CONFIGURING THE 772

You can configure the 772 with several jumper options. The following subsections describe these options.

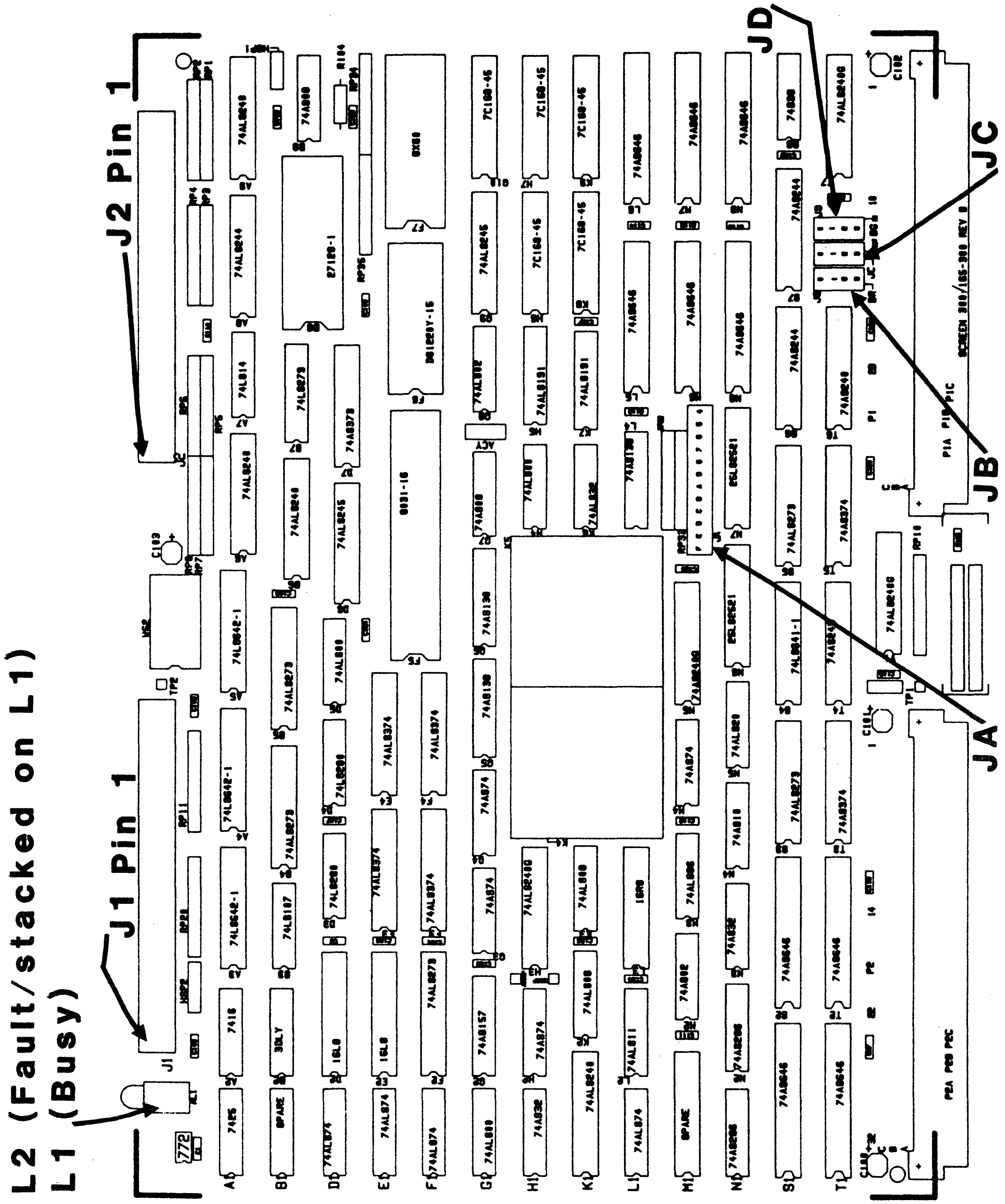


Figure 2-1. 772 - Component Location

2.2.1 Base Address Selection

Jumper block JA controls the base address. Table 2-1 shows how to set the jumpers for commonly used base addresses. Inserting a jumper makes the 772 respond to a 0 on that address line; removing a jumper makes the 772 respond to a 1. Connect the jumper between similar pin numbers on each block. (The 772 uses bits 1 through 3 to determine which register is being accessed.) The 772 is an A16 Slave, and responds to address modifier 02DH, and optionally 29H.

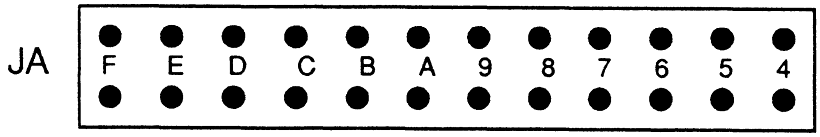


Figure 2-2. Base Address Jumper Block

Address Bit/ Screen Label -->	F	E	D	C	B	A	9	8	7	6	5	4
Address:												
0200	I	I	I	I	I	I	O	I	I	I	I	I
0800	I	I	I	I	O	I	I	I	I	I	I	I
EE70	O	O	O	I	O	O	O	I	I	O	O	O
EE60*	O	O	O	I	O	O	O	I	I	O	O	I

O = Out; I = In;

* Standard Factory Configuration

Table 2-1. Base Address Selection

2.2.2 Bus Request and Bus Grant Lines

The 772 uses the Bus Request and Bus Grant lines to become bus master. In VMEbus arbitration, there are four Bus Request/Grant levels: 0 through 3. The 772 drives one Bus Request line according to the jumper scheme you choose. The arbiter drives the four Bus Grant In lines: BG0IN* through BG3IN*. If the 772 receives a Bus Grant, and is not requesting the bus, it passes the grant by driving the appropriate Bus Grant Out line: BG0OUT* through BG3OUT*.

2.2.2 Bus Request and Bus Grant Lines (continued)

Select a Bus Request level by jumpering one Bus Request (BR0* through BR3*), one Bus Grant In, and one Bus Grant Out line to match the selected request level. Jumper the remaining Bus Grant In/Out lines so that the incoming signal passes through the board (i.e., jumper BGxIN* to BGxOUT*, where x represents the remaining Grant levels).

For example, Figure 2-3 shows the jumpering scheme for level 0 (Figure 2-3A shows the jumper blocks as they actually appear on the board; 2-3B is labeled for this example): jumper JB1 to JB5; then jumper JC1 to JC5, and JD1 to JD5. Jumper the remaining Grant levels from JC6 to JD2, JC7 to JD3, and JC8 to JD4. Factory configuration: Bus Request Level 3.

NOTE

Some VME processors only support Bus Request Level 3.

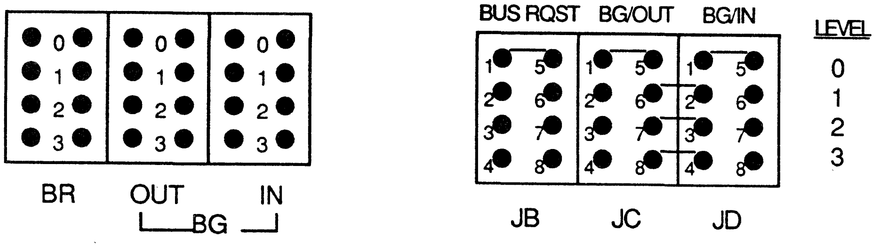


Figure 2-3A. Actual Board Layout

Figure 2-3B. Sample Jumpering Scheme

Figure 2-3. Jumpering Bus Request and Bus Grant Levels

2.2.3 Parallel Arbitration

If you are using the 772 in parallel arbitration, and the Bus Grant Out lines must be isolated from the next slot's Bus Grant In lines, remove all jumpers between JC 5-8 and JD 1-4 (see Figure 2-3B).

2.2.4 Light Emitting Diodes

The 772 has two light emitting diodes (LEDs). L1 (BSY) is the Busy LED (it is located closest to the printed circuit board). L2 (ERR) is the Error LED (it straddles L1). When L2 is on, SYSFAIL is asserted on the VMEbus.

2.3 PROMS AND PALS

Location	Part Number	Type
B8	180-002-138	EPROM
D2	181-001-021	PAL
L3	181-001-019	PAL
E2	181-001-020	PAL

Table 2-2. PROM/PAL Part Number and Location

2.4 BOARD LABELS / REVISION CONTROL

All Xylogics controllers use various revision control labels. This information is important when discussing configuration issues with OEM Engineering. Please familiarize yourself with your board revision levels before contacting us.

```
               772-001-01
                 |   |   |
Product__________|   |   |
Configuration________|   |___Revision Level
```

Figure 2-4. Sample Part Number

2.5 PREPARING THE COMPUTER SYSTEM

The backplane of your system must provide a VMEbus slot for the 772. The slot must be capable of handling a bus master, and the power source must handle the power consumption of the entire system, including the 772.

2.5.1 Backplane Jumpers

Remove any jumpers that short, or cause the Interrupt Acknowledge (IACK IN/OUT) and DMA Grants (BG 0-3 IN/OUT) to bypass the slot in which you are installing the 772.

2.5.2 Card Cage Slot

The card cage must have a slot at the proper DMA priority available for the 772. The 772 uses DMA to transfer data and IOPBs. Placement of the 772 in the DMA priority chain may be critical.

2.5.2 Card Cage Slot (continued)

The amount of bus bandwidth it uses will be high at times; this may affect other boards in the system. Likewise, other boards may not allow enough time for the 772 to DMA enough data to keep up with the tape; consider this when choosing a slot. If the 772 does not get a high enough priority, then its DMA falls behind what the tape requires, and the tape repositions. If the 772 priority is high, it gets enough DMA time, but other boards having insufficient buffers may starve from lack of DMA time. The priorities must be balanced for your system to work properly.

2.5.3 Power Considerations

The 772 affects the power consumption of the entire computer system. The 772 uses 4.2 amperes of +5 volts DC (4.75 to 5.25 volts) for all logic. Be sure the power supply can handle the entire power load. Readjust the voltages AFTER plugging in the 772. A power supply that is just adequate may cause intermittent and unusual problems due to noise generated by occasionally going into overcurrent protection.

2.6 PREPARING THE TAPE DRIVE

Unpack and configure the drive for use with the 772. This may entail setting up such parameters as formatter address, unit select, remote density select, ramp delay, etc. Consult the drive manual for the exact method for configuring your drive.

2.6.1 Drive Unit Select

A switch on the front of the drive, or switches on one of the drives internal circuit cards, selects the drive unit number and formatter address. The 772 accesses drives with unit numbers ranging from 0 through 3, and formatter addresses from 0 through 1 (allowing addressing up to eight drives). Pertec-formatted interface drives require one formatter card (embedded in one drive) for every four tape drives.

2.7 INSTALL AND CABLE THE 772

2.7.1 Install the 772

Double check the jumpering. Place the 772 into the computer card cage; make sure it is firmly seated. Be careful not to dislodge any socketed ICs. Situate the tape drive and connect it to its power source.

2.7.2 Cable the Subsystem

A cable set consists of two identical 50-pin flat ribbon cables that conform to the Pertec-formatted interface standard; these cables are typically 15- to 25-feet long. Xylogics does not provide the cables; they can usually be purchased from the drive vendor. Observe the J1 (Write Data)/J2 (Read Data) connector markings on the 772 when cabling the controller to the mating tape drive connector. All drives do not label connectors the same; you may have to read the drive manual to determine how to connect J1 and J2. Also, you must observe the pin "1" markings on the cable connector for proper orientation on both the drive and the 772. Using pull tabs on the cable connectors greatly reduces connector damage. (Only cable one tape drive for the initial system check. You can connect additional tape drives later.)

2.7.2.1 Mechanical Restraint

Xylogics recommends mechanically restraining both cables at each end to prevent accidental disconnection.

2.7.2.2 Tape Drive Grounds

Install a ground braid wire between the ground terminal on the tape drive(s) and the computer system ground.

2.8 INITIAL TESTS

This section relies upon your familiarity with your computer system's monitor and diagnostics.

2.8.1 Tape Drive Diagnostics

Many tape drive manufacturers offer both on-line and off-line diagnostic capability. Xylogics recommends initially running the full off-line drive diagnostic before trying to access the drive via the 772. This helps prove that the drive is functional. Each manufacturer's diagnostic is different; consult your drive manual.

2.8.2 Power-up and Self Test

The 772 initiates a self test upon power-up. The Error LED (L2) lights for a moment, and then goes off. If L2 remains on, and the Fatal Error Register indicates an IRAM checksum error, then you need to load good parameters into the IRAM. Otherwise, if L2

2.8.2 Power-up and Self Test (continued)

remains on, the board is not functioning properly (the Fatal Error Register may indicate the nature of the problem). When L2 is on, SYSFAIL is asserted on the VMEbus. Contact Xylogics for further assistance.

NOTE

Check the power supply voltage to ensure it is within limits (4.75 to 5.25 volts).

2.8.3 Drive On-line

Load a tape reel, press the load and on-line switches, and wait for the on-line indicator to light. Execute a Read Drive Parameters command to ensure the drive issues the correct status (see Section 4.1). If the IOPB completes without error, Byte 3 should at least have the BOT, DRRDY, and ONLIN bits set. If any of the three are not set, it is possible that the cables are improperly connected or the tape reel is improperly mounted. If this is not the case, then there is a possible hardware error on either the drive or the 772. If the problem persists, check the tape drive for functionality with an off-line diagnostic or tester.

2.9 DIAGNOSTICS

When you run your diagnostics:

- Run a full pass of the diagnostics.
- Cable and test any additional drives (see Section 2.10).

2.10 CABLING MULTIPLE DRIVES

Connect the first drive in the chain directly to the 772; connect additional drives together, starting with the first drive. For example, the 772 connects to Drive 0; Drive 0 to Drive 1; Drive 1 to Drive 2, etc. (see Figure 2-5). Be sure to maintain continuity of pin 1 and J1/J2 connectors between drives. Some drives have extra connectors on the I/O card for daisy-chaining cables. For drives that do not have extra connections, you must construct a cable with a third connector (see Figure 2-6).

2.10.1 Unit Select

If you are daisy-chaining drives, assign each drive a unique Unit Select number. The 772 accesses drives with unit numbers from 0 through 3, and formatter addresses from 0 through 1.

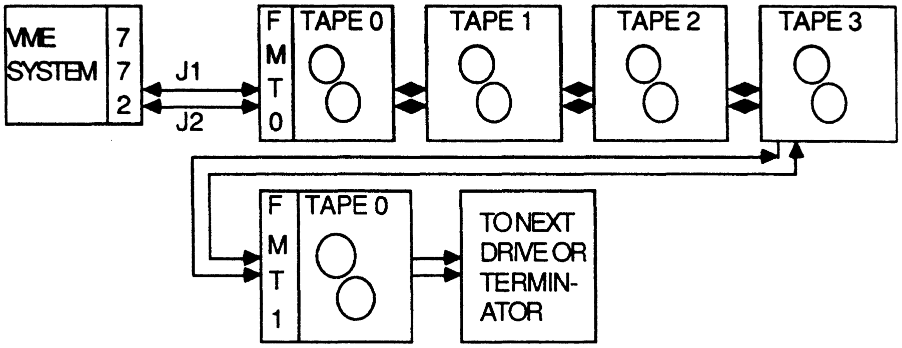


Figure 2-5. Cabling Multiple Drives

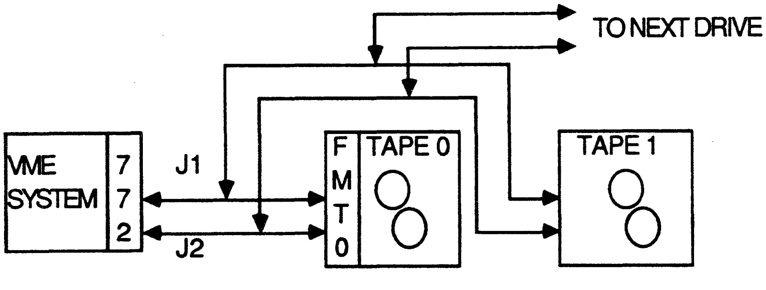


Figure 2-6. Daisy-chain Cable

SECTION 3: THE 772 REGISTERS

3.0 GENERAL

The 772 programming interface uses seven, one-byte long, I/O registers. The bus address jumpers define the base address of the register set. Table 3-1 lists the registers along with the address offset from the base address. The 772 responds to 16-bit words, but only 8 bits are valid.

The registers have one function when read, and another when written. The following subsections detail their definitions.

Register	Offset
IOPB Address Byte 0 (Least Significant Byte)	1
IOPB Address Byte 1	3
IOPB Address Byte 2	5
IOPB Address Byte 3 (Most Significant Byte)	7
IOPB Address Modifier	9
Control and Status Register	B
Fatal Error Register	D

Table 3-1. Register Offsets

NOTE

> The 772 supports VME short addressing for I/O devices (A16). It responds to Address Modifiers 29H and 2DH. For more information see the VMEbus Specification.

3.1 IOPB ADDRESS REGISTERS

The first four registers define the 32-bit address of an IOPB or IOPB chain. When these registers are written, the 772 interprets it as the address of the IOPB or IOPB chain to be executed. When read, and Remove IOPB (RIO) is set, the registers point to the IOPB or IOPB chain just completed by the 772.

The protocol for reading and writing this address register is defined by the use of Add IOPB (AIO) and Remove IOPB (RIO) in the Control and Status Register (see Section 3.3).

3.2 IOPB ADDRESS MODIFIER / PRIORITY IOPB REGISTER

This register defines the Address modifier of the IOPB address. The VMEbus Specification defines the address modifiers.

3.2 IOPB ADDRESS MODIFIER / PRIORITY IOPB REGISTER (continued)

There is no default value for this register; it must be written each time the IOPB Address Registers are written. This register also specifies whether an IOPB has priority over the current set of IOPBs in the 772 command queue. Section 3.3 defines the protocol for reading and writing this register.

```
                                          PRIORITY IOPB REGISTER
                                    ---------------------------------
                                    | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                                    ---------------------------------
PRIORITY IOPB REQUEST _______________|   |   |   |   |   |   |   |
RESERVED ____________________________________|   |   |   |   |   |
ADDRESS MODIFIER ____________________________|___|___|___|___|___|
```

Bit	Mnemonic	Definition
7	PRIO	PRIORITY IOPB REQUEST - When set, the IOPB, or IOPB chain, precedes all others (except the one in process) in the command queue.
6		RESERVED.
5-0	AM	ADDRESS MODIFIER - See the VMEbus Specification.

3.3 CONTROL AND STATUS REGISTER

When written, this register provides the host with control of the 772 operation; when read, it provides the host with 772 status information. Sections 3.3.1 and 3.3.2 define the bits in this register when read or written.

3.3.1 Control Register (Write)

```
                                          CONTROL REGISTER (WRITE)
                                    ---------------------------------
                                    | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                                    ---------------------------------
REGISTER MAINTENANCE MODE ___________|   |   |   |   |   |   |   |
RESERVED ________________________________|   |   |   |   |   |   |
ENABLE MAINTENANCE MODE _____________________|   |   |   |   |   |
RESERVED ________________________________________|   |   |   |   |
CONTROLLER RESET ____________________________________|   |   |   |
ADD IOPB ________________________________________________|   |   |
CLEAR RIO ___________________________________________________|   |
CLEAR RBS _______________________________________________________|
```

3.3.1 Control Register (Write) (continued)

Bit	Mnemonic	Definition
7	RMM	REGISTER MAINTENANCE MODE - When RMM and MM are set, the values previously written in all the registers (except the CSR) are echoed back.
6		RESERVED.
5	MM	ENABLE MAINTENANCE MODE - Setting MM and AIO places the 772 in Maintenance mode. This mode supports a different Register protocol and is used as a diagnostic tool. Section 8 outlines the Maintenance mode.
4		RESERVED.
3	CRST	CONTROLLER RESET - CRST signals the 772 microprocessor to perform a "soft" reset; it stops the DMA, and cancels any IOPBs in the queue. When the Controller Reset completes, the 772 resets the CSR to zero. A Controller Reset does not initiate a Power-up Self Test.
2	AIO	ADD IOPB - The host sets AIO to indicate that the 772 should execute the IOPB (chain) at the address pointed to by the IOPB Address and Address Modifier Registers. As soon as the host asserts AIO, the 772 asserts AIO Pending (AIOP) in the Status Register (indicating the 772 has received AIO, but has not yet processed the new chain address). AIOP is negated in the Status Register after the 772 internally stores the new chain address. The 772 can store up to 50 IOPB addresses in this manner. Reasserting AIO if AIOP is asserted in the Status Register violates the register protocol.
1	CRIO	CLEAR RIO - The host sets CRIO to clear RIO in the Status Register. Typically, the host sets CRIO after it reads the address of a completed IOPB chain from the IOPB Address and Modifier Registers. Clearing RIO enables the 772 to update the IOPB Address and Modifier Registers with the address and address modifier of a newly completed IOPB chain. Clearing RIO if RIO is not asserted in the Status Register violates the register protocol.

3.3.1 Control Register (Write) (continued)

Bit	Mnemonic	Definition
0	CRBS	CLEAR RBS - The host sets CRBS to clear RBS in the Status Register. Clearing RBS releases the registers for use by another host (see Section 8.2). (CRBS is only relevant in a multiprocessor environment.)

3.3.2 Status Register (Read)

```
                                          STATUS REGISTER (READ)
                                       ---------------------------------
                                       | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                                       ---------------------------------
BUSY ___________________________________|   |   |   |   |   |   |   |
FATAL ERROR ________________________________|   |   |   |   |   |   |
MAINTENANCE MODE ACTIVE ________________________|   |   |   |   |   |
RESERVED ___________________________________________|   |   |   |   |
CONTROLLER RESET ACTIVE ________________________________|   |   |   |
AIO PENDING ________________________________________________|   |   |
REMOVE IOPB ____________________________________________________|   |
REGISTER BUSY SEMAPHORE ____________________________________________|
```

Bit	Mnemonic	Definition
7	BUSY	BUSY - The 772 is executing IOPBs. The 772 sets BUSY when it clears AIOP to acknowledge the first IOPB address; it clears BUSY after completing all the IOPBs with no new ones pending (within 500 microseconds of the host clearing RIO on the last IOPB). The 772 redefines this bit in Maintenance mode (see Section 8.1).

3.3.2 Status Register (Read) (continued)

Bit	Mnemonic	Definition
6	FERR	FATAL ERROR - The 772 detected a fatal hardware error (a fatal error asserts SYSFAIL). A Controller Reset clears this bit. The Fatal Error Register contains more specific information. The 772 asserts FERR under the following conditions: (1) Maintenance Mode Test Failure; (2) Power-up Self Test Failure; (3) IOPB Checksum Miscompare; (4) IOPB DMA Fatal; (5) IOPB Address Alignment Error; (6) Firmware Error; (7) Cable Test Failure; (8) Illegal Maintenance Mode Test Number; and (9) ACFAIL Asserted.
5	MMA	MAINTENANCE MODE ACTIVE - When set, the 772 is in Maintenance mode (see Section 8).
4		RESERVED.
3	RSTA	CONTROLLER RESET ACTIVE - The host set CRST in the Control Register and the 772 is resetting.
2	AIOP	AIO PENDING - When set, AIO has been set in the Control Register, but the 772 has not acknowledged its receipt. When clear, AIO may be set again.
1	RIO	REMOVE IOPB - The 772 completed an IOPB (chain), and has made the address available in the IOPB Address and Address Modifier Registers. After the host reads the address and modifier, it must clear RIO by writing CRIO in the Control Register.
0	RBS	REGISTER BUSY SEMAPHORE - RBS allows multiple hosts to share access to the 772 registers without simultaneous access (see Section 8). (RBS is only relevant in a multiprocessor environment.)

3.4 FATAL ERROR REGISTER

If a fatal error occurs, the 772 returns the appropriate Completion Code in this register. Table 3-2 lists the fatal error codes; Section 6.4 describes them.

Code	Description
E0	IRAM Checksum Failure
E1-EF	Power-up Self Test
F0	IOPB Checksum Miscompare
F1	IOPB DMA Fatal
F2	IOPB Address Alignment Error
F3	Firmware Error
F4	Cable Test Failure
F5	Illegal Maintenance Mode Test Number
F6	ACFAIL Asserted

Table 3-2. Fatal Error Codes

SECTION 4: IOPB DESCRIPTION

4.0 GENERAL

This section describes the 772 Input/Output Parameter Block (IOPB); it begins with the standard IOPB for most data transfer commands and follows with variations of the IOPB.

4.1 STANDARD IOPB

The 772 uses the standard IOPB for data transfer commands and some general purpose commands.

STANDARD 772 IOPB

	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION							
05	0			BHT	0	UNIT		
06	LINK LIST LENGTH					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	REQUESTED COUNT HIGH							
09	REQUESTED COUNT LOW							
0A	LAST RECOVERED/IGNORED ERRORS							
0B	COUNT OF RECOVERED/IGNORED ERRORS							
0C	ACTUAL COUNT HIGH							
0D	ACTUAL COUNT LOW							
0E	0		DATA OR LINK ADDRESS MODIFIER					
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	DATA OR LINK ADDRESS HIGH							
11	DATA OR LINK ADDRESS							
12	DATA OR LINK ADDRESS							
13	DATA OR LINK ADDRESS LOW							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

4.1.1 IOPB Byte 0 (Command)

```
                              ---------------------------------
                              | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                              ---------------------------------
ERROR SUMMARY __________________|   |   |   |   |   |   |   |
DONE _______________________________|   |   |   |   |   |   |
CHAIN ENABLE ___________________________|   |   |   |   |   |
SCATTER/GATHER _____________________________|   |   |   |   |
COMMAND ________________________________________|___|___|___|
```

Bit	Mnemonic	Description
7	ERRS	ERROR SUMMARY - ERRS is only valid if DONE is set. If ERRS is clear, the 772 successfully completed the IOPB. If ERRS is set, a hard error occurred during IOPB processing. **NOTE** Clear DONE and ERRS before executing an IOPB.
6	DONE	DONE - When set, the IOPB is complete; if chained, software may remove the IOPB from the chain and reuse it.
5	CHEN	CHAIN ENABLE - When set, the Next IOPB Address Modifier and Next IOPB Address point to the next chained IOPB. When clear, this IOPB is not chained to another IOPB. If CHEN and IEC are set, the 772 returns the whole chain with one RIO; if CHEN is set and IEC is clear, the 772 returns one IOPB at a time.
4	SGM	SCATTER/GATHER MODE - When set, the IOPB is either a scatter (read) or a gather (write) tape transfer; a linked list describes the number of 16-bit words and to what address the 772 transfers each section of the data. The link address modifier and the link address specify the link list location. When clear, this IOPB specifies the data transfer address; the data is transferred to/from contiguous memory. SGM is only valid for standard reads and writes.
3-0	COMM	COMMAND - See Table 4-2.

4.1.2 IOPB Byte 1 (Status Byte 1)

After the 772 executes the IOPB, it sets DONE and posts a Completion Code in this byte (the 772 always updates this byte, regardless of AUD's status). Completion Codes are only valid if DONE is set. The Completion Code contains the highest error code in the error code hierarchy. For tape related errors, the 772 reports the same status, or a lower error code, in Status Bytes 2 and 3. Section 6 details each error code and its recommended recovery procedure.

4.1.3 IOPB Byte 2 (Status Byte 2)

IOPB Byte 2 is a Tape Status byte; it is only valid if DONE is set.

```
                                  ---------------------------------
                                  | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                                  ---------------------------------
HARD TAPE ERROR ____________________|   |   |   |   |   |   |   |
CORRECTED TAPE ERROR ___________________|   |   |   |   |   |   |
RECORD LENGTH SHORT ________________________|   |   |   |   |   |
RECORD LENGTH LONG _____________________________|   |   |   |   |
FILE MARK DETECTED _________________________________|   |   |   |
PHASE ENCODED ID BURST _________________________________|   |   |
END OF TAPE ________________________________________________|   |
WRITE-PROTECT __________________________________________________|
```

Bit	Mnemonic	Description
7	HER	HARD TAPE ERROR - The 772 sets HER when a hard tape error occurs.
6	CER	CORRECTED ERROR - The 772 sets CER when the tape drive indicates it corrected a media flaw.
5	RLS	RECORD LENGTH SHORT - The 772 sets RLS when it detects a Record Length Short error during a Read command.
4	RLL	RECORD LENGTH LONG - The 772 sets RLL when it detects a Record Length Long error during a Read command.
3	FMK	FILE MARK DETECTED - The 772 sets FMK when it detects a file mark during a Read or File Mark Search command, or when it successfully writes a file mark.
2	PEID	PHASE ENCODED ID BURST - The 772 sets PEID when it detects the phase encoded identification burst (1600 BPI).

4.1.3 IOPB Byte 2 (Status Byte 2) (continued)

Bit	Mnemonic	Description
1	EOT	END OF TAPE - The 772 sets EOT when it detects the End Of Tape marker. The 772 latches EOT to ensure it is detected.
0	WPT	WRITE-PROTECT - When set, the tape reel is write-protected.

4.1.4 IOPB Byte 3 (Status Byte 3)

IOPB Byte 3 is a Tape Status byte; it is only valid if DONE is set.

```
                              ---------------------------------
                              | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                              ---------------------------------
GCR/NRZ ID ____________________|   |   |   |   |   |   |   |
HIGH SPEED MODE ___________________|   |   |   |   |   |   |
BEGINNING OF TAPE _____________________|   |   |   |   |   |
REWIND ____________________________________|   |   |   |   |
DRIVE BUSY ____________________________________|   |   |   |
FORMATTER BUSY ____________________________________|   |   |
DRIVE READY ___________________________________________|   |
DRIVE ON-LINE _____________________________________________|
```

Bit	Mnemonic	Description
7	GC/NR	GCR/NRZ - When set, this bit indicates one of two tape densities. The tape is GCR (6250 BPI) if this bit and PEID (bit 2 of Byte 2) are set. The tape is NRZ (800 BPI) if PEID is not set when GC/NRZ is set.
6	HISD	HIGH SPEED MODE - When set, the drive is in High Speed mode.
5	BOT	BEGINNING OF TAPE - When set, the tape is positioned at the Beginning of Tape marker.
4	REW	REWIND - When set, the drive is rewinding.
3	DBSY	DRIVE BUSY - When set, the drive is busy with a command or data transfer.
2	FBSY	FORMATTER BUSY - When set, the tape drive formatter is busy.

4.1.4 IOPB Byte 3 (Status Byte 3) (continued)

Bit	Mnemonic	Description
1	DRRDY	DRIVE READY - When set, the tape drive is ready to accept commands from the 772.
0	ONLIN	ON-LINE - When set, a tape reel is loaded and the tape drive is on-line.

4.1.5 IOPB Byte 4 (Subfunction)

IOPB Byte 4 is the Subfunction byte. Subfunction Codes follow a convention that indicates whether the code is generic to all VME controllers, generic to a group of controllers (i.e., 772, 712, 751, etc.), or specific to a particular controller (see Table 4-1).

The 772 combines standard Command Codes with Subfunction Codes to execute commands. Table 4-2 lists the 772 Command and Subfunction Codes.

Class	Subfunction Codes (Hex)
Generic to All	00-1F
Generic Tape	20-3F
772-Specific	40-5F
Reserved	60-7F
Generic Disk	80-9F
751-Specific	A0-AF
712-Specific	B0-BF
Reserved	C0-FF

Table 4-1. Subfunction Code Classes

Code	Command	Subfunction	Description
0	NOP	00	No Operation
1	WRITE	00	Write
2	READ	00	Read

Table 4-2. Command/Subfunction Codes

4.1.5 IOPB Byte 4 (Subfunction) (continued)

Code	Command	Subfunction	Description
3	POSITION	20	Space Record Forward
		21	Space Record Reverse
		40	File Mark Search Forward
		41	File Mark Search Reverse
		42	Mult. File Mark Search Frwd.
4	DRIVE RESET	00	Drive Reset
		20	Load On-line
		21	Rewind
		22	Unload/Off-line
5	WRITE PARAMETERS	00	Write Controller Parameters
		20	Write Drive Parameters
6	READ PARAMETERS	00	Read Controller Parameters
		20	Read Drive Parameters
		40	Read Sense Bytes
		41	Read Extended Sense Bytes
7	EXTENDED WRITE	20	Write File Mark
		21	Erase
		40	Write Continuous
8	EXTENDED READ	40	Read Continuous
9	DIAGNOSTICS	00	Self Test
		40	Loopback Test
		41	Security Erase
A	ABORT	00	Abort Command
B	SET DRV PRMTRS	40	Drive NOP
		41	Reserved
		42	Set Low Density
		43	Set High Density
		44	Set 800 BPI
		45	Set 1600 BPI
		46	Set 3200 BPI
		47	Set 6250 BPI
		48	Set Low Speed And Normal Gap
		49	Set High Speed And Normal Gap
		4A	Set Low Speed And Long Gap
		4B	Set High Speed And Long Gap
C	CMD PASS	40	Command Pass Through To Drive
D-F	RESERVED	XX	

Table 4-2. Command/Subfunction Codes (continued)

4.1.6 IOPB Byte 5 (Unit)

```
                                   --------------------------------
                                   | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                                   --------------------------------
RESERVED __________________________|___|___|   |   |   |   |   |
BLACK HOLE TRANSFER _______________________|   |   |   |   |   |
RESERVED __________________________________________|   |   |   |
UNIT ______________________________________________|___|___|
```

Bit	Mnemonic	Description
7-5		RESERVED.
4	BHT	BLACK HOLE TRANSFER - When set, the 772 does not increment the bus address during a data transfer; IOPB transfers occur normally. When clear, the 772 does increment the bus address.
3		RESERVED.
2-0	UNIT	UNIT NUMBER - These bits specify the tape drive Unit Number for the operation. Bits 0 and 1 are the Unit Selects for each formatter. Bit 2 selects one of two possible formatters.

4.1.7 IOPB Byte 6 (Interrupt Level)

```
                                   --------------------------------
                                   | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                                   --------------------------------
LINK LIST LENGTH __________________|___|___|___|___|   |   |   |
INTERRUPT LEVEL ___________________________________|___|___|
```

Bit	Mnemonic	Description
7-3	LLL	LINK LIST LENGTH - These bits specify the length of a linked list for Scatter/Gather commands. Each element refers to an 8-byte block in the linked list. See Section 8.4.2.
2-0	INT	INTERRUPT LEVEL - The 772 uses the value of these bits as the VMEbus interrupt level after completing the IOPB. The 772 will not interrupt if bits 0 through 2 are clear.

4.1.8 IOPB Byte 7 (Interrupt Vector)

IOPB Byte 7 determines the interrupt vector that the 772 uses upon command completion if interrupts are enabled. This byte is not valid if the interrupt level is zero.

4.1.9 IOPB Bytes 8 and 9 (Count)

IOPB Byte 8 is Requested Count High; Byte 9 is Requested Count Low. These bytes specify the number of bytes to be transferred in a data transfer, the number of records to skip, the number of file marks to search, or the number of file marks to write. The maximum byte count is 65,536 (a 0 **in the count field equals 65,536)**; the extended read/write commands must be used for larger records. The maximum count for Skip Records or File Mark Search is 65,535; the 772 reports an error if you issue a count of zero for these commands.

NOTE

Depending on the command, Bytes 8 through 13 have different definitions (see Sections 4.2 through 4.4).

4.1.10 IOPB Byte A (Last Error)

If the Read/Write Retry or Ignore Read/Write feature is enabled, IOPB Byte A indicates the code of the last recovered or ignored error for this IOPB. The codes are the same as those normally written in the Completion Code in Byte 1 (see Section 4.3).

4.1.11 IOPB Byte B (Error Count)

Depending on which feature is enabled, IOPB Byte B indicates the number of retries that were necessary to recover an error, or the the number of ignored errors that occurred.

4.1.12 IOPB Bytes C and D (Actual Count)

IOPB Byte C is Actual Count High; Byte D is Actual Count Low. These bytes indicate the actual number of bytes transferred in a successful completion, or in a Record Length Short error condition. The 772 also posts the actual count done after Position commands such as File Mark Search and Space Record.

4.1.13 IOPB Byte E (Data Address Modifier)

```
                               ---------------------------------
                               | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                               ---------------------------------
RESERVED ______________________|___|   |   |   |   |   |   |   |
DATA OR LINK ADDRESS MODIFIER ________|___|___|___|___|___|___|
```

Bit	Description
7-6	RESERVED.
5-0	DATA OR LINK ADDRESS MODIFIER - If SGM is set, these bits specify the Link List Address Modifier; if SGM is clear, the field specifies the Data Address Modifier. The 772 uses these modifiers to complete the address (typically, they are the same as the modifier used for the IOPB addresses).

4.1.14 IOPB Byte F (Next IOPB Address Modifier)

```
                               ---------------------------------
                               | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                               ---------------------------------
PRIORITY IOPB _________________|   |   |   |   |   |   |   |
RESERVED __________________________|   |   |   |   |   |   |
NEXT IOPB ADDRESS MODIFIER ___________|___|___|___|___|___|___|
```

Bit	Mnemonic	Description
7	PRIO	PRIORITY IOPB - PRIO has the same function as PRIO in the Priority IOPB Register. If PRIO and AIO are set, setting this bit causes the IOPB to precede all others in the command queue (except for the IOPB in process).
6		RESERVED.
5-0	NIOPB	NEXT IOPB ADDRESS MODIFIER - The Next IOPB Address Modifier, along with the Next IOPB Address, point to the next IOPB in the chain. (This address should match the address in the AM Register.)

4.1.15 IOPB Bytes 10 Through 13 (DMA Data Address)

IOPB Bytes 10 through 13 are the Data or Link List Address pointers. IOPB Byte 10 is Data or Link Address High; Byte 13 is Data or Link Address Low. If SGM is set, this address points to the linked list; if SGM is clear, it points to the data address. The 772 uses these bytes with the Data or Link List Address Modifiers to determine the data or link list address.

NOTE

The link list address must be on a 16-bit word boundary.

4.1.16 IOPB Bytes 14 Through 17 (Next IOPB Address)

IOPB Bytes 14 through 17 are the Next IOPB Address pointers. IOPB Byte 14 is Next IOPB Address High; Byte 17 is Next IOPB Address Low. If CHEN is set in Byte 0, the 772 uses Bytes 14 through 17 with the Next IOPB Address Modifier to point to the next IOPB in the chain.

NOTE

The Next IOPB address must be on a 16-bit word boundary. This address is the same as the address loaded directly into the register; calculate it in the same manner.

4.1.17 IOPB Bytes 18 and 19 (IOPB Checksum)

IOPB Byte 18 is IOPB Checksum High; Byte 19 is IOPB Checksum Low. The IOPB Checksum bit (ICS) must be set with a Controller Parameters command for the 772 to verify checksums. The 772 calculates the checksum by adding Bytes 0 through 7; it returns the checksum with any IOPB that errors, or if AUD is set. If AUD is clear, the 772 does not return the Checksum bytes for successfully completed IOPBs.

NOTE

The Write Controller Parameters command must have a valid checksum value if you are setting ICS.

4.2 CONTROLLER PARAMETERS IOPB

This IOPB sets various controller parameters. The 772 uses the standard IOPB, but redefines bits in Bytes 8 through E, and 10 through 13.

CONTROLLER PARAMETERS

	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION							
05	0				UNIT			
06	0				INTERRUPT LEVEL			
07	INTERRUPT VECTOR							
08	AUD	TMOD	0	ICS	EDT	NPRM	AIOR	
09	TDT		0	ROR	0			
0A	OVR	WWD	IEC	0				
0B	THROTTLE							
0C	EPROM RELEASE LEVEL							
0D	0							
0E	CONTROLLER TYPE							
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	EPROM PART NUMBER HIGH							
11	EPROM PART NUMBER LOW							
12	EPROM REVISION LEVEL							
13	0							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

4.2.1 IOPB Byte 8 (Controller Parameters A)

```
                              ---------------------------------
                              | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                              ---------------------------------
AUTO-UPDATE ____________________|   |   |   |   |   |   |   |
TRANSFER MODE ______________________|   |   |   |   |   |   |
RESERVED _______________________________|   |   |   |   |   |
IOPB CHECKSUM ______________________________|   |   |   |   |
ENABLE DMA TIMEOUT _____________________________|   |   |   |
NON-PRIVILEGED REGISTER MODE _______________________|   |   |
AIO RESPONSE TIME ______________________________________|___|
```

Bit	Mnemonic	Description
7	AUD	AUTO-UPDATE - When set, the 772 updates the IOPB to the transfer's ending parameters; it updates all possible bytes in the IOPB. If an error occurs, the 772 updates the IOPB regardless of AUD's status. When clear, the 772 updates Bytes 0 through 3 upon successful command completion. Xylogics recommends setting AUD. Commands that return information (parameters, etc.) update the IOPB regardless of AUD's status.
6	TMOD	TRANSFER MODE - When set, the 772 executes transfers in Longword mode. When clear, it executes transfers in Word mode. (The 772 always transfers IOPBs in Word mode.) If a transfer starts on an improper address boundary, the 772 first transfers a byte, and/or a word, as necessary to align boundaries, and continues the transfer in the selected mode. The 772 may end the transfer with a byte and/or word, if necessary.
5		RESERVED.
4	ICS	IOPB CHECKSUM - When set, the 772 reads the IOPB and compares the checksum it generated during the read with the checksum the software driver appended to the IOPB. The 772 reports a fatal error in the CSR if the compare fails; it updates the Checksum bytes if the IOPB errors (non-fatal). The 772 also updates the Checksum bytes in any IOPB if AUD is set.

NOTE

Since this feature adds 50 microseconds to each transfer, it effects the 751's performance.

4.2.1 IOPB Byte 8 (Controller Parameters A) (continued)

Bit	Mnemonic	Description
3	EDT	ENABLE DMA TIMEOUT - When set, the 772 enables a DMA bus error timer. When clear, the 772 relies on an external VMEbus transfer timer.
2	NPRM	NON-PRIVILEGED REGISTER MODE - When set, the 772 responds to Address Modifiers 2DH and 29H. When clear, the 772 only responds to 2DH. (2DH is the Supervisory Access mode; 29H is Non-privileged mode.)
1-0	AIOR	AIO RESPONSE TIME - These bits respond to the four values that indicate the maximum AIO response time. This is the time from setting AIO to the time the 772 clears it. The shorter the response time, the greater the 772 overhead.

Value	Time
00	100 us (Default)
01	75 us
02	62 us
03	50 us

Table 4-3. AIO Response Times

4.2.2 IOPB Byte 9 (Controller Parameters B)

```
                                  ---------------------------------
                                  | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                                  ---------------------------------
THROTTLE DEAD TIME ______________|___|   |   |   |   |   |   |
RESERVED ____________________________|   |   |   |   |   |   |
RELEASE ON REQUEST ______________________|   |   |   |   |   |
RESERVED ____________________________________|___|___|___|___|
```

Bit	Mnemonic	Description
7-6	TDT	THROTTLE DEAD TIME - When set, TDT selects one of four minimum time periods that determine the time the 772 remains off the bus between throttle bursts (see Section 8.5).
5		RESERVED.

4.2.2 IOPB Byte 9 (Controller Parameters B) (continued)

Bit	Mnemonic	Description
4	ROR	RELEASE ON REQUEST - When set, the 772 releases the bus at the request of other bus masters; otherwise it continues with the next throttle burst. The 772 monitors the bus request lines and releases the bus only if another bus request is pending. It completes its specified throttle burst before releasing the bus due to a pending request. If clear, the 772 releases the bus after every throttle burst and rearbitrates if more data transfers are pending.
3-0		RESERVED.

4.2.3 IOPB Byte A (Controller Parameters C)

```
                              _________________________________
                              | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                              ---------------------------------
OVERLAP REWIND _________________|   |   |   |   |   |   |   |
WRITE WAIT FOR DMA _________________|   |   |   |   |   |   |
INTERRUPT AT END OF CHAIN ______________|   |   |   |   |   |
RESERVED ___________________________________|___|___|___|___|
```

Bit	Mnemonic	Description
7	OVR	OVERLAP REWIND - When set, the 772 skips over an IOPB in a chain that is currently rewinding and executes commands for any drive not rewinding. The 772 remembers it skipped an IOPB and updates its status after the tape rewinds. When clear, the 772 waits for the drive currently rewinding to complete before executing further commands.
6	WWD	WRITE WAIT FOR DMA - When set, the 772 will not start tape write transfers until the DMAC receives data. This ensures that Data Late errors do not occur when using drives with cache memories that respond to tape writes immediately.
5	IEC	INTERRUPT AT END OF CHAIN - When set, the 772 returns all IOPB chains with one RIO and one interrupt; it does not relink or unlink IOPBs. The RIO address of a completed chain is the address of the first IOPB in the chain. The 772 also uses the interrupt level and vector of the first IOPB in the chain.

4.2.3 IOPB Byte A (Controller Parameters C) (continued)

Bit	Mnemonic	Description
5	IEC	INTERRUPT AT END OF CHAIN (continued) - When clear, the 772 does not chain RIOs or IOPBs; it returns all chains unlinked. (Do not set or clear IEC while the 772 is processing an IOPB chain.)
4-0		RESERVED.

4.2.4 IOPB Byte B (Controller Parameters D)

Bits 0 through 7 are the Throttle (THRO) bits. The throttle is the maximum number of transfers allowed each time the 772 becomes bus master. The throttle value determines the maximum DMA burst length for both data and IOPB DMA transfers. Each bit position represents a binary weight, allowing a throttle from 1 to 256. Table 4-4 lists the throttle values.

Value	Weight
0	256
1	1
2	2
3	3
:	:
255	255

Table 4-4. Throttle Values

4.2.5 IOPB Byte C (EPROM Release Level)

IOPB Byte C contains the release level of the EPROM plugged into the board.

4.2.6 IOPB Byte E (Controller Type)

IOPB Byte E is the Controller Type byte. Xylogics assigns each VME controller a unique controller type code.

Controller	Code (H)
712	12
751	51
772	72

Table 4-5. Controller Type Codes

4.2.7 IOPB Bytes 10 and 11 (EPROM Part Number)

The 772 returns a portion of the EPROM part number. The four nibbles in these two bytes refer to the part number's last four digits. For example, if the EPROM part number is 180-002-138, Byte 10 contains a 21(H) and Byte 11 contains a 38(H).

4.2.8 IOPB Byte 12 (EPROM Revision Level)

IOPB Byte 12 contains the revision level of the EPROM plugged into the board.

4.3 WRITE DRIVE PARAMETERS IOPB

DRIVE PARAMETERS

<table>
<tr><th></th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>00</td><td>ERRS</td><td>DONE</td><td>CHEN</td><td>SGM</td><td colspan="4">COMMAND</td></tr>
<tr><td>01</td><td colspan="8">COMPLETION CODE</td></tr>
<tr><td>02</td><td>HER</td><td>CER</td><td>RLS</td><td>RLL</td><td>FMK</td><td>PEID</td><td>EOT</td><td>WPT</td></tr>
<tr><td>03</td><td>GC/NR</td><td>HISD</td><td>BOT</td><td>REW</td><td>DBSY</td><td>FBSY</td><td>DRRDY</td><td>ONLIN</td></tr>
<tr><td>04</td><td colspan="8">SUBFUNCTION</td></tr>
<tr><td>05</td><td colspan="5">0</td><td colspan="3">UNIT</td></tr>
<tr><td>06</td><td colspan="5">0</td><td colspan="3">INTERRUPT LEVEL</td></tr>
<tr><td>07</td><td colspan="8">INTERRUPT VECTOR</td></tr>
<tr><td>08</td><td>IRER</td><td>IWER</td><td>RRTY</td><td>WRTY</td><td>GRTY</td><td>DSB</td><td>SWWD</td><td>SWBY</td></tr>
<tr><td>09</td><td>LGAP</td><td>IPOW</td><td>SPD</td><td>ASS</td><td>0</td><td colspan="3">DENSITY</td></tr>
<tr><td>0A</td><td colspan="8">SET DENSITY TO 800 BPI</td></tr>
<tr><td>0B</td><td colspan="8">SET DENSITY TO 1600 BPI</td></tr>
<tr><td>0C</td><td colspan="8">SET DENSITY TO 3200 BPI</td></tr>
<tr><td>0D</td><td colspan="8">SET DENSITY TO 6250 BPI</td></tr>
<tr><td>0E</td><td colspan="8">WRITE RECORD WITH VARIABLE IRG</td></tr>
<tr><td>0F</td><td>PRIO</td><td>0</td><td colspan="6">NEXT IOPB ADDRESS MODIFIER</td></tr>
<tr><td>10</td><td colspan="8">DATA BUSY TIMER</td></tr>
<tr><td>11</td><td colspan="8">0</td></tr>
<tr><td>12</td><td colspan="8">0</td></tr>
<tr><td>13</td><td colspan="8">0</td></tr>
<tr><td>14</td><td colspan="8">NEXT IOPB ADDRESS HIGH</td></tr>
<tr><td>15</td><td colspan="8">NEXT IOPB ADDRESS</td></tr>
<tr><td>16</td><td colspan="8">NEXT IOPB ADDRESS</td></tr>
<tr><td>17</td><td colspan="8">NEXT IOPB ADDRESS LOW</td></tr>
<tr><td>18</td><td colspan="8">IOPB CHECKSUM HIGH</td></tr>
<tr><td>19</td><td colspan="8">IOPB CHECKSUM LOW</td></tr>
</table>

4.3.1 IOPB Byte 8 (Drive Parameters A)

```
                              ---------------------------------
                              | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                              ---------------------------------
IGNORE READ ERROR ______________|   |   |   |   |   |   |   |
IGNORE WRITE ERROR _________________|   |   |   |   |   |   |
READ RETRY _____________________________|   |   |   |   |   |
WRITE RETRY ________________________________|   |   |   |   |
GAP RETRY ON WRITE _____________________________|   |   |   |
TAPE DRIVE DENSITY SELECT __________________________|   |   |
SWAP WORD ______________________________________________|   |
SWAP BYTE __________________________________________________|
```

Bit	Mnemonic	Description
7	IRER	IGNORE READ ERROR - When set, the 772 ignores File Mark Detected On Read, Hard Tape, Corrected Tape, Record Length Long, Record Length Short, and Tape Parity errors; it does not set the various tape error bits or return a completion status. The controller reports the type and number of ignored errors in Bytes A and B.
6	IWER	IGNORE WRITE ERROR - When set, the 772 ignores Hard Tape, File Mark Write Fault, and Tape Parity errors; it does not set the various tape error bits or return a completion status. The controller reports the type and number of ignored errors in Bytes A and B.
5	RRTY	READ RETRY - When set, and a hard error occurs, the 772 retries the Read command four times before reporting an error.
4	WRTY	WRITE RETRY - When set, and a hard error occurs, the 772 retries the Write command up to two times over the same area of tape; it reports a hard error if the error persists.
3	GRTY	GAP RETRY ON WRITE - When set, the 772 tries to write an extended gap over the section of tape where the error occurred during a Write operation; the controller repositions to the beginning of the record, writes a 3-inch gap (ERASE), and retries the write. The 772 repeats this procedure up to four times before reporting a hard error.

4.3.1 IOPB Byte 8 (Drive Parameters A) (continued)

Bit	Mnemonic	Description
2	DSB	DENSITY SELECT BIT - When set, the 772 selects the tape drive density over pin P1-36 with Codes 2 and 3 of the density select field in Byte 9. Setting DSB also enables writing long interrecord gaps via pin P1-44. When clear, the 772 selects density using Codes 4 through 7 of the density select field (this is the density default; you can select other codes with the Write Drive Parameters Subfunction Codes); this also selects Long Gap over pin P1-36. See Section 10.2.

DSB Set	DSB Clear
Use Density Codes 0-3	Use Density Codes 4-1
P1-36 Selects Density	P1-36 Selects Long Gap
P1-44 Selects Long Gap	P1-44 Not Used

Table 4-6. Density Selected via Command Lines

1	SWWD	SWAP WORD - When set, the 772 swaps the significance of the two words in a longword (data transfers only).
0	SWBY	SWAP BYTE - When set, the 772 swaps the significance of the two bytes in a word (data transfers only).

4.3.2 IOPB Byte 9 (Drive Parameters B)

```
                                   ---------------------------------
                                   | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                                   ---------------------------------
SELECT INTERRECORD GAP ______________|   |   |   |   |   |   |   |
INHIBIT PARITY ON WRITE _________________|   |   |   |   |   |   |
SPEED SELECT ________________________________|   |   |   |   |   |
AUTO-STREAMING SELECT ___________________________|   |   |   |   |
RESERVED ____________________________________________|   |   |   |
DENSITY SELECT __________________________________________|___|___|
```

4.3.2 IOPB Byte 9 (Drive Parameters B) (continued)

Bit	Mnemonic	Description
7	LGAP	SELECT INTERRECORD GAP - When set, the tape drive writes an extended interrecord gap. LGAP is used in conjunction with DSB (DSB determines which pin on the P1 connector selects long gap). The actual gap length is drive manufacturer- and density-dependent. When clear, the drive uses the default interrecord gap size for the selected density.
6	IPOW	INHIBIT PARITY ON WRITE - When set, the 772 ignores Read Parity errors during Write operations. Many tape drives employing cache buffers do not provide valid read after write strobes, causing the 772 to detect parity errors. When clear, the 772 checks read parity on writes.
5	SPD	SPEED SELECT - When set, the tape drive remains in High Speed (Streaming) mode for all transfers. When clear, the tape drive runs in Low Speed (Start/Stop) mode. The tape drive you are using determines the actual speed.
4	ASS	AUTO-STREAMING SELECT - When set, the 772 measures the time between commands (reinstruct time) against preset values and automatically switches the tape drive into high speed or low speed, depending on the comparison (see Section 8.9).
3		RESERVED.
2-0	DENSITY	DENSITY SELECT - This field drives the density select line (P1-36) offered by certain manufacturers, or selects density via the tape command lines, depending on DSB's value. By writing a code in this byte, the 772 always uses that particular density unless a separate Set Drive Parameters command changes the density state. Table 4-7 lists the density codes.

Code	Action
0	Use Density Default
1	Use Density Default
2	Set Low Density Mode
3	Set High Density Mode
4	Set 800 BPI - Byte A
5	Set 1600 BPI - Byte B
6	Set 3200 BPI - Byte C
7	Set 6250 BPI - Byte D

Table 4-7. Density Codes

4.3.3 IOPB Byte 10 (Data Busy Timer)

This byte controls the timeout associated with the tape interface signal Data Busy (DBSY). This timeout is programmable because many of the caching tape drives have longer DBSY times during error correction. The default value (0) is a .25 second timeout and the maximum timeout is 64 seconds. Other timeout values are in .25 second increments (see Table 4-8). Xylogics recommends values greater than 7FH for cache drives.

Byte Value (Hex)	Timeout (Seconds)
0	.25
1	.50
2	.75
3	1.00
:	:
FE	63.75
FF	64.00

Table 4-8. Data Busy Timeout

4.3.4 IOPB Bytes A Through D (Density Select)

7	6	5	4	3	2	1	0
LGAP	THR1	HSP	ERASE	WFM	EDIT	WRITE	REVERSE

The 772 uses these bytes to select the density of a particular tape drive via the standard tape interface command lines. These bytes are only valid if DSB is clear. Each byte duplicates the tape drive command lines: A = 800 BPI; B = 1600 BPI; C = 3200 BPI; and D = 6250 BPI.

Load the specific code for each density in the appropriate byte and execute the command. (Tape manufacturers use different codes to select density; since the code bits are not always in the same order from one manufacturer to another, the hex codes may not match ours, but the bits are always the same. See Table 4-9, or consult your tape drive manual for proper codes.) Each time a set density code or a Set Drive Parameters command is issued, the 772 uses the information in these bytes to select the default density.

4.3.4 IOPB Bytes A Through D (Density Select) (continued)

Command:		800/NRZ	1600/PE	3200/PE	6250/GCR	WRT+VAR GAP
Anritsu	2500	—	1C	1D	—	—
Cipher	F880	—	—	—	—	—
	F890	—	1C	1D	—	—
	M990	—	1C	1D	03	—
CDC	92181	—	—	—	—	—
	92185	—	1C	—	1D	82
Fujitsu	2242	—	1C	—	1D	—
Kennedy	9400	—	—	—	—	—
	9600	0E	1C	—	—	—
Pertec	FS1000	—	*	1D	—	—
	FS2000	13	1C	1D	03	—
STC	2920	—	1C	—	1D	—
Telex Shamrock		FC	7C*	—	7D	—
Thorn	9800**	—	—	—	—	—
	9900	0A	1C	1D	—	0E

Key:

— The Tape drive will not support or select this density. Write 00 in the associated byte.

* Defaults to 1600/PE at BOT.

** Selects density via interface pin P1-36.

Table 4-9. Density Selection Codes

4.3.5 IOPB Byte E (Variable IRG)

This byte enables the 772 to write variable length interrecord gaps; it writes an interrecord gap until the next record arrives. Use the values provided in Table 4-9 under WRT+VAR GAP.

4.4 COMMAND PASS THROUGH TO DRIVE IOPB

This command allows the 772 to support any manufacturer's method of selecting a feature. The 772 allows you to directly interface the tape drive command lines.

COMMAND PASS THROUGH TO DRIVE

	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION							
05	0					UNIT		
06	0					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	0						BYTE COUNT	
09	0							
0A	TAPE COMMAND BYTE 1							
0B	TAPE COMMAND BYTE 2							
0C	TAPE COMMAND BYTE 3							
0D	TAPE COMMAND BYTE 4							
0E	0							
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	0							
11	0							
12	0							
13	0							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

4.4.1 IOPB Byte 8 (Byte Count)

```
                              ---------------------------------
                              | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                              ---------------------------------
RESERVED ______________________|___|___|___|___|___|___|   |   |
BYTE COUNT ____________________________________________|___|
```

Bit	Description
7-2	RESERVED.
1-0	BYTE COUNT - These bits determine the number of tape command bytes to send to the drive; 0=1 byte, 1=2 bytes, etc.

4.4.2 IOPB Bytes A Through D (Tape Command)

These bytes allow software to directly manipulate the tape drive command lines, allowing the 772 to support all manufacturer's special command sets. You must not use Command Pass Through To Drive with commands that require other parameters set, such as reads and writes. Typically, only the Tape Command byte is used. Megatape MT500 drives require a command plus a track number when selecting a track; in this case Bytes 1 and 2 are used (i.e., Command 1=Select Track; Command 2=Track Number). See Section 8.10.

```
                                TAPE COMMAND BYTES 1-4
                              ---------------------------------
                              | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
                              ---------------------------------
LGAP __________________________|   |   |   |   |   |   |   |
THR1 ______________________________|   |   |   |   |   |   |
HSP ___________________________________|   |   |   |   |   |
ERASE _________________________________________|   |   |   |   |
WFM ___________________________________________|   |   |   |
EDIT _______________________________________________|   |   |
WRITE ______________________________________________________|   |
REVERSE ________________________________________________________|
```

SECTION 5: COMMANDS

5.0 GENERAL

Each tape command begins a new page. An IOPB diagram follows each command description. The diagrams are highlighted to indicate which fields the 772 absolutely requires for execution, which fields are optional for the command, and which fields return after command execution.

Each 772 IOPB is 26-bytes long. Reserving all 26 bytes in memory (for each IOPB) maintains IOPB integrity. Generally, all commands use Bytes 0 through 19H.

5.0.1 Setting Up The Command

Each IOPB diagram indicates the bytes or fields that must be set for each operation. Certain parameters are essential; others are optional. All commands require the Command, Unit, Interrupt Level, and Interrupt Vector fields to contain valid information.

5.0.2 Completing The Command

After the 772 completes the command, it updates IOPB Bytes 0 through 3 with ERRS, DONE, a Completion Code, and tape drive status information. The 772 only updates the entire IOPB if Auto-update (AUD) is enabled, an error occurs, or a command returns information via the IOPB. If AUD is set, and no errors occur, the 772 sets DONE, posts a Completion Code of zero in Byte 1, and the tape drive status in Bytes 2 and 3; for any command that DMAs data to/from memory, the 772 updates the data address to point to the last address plus one of the transfer. See Table 5-1.

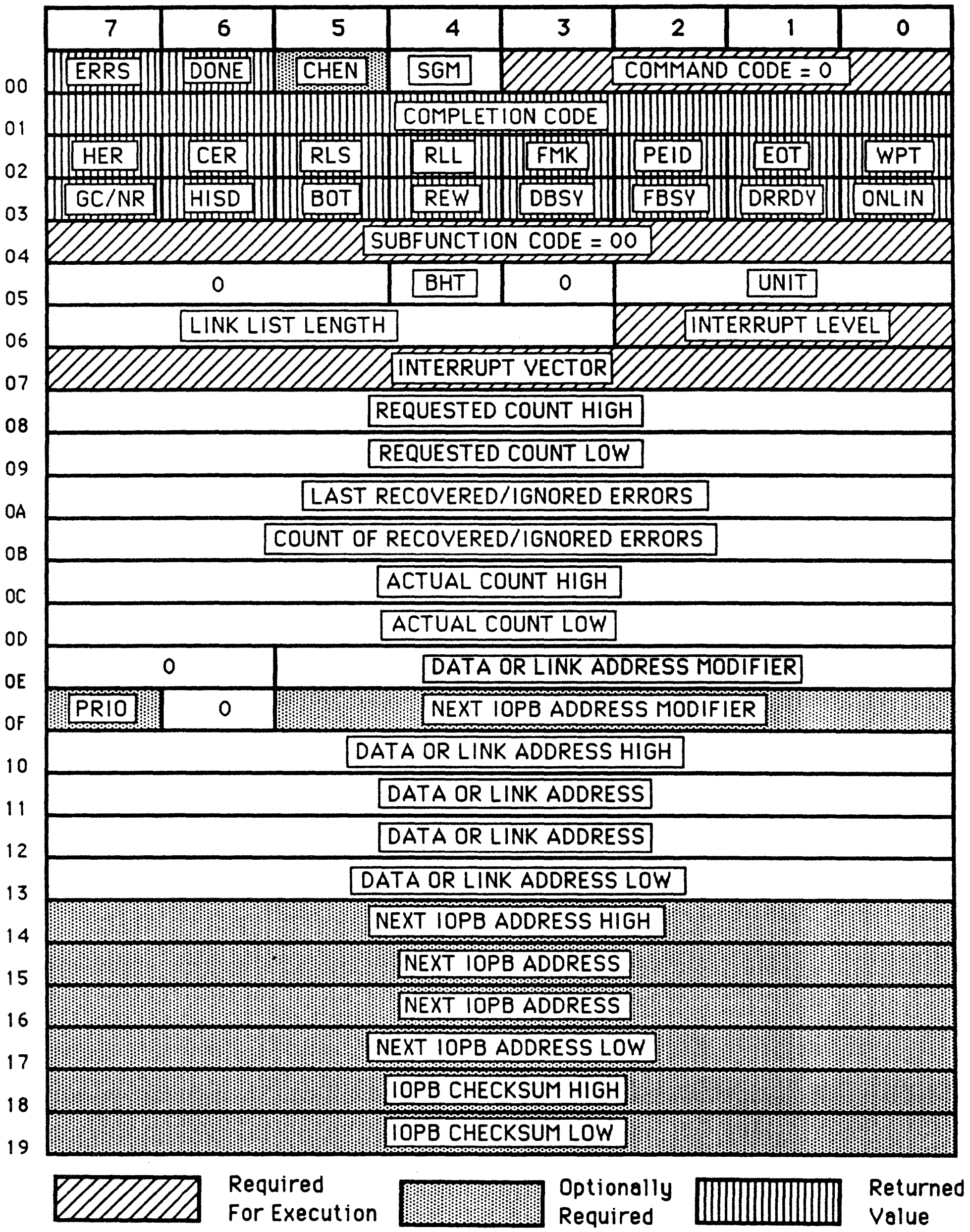
Status	Action
AUD Clear/No Error	772 updates Bytes 0-3 with ERRS, DONE, Completion Code, and tape status
AUD Set/No Error Occurs	772 updates the entire IOPB
AUD Clear/Error Occurs	772 updates the entire IOPB
AUD Clear/Command Returns Information Via the IOPB	772 updates the entire IOPB

Table 5-1. Command Completion

5.1 NO OPERATION

The NOP command is a diagnostic tool; the 772 reads an IOPB from memory into its IRAM and DMAs it back to memory marked DONE. You can run this command by setting the NOP code in the Command byte.

NOP



	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 0			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION CODE = 00							
05	0			BHT	0	UNIT		
06	LINK LIST LENGTH					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	REQUESTED COUNT HIGH							
09	REQUESTED COUNT LOW							
0A	LAST RECOVERED/IGNORED ERRORS							
0B	COUNT OF RECOVERED/IGNORED ERRORS							
0C	ACTUAL COUNT HIGH							
0D	ACTUAL COUNT LOW							
0E	0		DATA OR LINK ADDRESS MODIFIER					
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	DATA OR LINK ADDRESS HIGH							
11	DATA OR LINK ADDRESS							
12	DATA OR LINK ADDRESS							
13	DATA OR LINK ADDRESS LOW							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

▨ Required For Execution
░ Optionally Required
▥ Returned Value

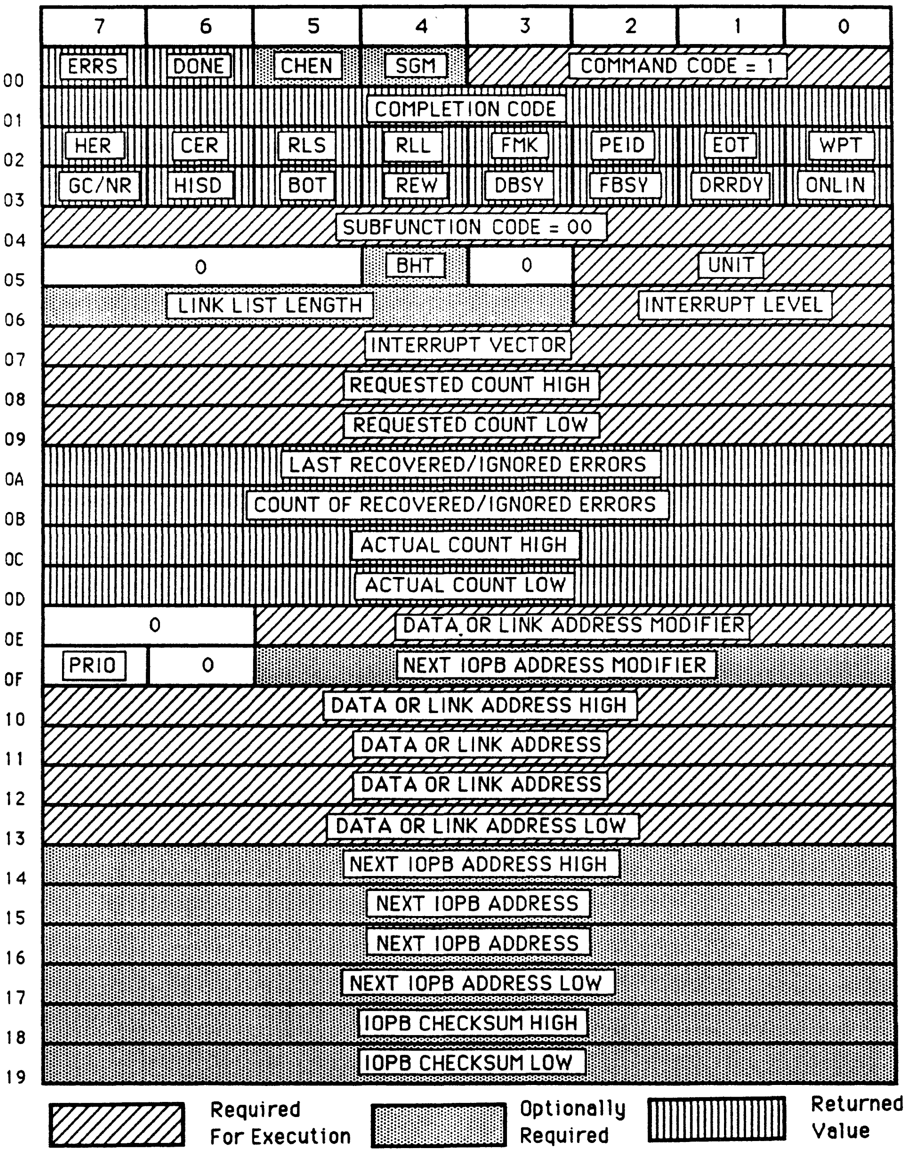
5.2 WRITE DATA

After reading and decoding the IOPB, the 772 reads the data from host memory and writes the data contiguously to the tape.

Write Data has two IOPB formats. In Normal mode, the IOPB specifies one contiguous block of data to write to the tape. The transferred record can be 1- to 65,536-bytes long.

In Gather Write mode, the IOPB specifies up to 32 different host memory data blocks, of varying sizes, to write to the tape. The block can contain any even number of bytes and the total must agree with the byte count. **(A zero in the count field equals the maximum record length [65,536 bytes]. FFFF[H]=65,535.)** See Section 8.4 for more detail on Scatter/Gather operations.

WRITE DATA



	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 1			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION CODE = 00							
05	0			BHT	0	UNIT		
06	LINK LIST LENGTH					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	REQUESTED COUNT HIGH							
09	REQUESTED COUNT LOW							
0A	LAST RECOVERED/IGNORED ERRORS							
0B	COUNT OF RECOVERED/IGNORED ERRORS							
0C	ACTUAL COUNT HIGH							
0D	ACTUAL COUNT LOW							
0E	0		DATA OR LINK ADDRESS MODIFIER					
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	DATA OR LINK ADDRESS HIGH							
11	DATA OR LINK ADDRESS							
12	DATA OR LINK ADDRESS							
13	DATA OR LINK ADDRESS LOW							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

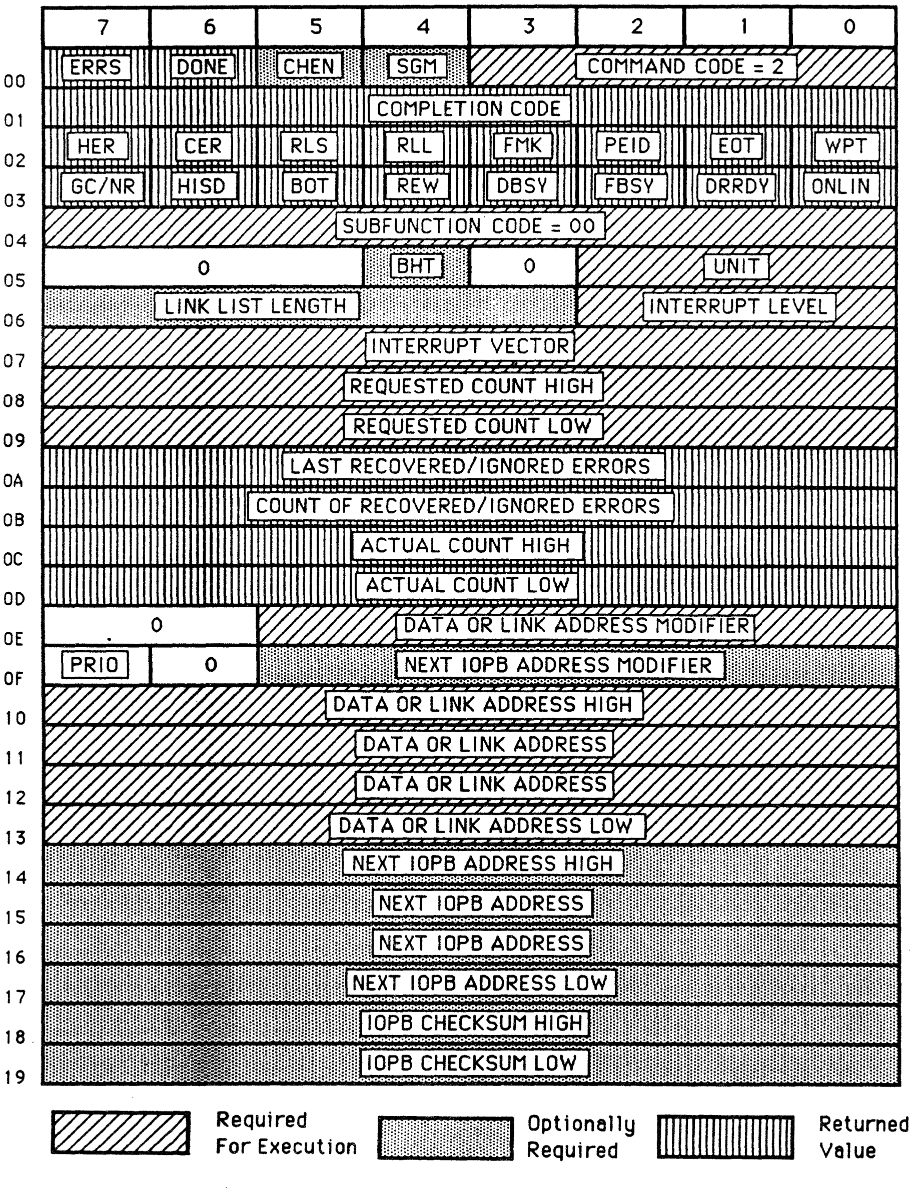
5.3 READ DATA

After reading and decoding the IOPB, the 772 reads the specified number of bytes from the tape, and writes the data to the specified host memory address.

Read Data has two IOPB formats. In Normal mode, the IOPB specifies one contiguous block of host memory that the 772 uses to place the data from the tape. The transferred record can be 1- to 65,536-bytes long.

In Scatter Read mode, the IOPB specifies up to 32 different blocks of host memory, of various size, where the tape data is to be placed. The block can contain any even number of bytes and the total must agree with the byte count. **(A zero in the count field equals the maximum record length [65,536 bytes]. FFFF[H]=65,535.)** See Section 8.4 for more detailed information on Scatter/Gather.

READ DATA



	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 2			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION CODE = 00							
05	0			BHT	0	UNIT		
06	LINK LIST LENGTH					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	REQUESTED COUNT HIGH							
09	REQUESTED COUNT LOW							
0A	LAST RECOVERED/IGNORED ERRORS							
0B	COUNT OF RECOVERED/IGNORED ERRORS							
0C	ACTUAL COUNT HIGH							
0D	ACTUAL COUNT LOW							
0E	0		DATA OR LINK ADDRESS MODIFIER					
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	DATA OR LINK ADDRESS HIGH							
11	DATA OR LINK ADDRESS							
12	DATA OR LINK ADDRESS							
13	DATA OR LINK ADDRESS LOW							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

▨ Required For Execution

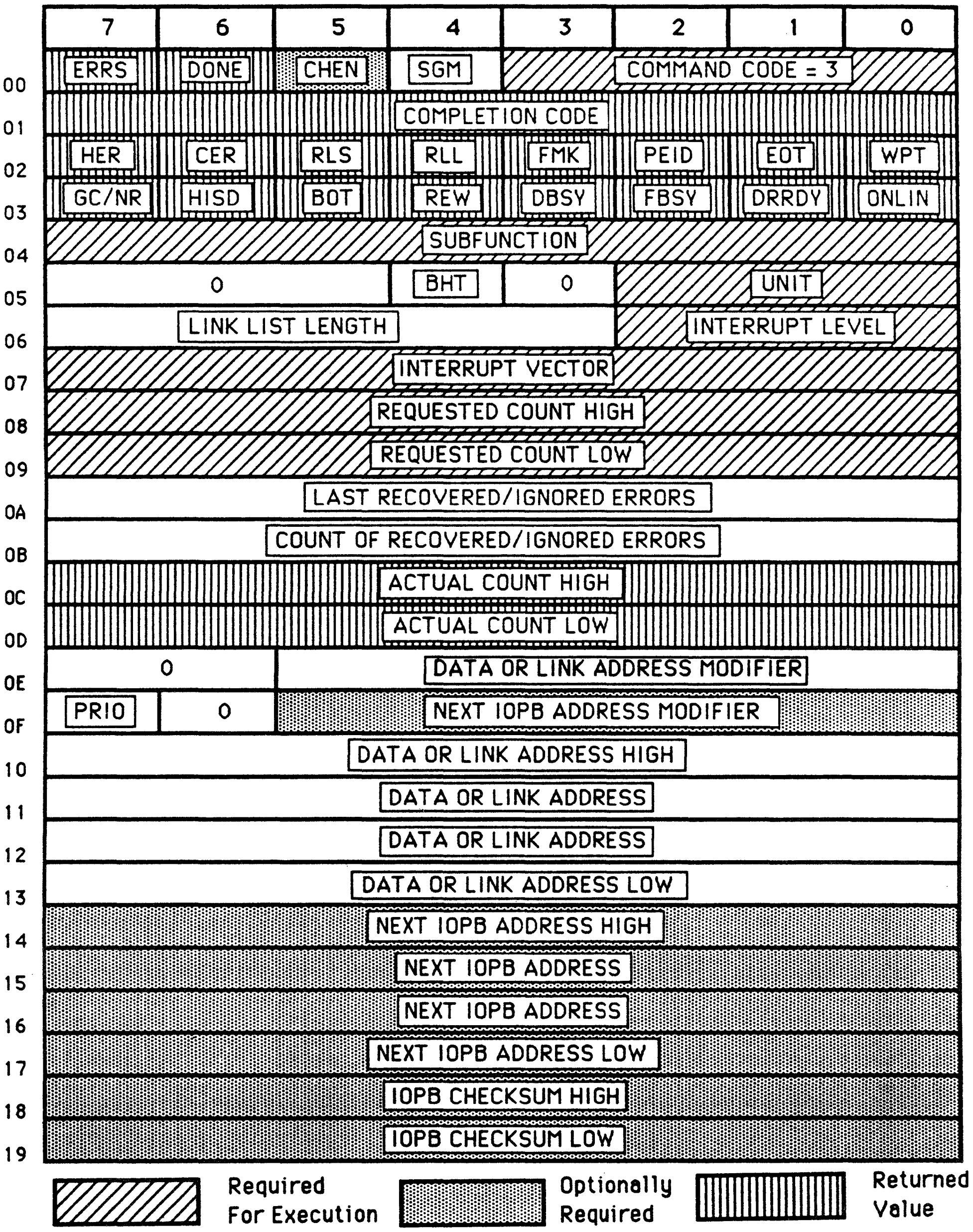
░ Optionally Required

▥ Returned Value

5.4 POSITION

The Position commands move tape forward and reverse over records or files, without transferring data. The 772 uses the count field to set up the number of records to space over or the number of file marks to search for or skip.

POSITION



<table>
<tr><th></th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>00</td><td>ERRS</td><td>DONE</td><td>CHEN</td><td>SGM</td><td colspan="4">COMMAND CODE = 3</td></tr>
<tr><td>01</td><td colspan="8">COMPLETION CODE</td></tr>
<tr><td>02</td><td>HER</td><td>CER</td><td>RLS</td><td>RLL</td><td>FMK</td><td>PEID</td><td>EOT</td><td>WPT</td></tr>
<tr><td>03</td><td>GC/NR</td><td>HISD</td><td>BOT</td><td>REW</td><td>DBSY</td><td>FBSY</td><td>DRRDY</td><td>ONLIN</td></tr>
<tr><td>04</td><td colspan="8">SUBFUNCTION</td></tr>
<tr><td>05</td><td colspan="3">0</td><td>BHT</td><td>0</td><td colspan="3">UNIT</td></tr>
<tr><td>06</td><td colspan="5">LINK LIST LENGTH</td><td colspan="3">INTERRUPT LEVEL</td></tr>
<tr><td>07</td><td colspan="8">INTERRUPT VECTOR</td></tr>
<tr><td>08</td><td colspan="8">REQUESTED COUNT HIGH</td></tr>
<tr><td>09</td><td colspan="8">REQUESTED COUNT LOW</td></tr>
<tr><td>0A</td><td colspan="8">LAST RECOVERED/IGNORED ERRORS</td></tr>
<tr><td>0B</td><td colspan="8">COUNT OF RECOVERED/IGNORED ERRORS</td></tr>
<tr><td>0C</td><td colspan="8">ACTUAL COUNT HIGH</td></tr>
<tr><td>0D</td><td colspan="8">ACTUAL COUNT LOW</td></tr>
<tr><td>0E</td><td colspan="2">0</td><td colspan="6">DATA OR LINK ADDRESS MODIFIER</td></tr>
<tr><td>0F</td><td>PRIO</td><td>0</td><td colspan="6">NEXT IOPB ADDRESS MODIFIER</td></tr>
<tr><td>10</td><td colspan="8">DATA OR LINK ADDRESS HIGH</td></tr>
<tr><td>11</td><td colspan="8">DATA OR LINK ADDRESS</td></tr>
<tr><td>12</td><td colspan="8">DATA OR LINK ADDRESS</td></tr>
<tr><td>13</td><td colspan="8">DATA OR LINK ADDRESS LOW</td></tr>
<tr><td>14</td><td colspan="8">NEXT IOPB ADDRESS HIGH</td></tr>
<tr><td>15</td><td colspan="8">NEXT IOPB ADDRESS</td></tr>
<tr><td>16</td><td colspan="8">NEXT IOPB ADDRESS</td></tr>
<tr><td>17</td><td colspan="8">NEXT IOPB ADDRESS LOW</td></tr>
<tr><td>18</td><td colspan="8">IOPB CHECKSUM HIGH</td></tr>
<tr><td>19</td><td colspan="8">IOPB CHECKSUM LOW</td></tr>
</table>

5.4.1 Position Subfunction Codes

Code	Description
20	SPACE RECORD FORWARD: spaces forward the number of records specified in the count field. Each count places the tape head in the interrecord gap that separates records from one another (see Figure 5-1). If AUD is set, the 772 reports the actual number of records spaced over. If the 772 detects a tape mark, tape motion ceases and the controller reports a File Mark Detected On Read error.
21	SPACE RECORD REVERSE: same as the Space Foward command, except records are spaced in the reverse direction. The 772 aborts this command if it encounters a BOT marker (Reverse Into BOT error).
40	FILE MARK SEARCH FORWARD: searches forward the number of file marks specified in the count field. Each count places the tape heads in the interrecord gap just after the file mark in question. If AUD is set, the 772 reports the actual number of file marks found. If this command is issued, and there are no file marks on the tape, the 772 searches until it detects EOT.
41	FILE MARK SEARCH REVERSE: same as Search Reverse, except the 772 searches for file marks in the reverse direction. Each count places the tape heads in the interrecord gap just before the file mark in question. The 772 aborts this command if it encounters BOT.
42	MULTIPLE FILE MARK SEARCH FORWARD: searches forward for a specified number of consecutive file marks. This is especially useful for positioning the tape heads at the logical end of tape (usually indicated by several consecutive file marks). This command follows the same completion rules as File Mark Search Forward.

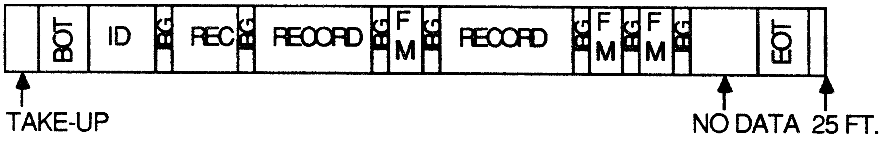
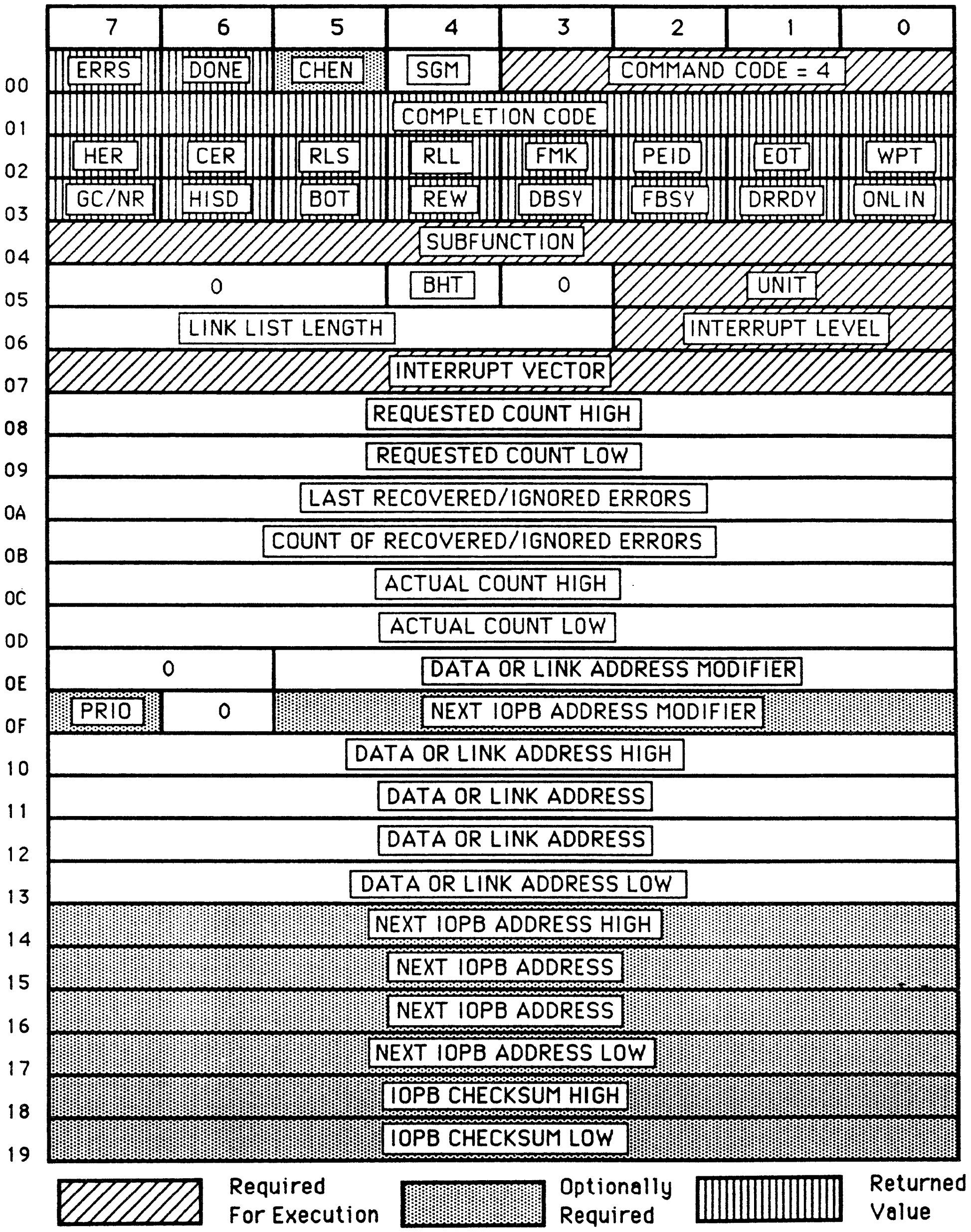


Figure 5-1. Typical Tape Format

5.5 DRIVE RESET

The 772 commands the drive to reset, go on-line, go off-line, or rewind.

DRIVE RESET



	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 4			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION							
05	0			BHT	0	UNIT		
06	LINK LIST LENGTH					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	REQUESTED COUNT HIGH							
09	REQUESTED COUNT LOW							
0A	LAST RECOVERED/IGNORED ERRORS							
0B	COUNT OF RECOVERED/IGNORED ERRORS							
0C	ACTUAL COUNT HIGH							
0D	ACTUAL COUNT LOW							
0E	0		DATA OR LINK ADDRESS MODIFIER					
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	DATA OR LINK ADDRESS HIGH							
11	DATA OR LINK ADDRESS							
12	DATA OR LINK ADDRESS							
13	DATA OR LINK ADDRESS LOW							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

▨ Required For Execution
░ Optionally Required
▥ Returned Value

5.5.1 Drive Reset Subfunction Codes

Code	Description
00	DRIVE RESET: resets the tape drive by dropping the Formatter Enable signal. Use this command if a tape runaway condition occurs. Always consider the tape position unknown following a Drive Reset.
20	LOAD ON-LINE: brings the drive on-line and to load point (BOT). This is useful in remote installations if a power loss occurs. Only certain drive manufacturers support this feature.
21	REWIND: moves the tape at high speed in the reverse direction until the BOT marker is detected. The tape drive should indicate it is at BOT or load point. The Rewind command completes immediatly, although the tape is still rewinding. To verify the tape drive has completed rewinding, software must issue either a Read Drive Parameters or a Drive NOP command. The following conditions should be true: BOT set, REW clear, and DRRDY set. **(Caution: even if REW is clear, the drive may not be ready** [DRRDY clear]).
22	OFF-LINE/UNLOAD: moves the tape at high speed in the reverse direction until the BOT marker is detected. The tape continues moving at low speed until it loses tension and the drive goes off-line. The Off-line/Unload command completes immediately, although the tape has not completed the operation. To verify the tape drive has completed unloading, software must issue either a Read Drive Parameters or Drive NOP command and examine the status of the ONLIN bit in Byte 3.

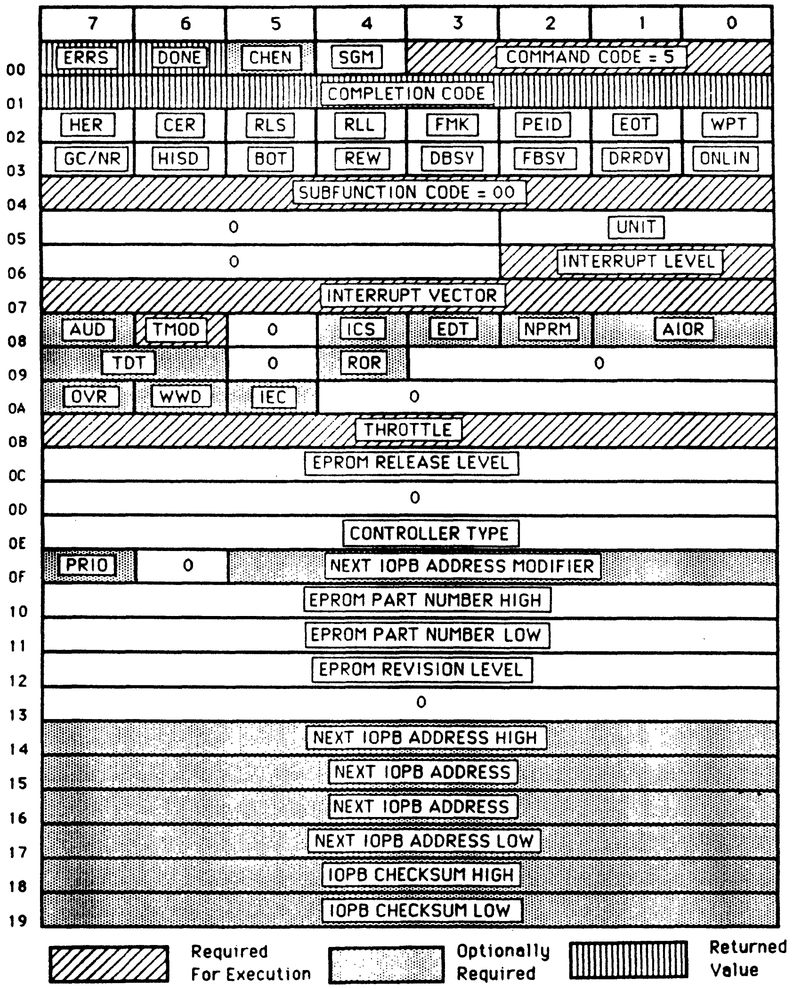
5.6 WRITE PARAMETERS

The Write Parameters command writes controller parameters or drive parameters, depending on the subfunction. (A Write Controller Parameters command must have a valid checksum value if you are setting ICS.)

5.6.1 Write Parameters Subfunction Codes

Code	Description
00	WRITE CONTROLLER PARAMETERS: initializes the 772 with its operational parameters. These parameters are permanently written into a battery backed-up RAM. Only reissuing the command or an IRAM failure causes the parameter values to change. Sections 4.2 through 4.3 define how to change the parameters for individual applications. The 772 assumes no default parameters, however, Xylogics sets parameters during diagnostic verification at the factory.

WRITE CONTROLLER PARAMETERS



	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 5			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION CODE = 00							
05	0					UNIT		
06	0					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	AUD	TMOD	0	ICS	EDT	NPRM	AIOR	
09	TDT		0	ROR	0			
0A	OVR	WWD	IEC	0				
0B	THROTTLE							
0C	EPROM RELEASE LEVEL							
0D	0							
0E	CONTROLLER TYPE							
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	EPROM PART NUMBER HIGH							
11	EPROM PART NUMBER LOW							
12	EPROM REVISION LEVEL							
13	0							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

▨ Required For Execution
░ Optionally Required
▥ Returned Value

5.6.1 Write Parameters Subfunction Codes (continued)

Code	Description
20	WRITE DRIVE PARAMETERS: the 772 sets the various tape drive parameters; it assumes no default values, but once loaded, the parameters remain stored in the 772 IRAM. Only reissuing the command or an IRAM failure causes the parameter values to change. Like Controller Parameters, the 772 has Drive Parameters that were set by factory diagnostics. Up to eight different sets of drive parameters can be stored by Unit Number in the IRAM. After issuing this command, use the Set Drive Parameters command to quickly change parameters.

WRITE DRIVE PARAMETERS

	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 5			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION CODE = 20							
05	0					UNIT		
06	0					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	IRER	IWER	RRTY	WRTY	GRTY	DSB	SWWD	SWBY
09	LGAP	IPOW	SPD	ASS	0	DENSITY		
0A	SET DENSITY TO 800 BPI							
0B	SET DENSITY TO 1600 BPI							
0C	SET DENSITY TO 3200 BPI							
0D	SET DENSITY TO 6250 BPI							
0E	WRITE RECORD WITH VARIABLE IRG							
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	DATA BUSY TIMER							
11	0							
12	0							
13	0							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

▨ Required For Execution

░ Optionally Required

▥ Returned Value

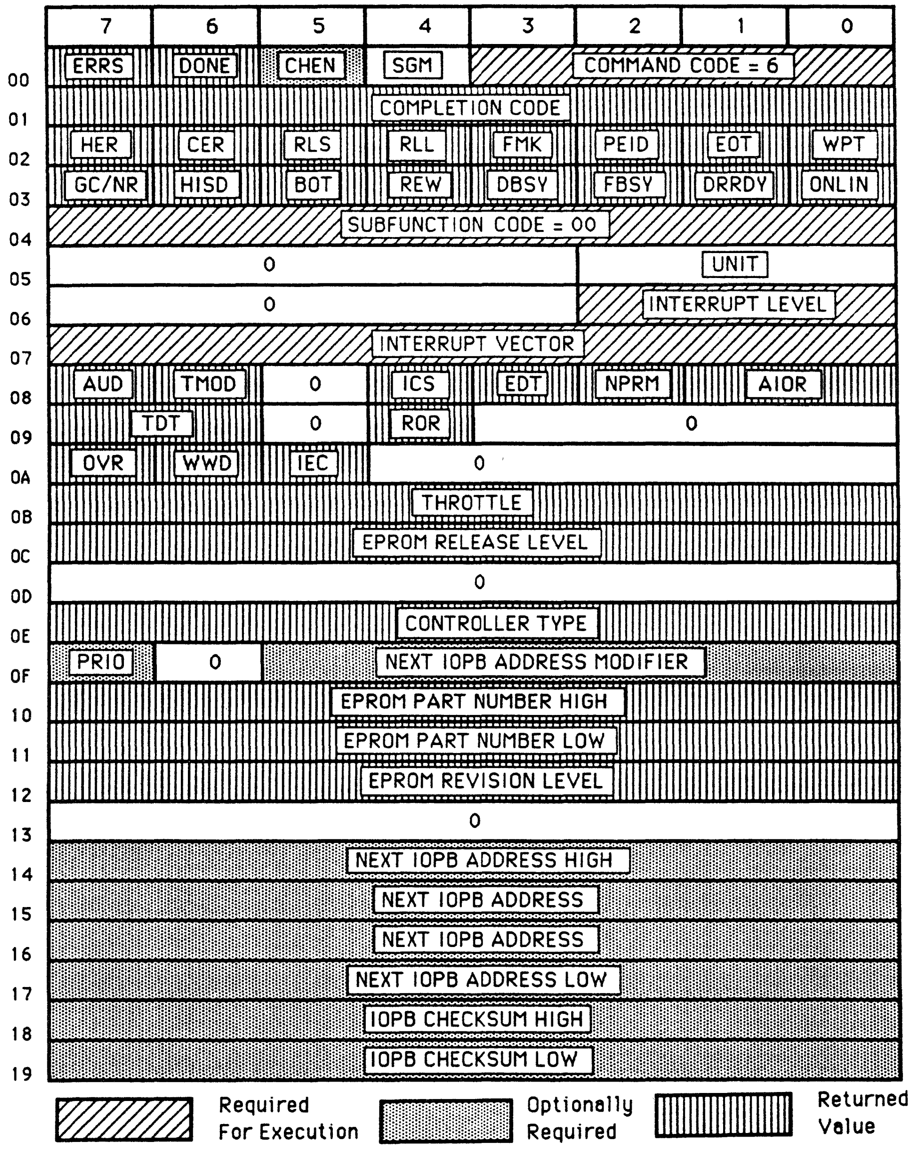
5.7 READ PARAMETERS

The Read Parameters command reads controller parameters, drive parameters, or drive sense information, depending on the subfunction.

5.7.1 Read Parameters Subfunction Codes

Code	Description
00	READ CONTROLLER PARAMETERS: returns the controller parameters written by the last Write Controller Parameters command; it also tests the IRAM checksum. Bytes E through 13 contain specific controller type and revision information that is stored and read from the EPROM.

READ CONTROLLER PARAMETERS



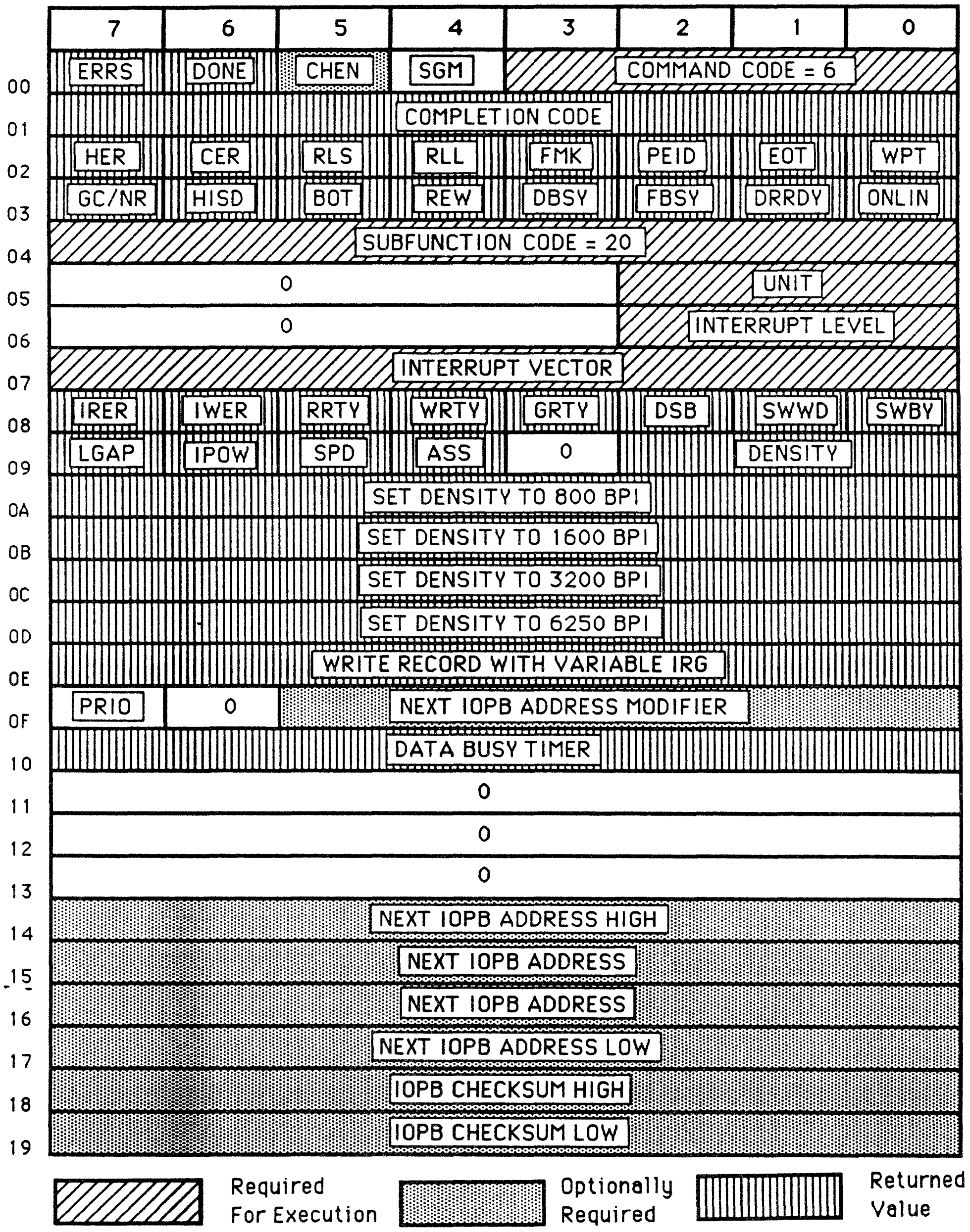
	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 6			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION CODE = 00							
05	0					UNIT		
06	0					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	AUD	TMOD	0	ICS	EDT	NPRM	AIOR	
09	TDT		0	ROR	0			
0A	OVR	WWD	IEC	0				
0B	THROTTLE							
0C	EPROM RELEASE LEVEL							
0D	0							
0E	CONTROLLER TYPE							
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	EPROM PART NUMBER HIGH							
11	EPROM PART NUMBER LOW							
12	EPROM REVISION LEVEL							
13	0							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

▨ Required For Execution
░ Optionally Required
▥ Returned Value

5.7.1 Read Parameters Subfunction Codes (continued)

Code	Description
20	READ DRIVE PARAMETERS: returns the drive parameters written by the last Write Drive Parameters command for the unit selected, and the IRAM checksum.

READ DRIVE PARAMETERS



	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 6			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION CODE = 20							
05	0					UNIT		
06	0					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	IRER	IWER	RRTY	WRTY	GRTY	DSB	SWWD	SWBY
09	LGAP	IPOW	SPD	ASS	0	DENSITY		
0A	SET DENSITY TO 800 BPI							
0B	SET DENSITY TO 1600 BPI							
0C	SET DENSITY TO 3200 BPI							
0D	SET DENSITY TO 6250 BPI							
0E	WRITE RECORD WITH VARIABLE IRG							
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	DATA BUSY TIMER							
11	0							
12	0							
13	0							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

▨ Required For Execution

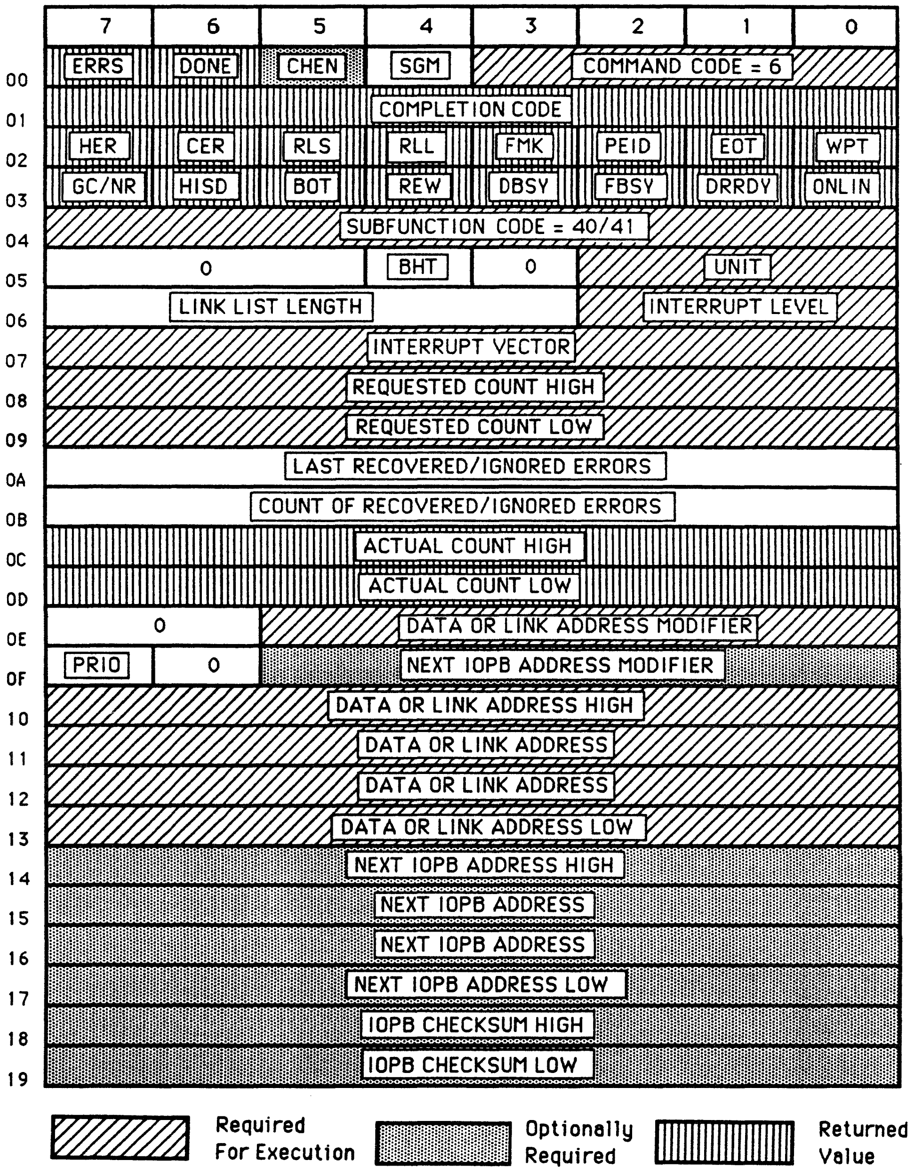
░ Optionally Required

▥ Returned Value

5.7.1 Read Parameters Subfunction Codes (continued)

Code	Description
40	READ SENSE BYTES: returns drive-specific status and diagnostic information to a host memory buffer specified in the IOPB. This command is similar to the Read command format in that it requires a byte count and buffer address. Consult your drive manufacturer's manual for the number of bytes returned and their definitions.
41	READ EXTENDED SENSE BYTES: this command is almost identical to the Read Sense Bytes commands, except the tape drive provides more information. This command is mainly used for diagnostic purposes.

READ SENSE / READ EXTENDED SENSE



	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 6			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION CODE = 40/41							
05	0			BHT	0	UNIT		
06	LINK LIST LENGTH					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	REQUESTED COUNT HIGH							
09	REQUESTED COUNT LOW							
0A	LAST RECOVERED/IGNORED ERRORS							
0B	COUNT OF RECOVERED/IGNORED ERRORS							
0C	ACTUAL COUNT HIGH							
0D	ACTUAL COUNT LOW							
0E	0		DATA OR LINK ADDRESS MODIFIER					
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	DATA OR LINK ADDRESS HIGH							
11	DATA OR LINK ADDRESS							
12	DATA OR LINK ADDRESS							
13	DATA OR LINK ADDRESS LOW							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

▨ Required For Execution

░ Optionally Required

▥ Returned Value

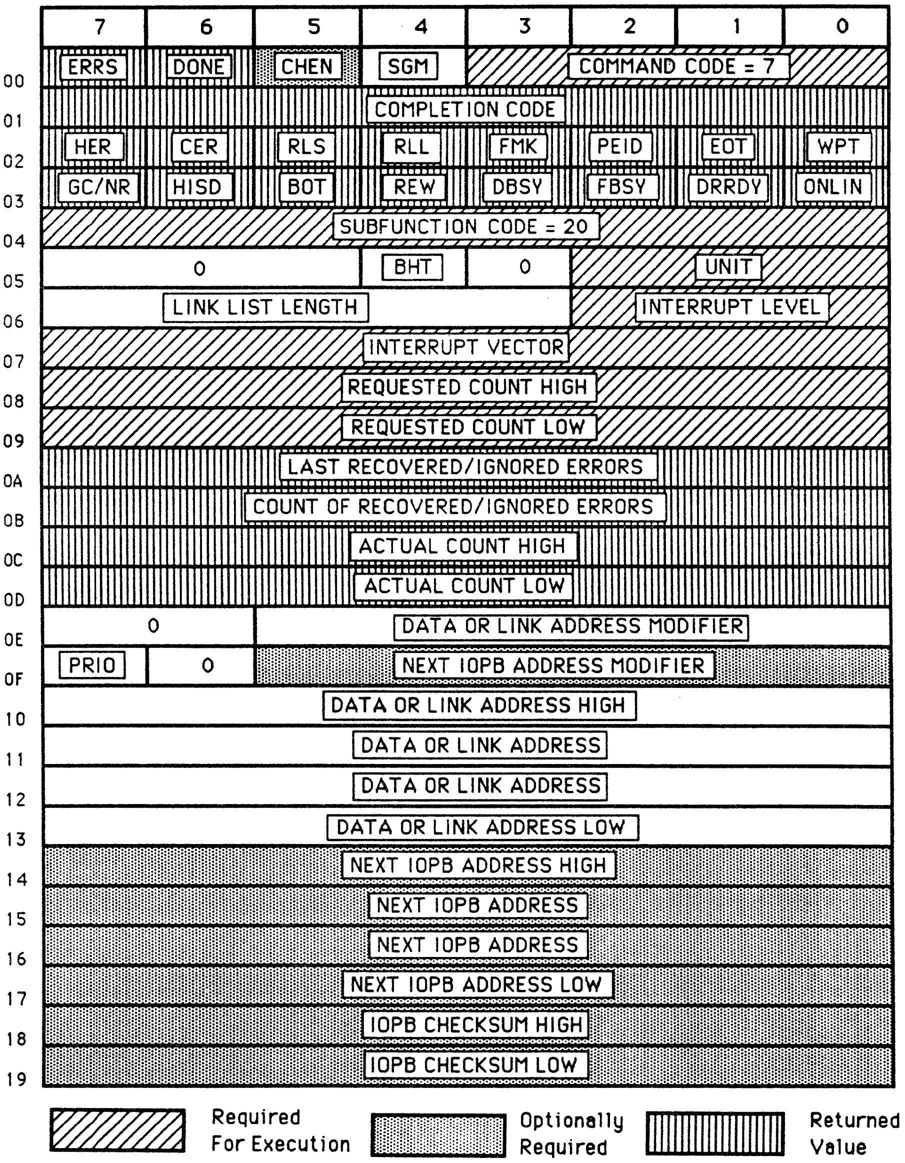
5.8 EXTENDED WRITE

This command controls three separate Write functions: Write File Mark, Erase, and Write Continuous. These functions require different IOPB formats. Section 5.8.1 explains these functions and follows with IOPB diagrams.

5.8.1 Extended Write Subfunction Codes

Code	Description
20	WRITE FILE MARK: the 772 issues a Write File Mark command to the tape drive. File marks are special records that logically group data records on tape. Host software should write at least one file mark (preferably two) at the logical end of tape. (Write File Mark uses the count field to specify the number of file marks to write.)

WRITE FILE MARK



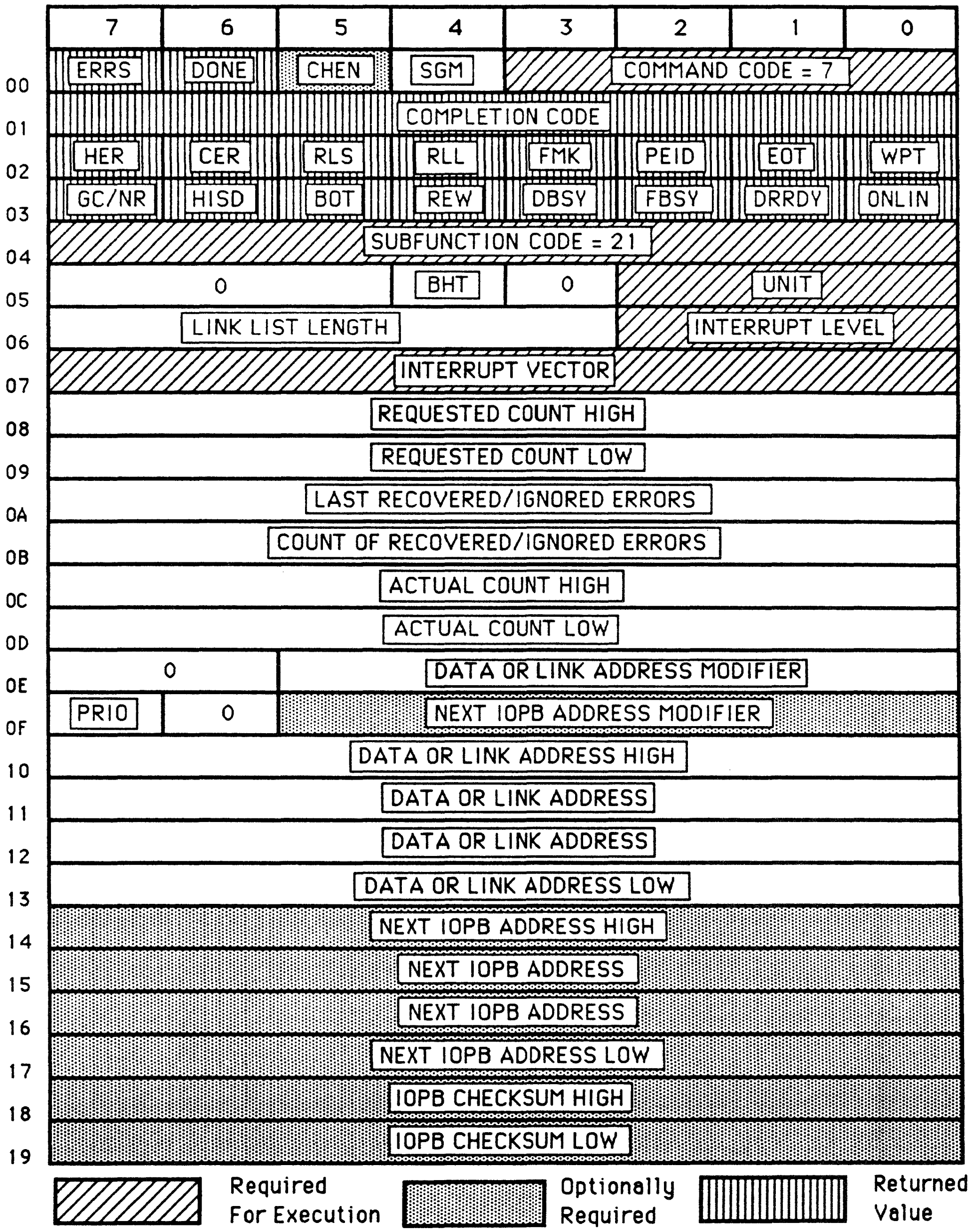
<table>
<tr><th></th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>00</td><td>ERRS</td><td>DONE</td><td>CHEN</td><td>SGM</td><td colspan="4">COMMAND CODE = 7</td></tr>
<tr><td>01</td><td colspan="8">COMPLETION CODE</td></tr>
<tr><td>02</td><td>HER</td><td>CER</td><td>RLS</td><td>RLL</td><td>FMK</td><td>PEID</td><td>EOT</td><td>WPT</td></tr>
<tr><td>03</td><td>GC/NR</td><td>HISD</td><td>BOT</td><td>REW</td><td>DBSY</td><td>FBSY</td><td>DRRDY</td><td>ONLIN</td></tr>
<tr><td>04</td><td colspan="8">SUBFUNCTION CODE = 20</td></tr>
<tr><td>05</td><td colspan="3">0</td><td>BHT</td><td>0</td><td colspan="3">UNIT</td></tr>
<tr><td>06</td><td colspan="5">LINK LIST LENGTH</td><td colspan="3">INTERRUPT LEVEL</td></tr>
<tr><td>07</td><td colspan="8">INTERRUPT VECTOR</td></tr>
<tr><td>08</td><td colspan="8">REQUESTED COUNT HIGH</td></tr>
<tr><td>09</td><td colspan="8">REQUESTED COUNT LOW</td></tr>
<tr><td>0A</td><td colspan="8">LAST RECOVERED/IGNORED ERRORS</td></tr>
<tr><td>0B</td><td colspan="8">COUNT OF RECOVERED/IGNORED ERRORS</td></tr>
<tr><td>0C</td><td colspan="8">ACTUAL COUNT HIGH</td></tr>
<tr><td>0D</td><td colspan="8">ACTUAL COUNT LOW</td></tr>
<tr><td>0E</td><td colspan="2">0</td><td colspan="6">DATA OR LINK ADDRESS MODIFIER</td></tr>
<tr><td>0F</td><td>PRIO</td><td>0</td><td colspan="6">NEXT IOPB ADDRESS MODIFIER</td></tr>
<tr><td>10</td><td colspan="8">DATA OR LINK ADDRESS HIGH</td></tr>
<tr><td>11</td><td colspan="8">DATA OR LINK ADDRESS</td></tr>
<tr><td>12</td><td colspan="8">DATA OR LINK ADDRESS</td></tr>
<tr><td>13</td><td colspan="8">DATA OR LINK ADDRESS LOW</td></tr>
<tr><td>14</td><td colspan="8">NEXT IOPB ADDRESS HIGH</td></tr>
<tr><td>15</td><td colspan="8">NEXT IOPB ADDRESS</td></tr>
<tr><td>16</td><td colspan="8">NEXT IOPB ADDRESS</td></tr>
<tr><td>17</td><td colspan="8">NEXT IOPB ADDRESS LOW</td></tr>
<tr><td>18</td><td colspan="8">IOPB CHECKSUM HIGH</td></tr>
<tr><td>19</td><td colspan="8">IOPB CHECKSUM LOW</td></tr>
</table>

▨ Required For Execution
░ Optionally Required
▥ Returned Value

5.8.1 Extended Write Subfunction Codes (continued)

Code	Description
21	ERASE: the drive erases 3-inches of tape per command. The only IOPB parameters ERASE requires are the Command and Subfuntion Codes. Use this command to erase over bad tape when write retries are not enabled.

ERASE



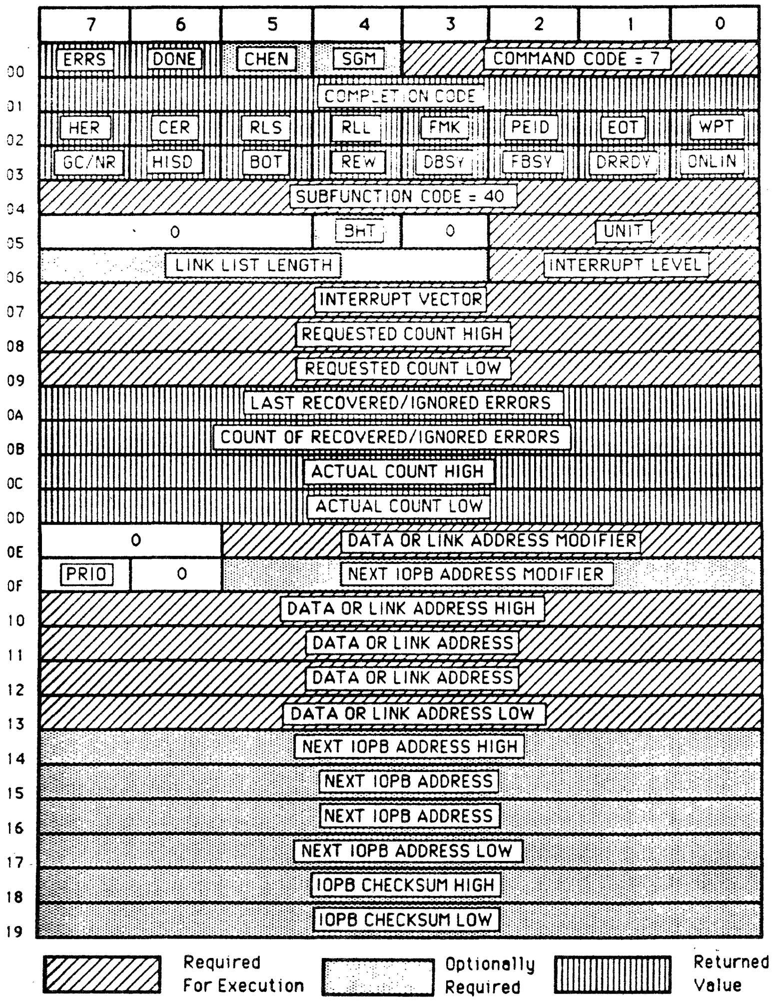
	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 7			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION CODE = 21							
05	0			BHT	0	UNIT		
06	LINK LIST LENGTH					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	REQUESTED COUNT HIGH							
09	REQUESTED COUNT LOW							
0A	LAST RECOVERED/IGNORED ERRORS							
0B	COUNT OF RECOVERED/IGNORED ERRORS							
0C	ACTUAL COUNT HIGH							
0D	ACTUAL COUNT LOW							
0E	0		DATA OR LINK ADDRESS MODIFIER					
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	DATA OR LINK ADDRESS HIGH							
11	DATA OR LINK ADDRESS							
12	DATA OR LINK ADDRESS							
13	DATA OR LINK ADDRESS LOW							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

▨ Required For Execution
░ Optionally Required
▥ Returned Value

5.8.1 Extended Write Subfunction Codes (continued)

Code	Description
40	WRITE CONTINUOUS: allows the 772 to write records of unlimited size. IOPBs must be chained or queued for this feature to work. All data addresses must be on a word boundary, and the byte count must be even. When the 772 completes the byte count of the first IOPB, it decodes the next IOPB, and begins the data transfer without letting the tape drive write an interrecord gap (the 772 never sends the Last Word signal to the tape drive). The FIFO empties if software fails to supply the next IOPB address in time for the 772 to decode it and DMA data to the FIFO. At this point, the 772 writes an interrecord gap which effectively treats the last Continuous command as a standard Write (and a Continue Reload error occurs); in normal operation, terminate Write Continuous with a standard Write command or a Continue Reload error will occur. Xylogics recommends implementing a circular buffer scheme to compensate for the large amount of memory this feature requires.

WRITE CONTINUOUS



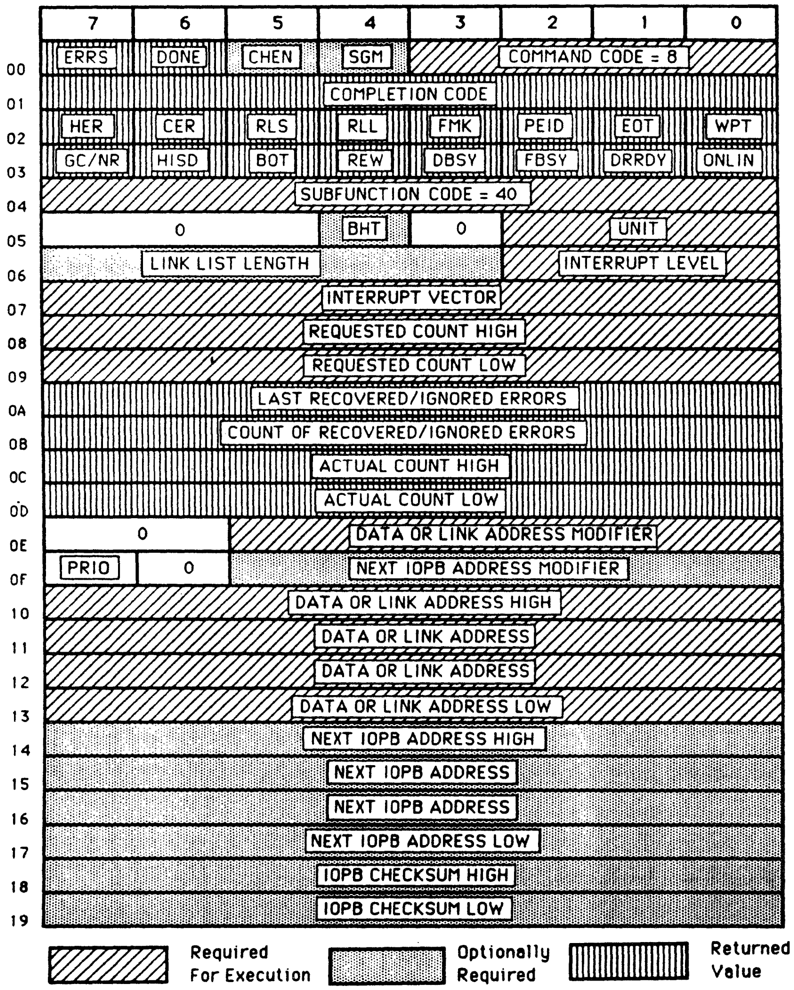
	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 7			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION CODE = 40							
05	0			BHT	0	UNIT		
06	LINK LIST LENGTH					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	REQUESTED COUNT HIGH							
09	REQUESTED COUNT LOW							
0A	LAST RECOVERED/IGNORED ERRORS							
0B	COUNT OF RECOVERED/IGNORED ERRORS							
0C	ACTUAL COUNT HIGH							
0D	ACTUAL COUNT LOW							
0E	0		DATA OR LINK ADDRESS MODIFIER					
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	DATA OR LINK ADDRESS HIGH							
11	DATA OR LINK ADDRESS							
12	DATA OR LINK ADDRESS							
13	DATA OR LINK ADDRESS LOW							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

5.9 EXTENDED READ

5.9.1 Extended Read Subfunction Code

Code	Description
40	READ CONTINUOUS: allows the 772 to read records of unlimited size. IOPBs must be chained or queued for this feature to work. All data addresses must be on a word boundary, and the byte count must be even. When the 772 completes the byte count of the first IOPB in a chain, it decodes the next IOPB, and begins the transfer where the first transfer left off. If software fails to supply the next IOPB in time for the 772 to decode it, the FIFO overflows with data from the tape record, and a Continue Reload error occurs. Terminate Read Continuous with a standard Read command or a Continue Reload error will occur. Using a circular buffer scheme helps compensate for the large memory this feature requires.

READ CONTINUOUS



	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 8			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION CODE = 40							
05	0			BHT	0	UNIT		
06	LINK LIST LENGTH					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	REQUESTED COUNT HIGH							
09	REQUESTED COUNT LOW							
0A	LAST RECOVERED/IGNORED ERRORS							
0B	COUNT OF RECOVERED/IGNORED ERRORS							
0C	ACTUAL COUNT HIGH							
0D	ACTUAL COUNT LOW							
0E	0		DATA OR LINK ADDRESS MODIFIER					
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	DATA OR LINK ADDRESS HIGH							
11	DATA OR LINK ADDRESS							
12	DATA OR LINK ADDRESS							
13	DATA OR LINK ADDRESS LOW							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

▨ Required For Execution
░ Optionally Required
▥ Returned Value

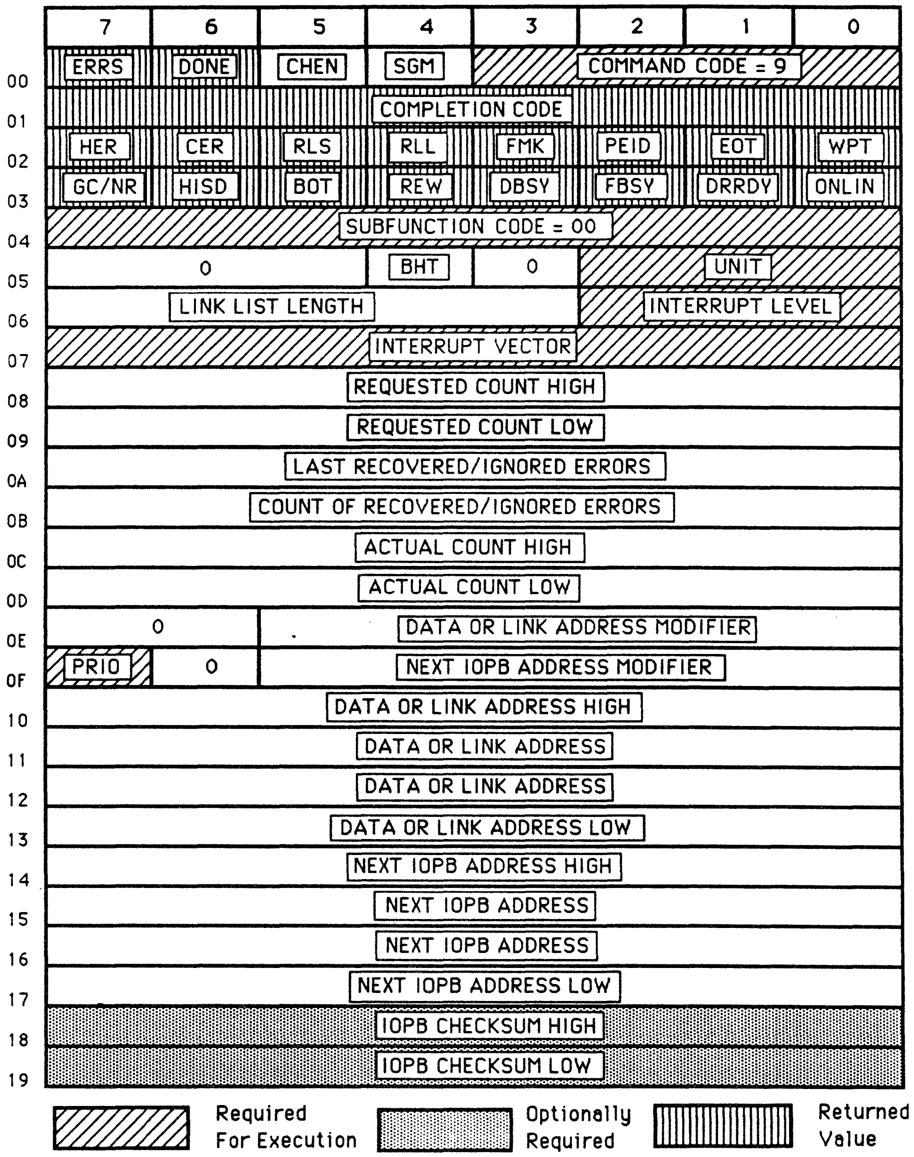
5.10 DIAGNOSTICS

The 772 provides both on-board self test diagnostics as well as drive-specific tests and functions.

5.10.1 Diagnostic Subfunction Codes

Code	Description
00	SELF TEST: the 772 executes the on-board Self Test code; it reports errors from this test in the Fatal Error Register (see Section 6). You can only use Self Test with a single priority IOPB (i.e., no chaining, and no IOPBs in the 772 queue).

SELF TEST



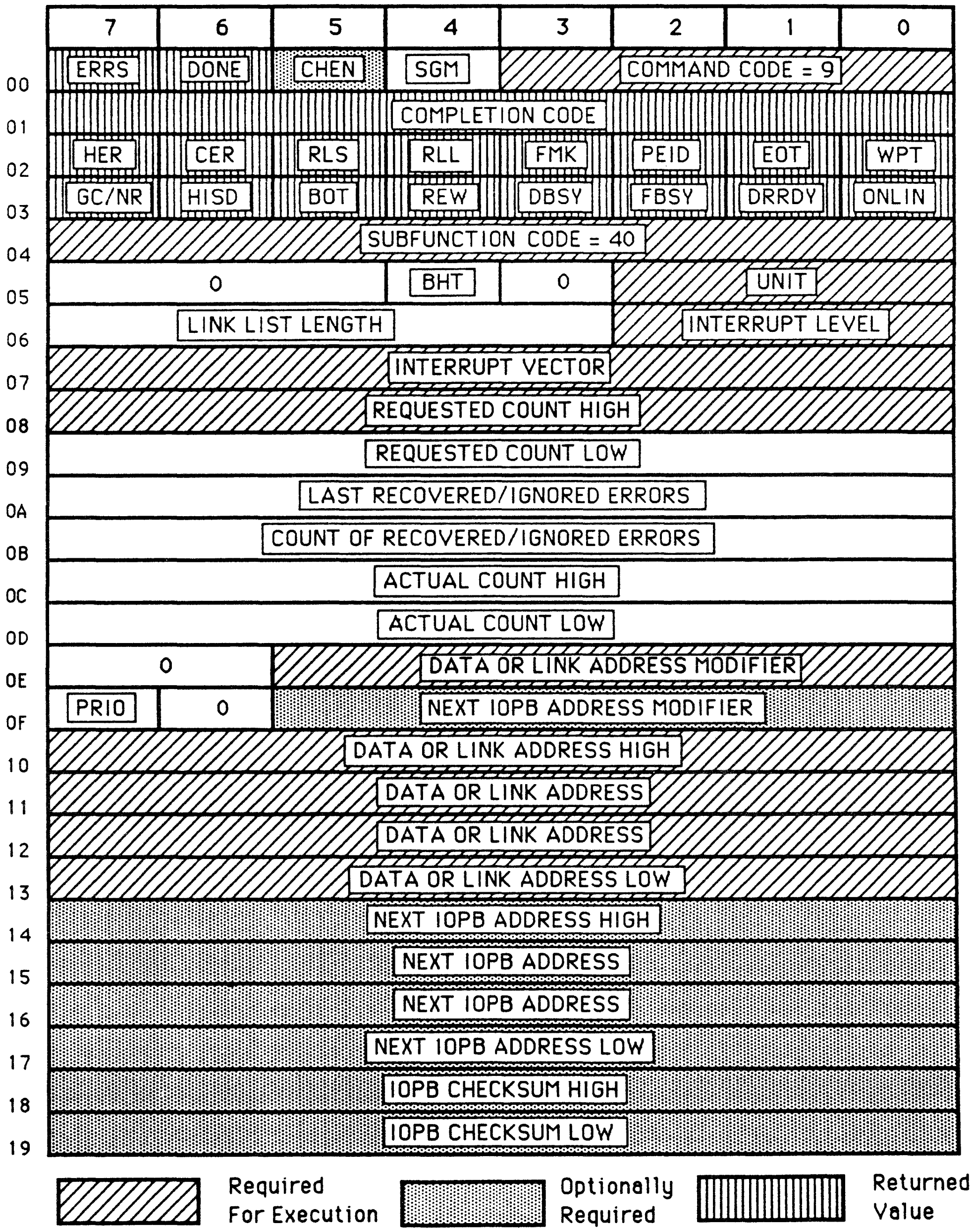
	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 9			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION CODE = 00							
05	0			BHT	0	UNIT		
06	LINK LIST LENGTH					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	REQUESTED COUNT HIGH							
09	REQUESTED COUNT LOW							
0A	LAST RECOVERED/IGNORED ERRORS							
0B	COUNT OF RECOVERED/IGNORED ERRORS							
0C	ACTUAL COUNT HIGH							
0D	ACTUAL COUNT LOW							
0E	0		DATA OR LINK ADDRESS MODIFIER					
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	DATA OR LINK ADDRESS HIGH							
11	DATA OR LINK ADDRESS							
12	DATA OR LINK ADDRESS							
13	DATA OR LINK ADDRESS LOW							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

▨ Required For Execution
░ Optionally Required
▥ Returned Value

5.10.1 Diagnostic Subfunction Codes (continued)

Code	Description
40	LOOPBACK TEST: issued to the tape drive formatter as a Write command, but the tape is not written. The data received is routed through the write logic of the drive formatter, back through the read logic of the tape drive interface, and then back to the read logic of the 772. The 772 checks the parity of the read data, but does not store it. Use this tape drive diagnostic to check the formatter's read and write functions. Only certain tape drive manufacturer's support this command.

LOOPBACK TEST



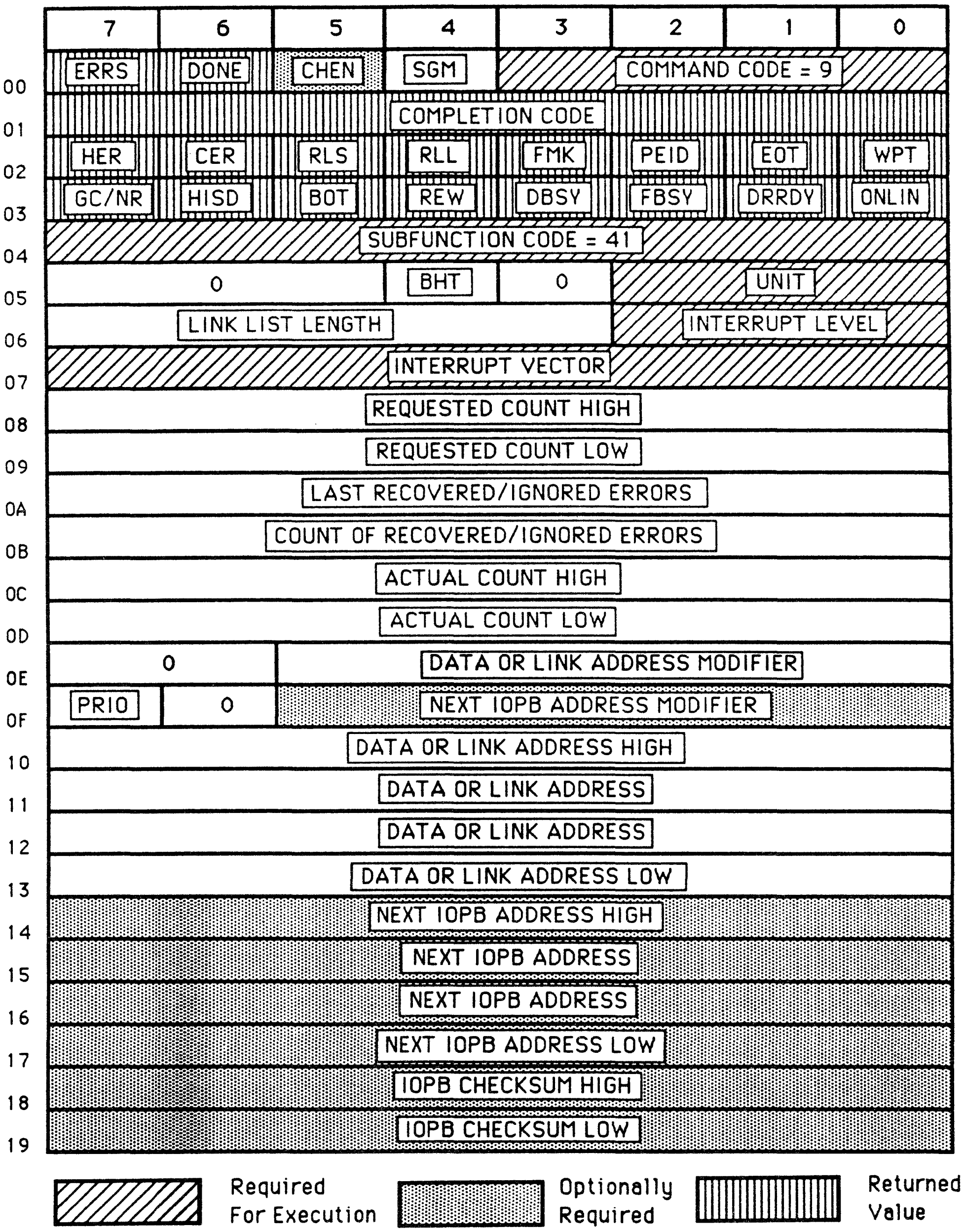
	7	6	5	4	3	2	1	0
00	▥ ERRS	▥ DONE	░ CHEN	SGM	▨ COMMAND CODE = 9			
01	▥ COMPLETION CODE							
02	▥ HER	▥ CER	▥ RLS	▥ RLL	▥ FMK	▥ PEID	▥ EOT	▥ WPT
03	▥ GC/NR	▥ HISD	▥ BOT	▥ REW	▥ DBSY	▥ FBSY	▥ DRRDY	▥ ONLIN
04	▨ SUBFUNCTION CODE = 40							
05	0			BHT	0	▨ UNIT		
06	LINK LIST LENGTH					▨ INTERRUPT LEVEL		
07	▨ INTERRUPT VECTOR							
08	▨ REQUESTED COUNT HIGH							
09	REQUESTED COUNT LOW							
0A	LAST RECOVERED/IGNORED ERRORS							
0B	COUNT OF RECOVERED/IGNORED ERRORS							
0C	ACTUAL COUNT HIGH							
0D	ACTUAL COUNT LOW							
0E	0		▨ DATA OR LINK ADDRESS MODIFIER					
0F	PRIO	0	░ NEXT IOPB ADDRESS MODIFIER					
10	▨ DATA OR LINK ADDRESS HIGH							
11	▨ DATA OR LINK ADDRESS							
12	▨ DATA OR LINK ADDRESS							
13	▨ DATA OR LINK ADDRESS LOW							
14	░ NEXT IOPB ADDRESS HIGH							
15	░ NEXT IOPB ADDRESS							
16	░ NEXT IOPB ADDRESS							
17	░ NEXT IOPB ADDRESS LOW							
18	░ IOPB CHECKSUM HIGH							
19	░ IOPB CHECKSUM LOW							

▨ Required For Execution ░ Optionally Required ▥ Returned Value

5.10.1 Diagnostic Subfunction Codes (continued)

Code	Description
41	SECURITY ERASE: the drive erases the entire length of tape to EOT; then software must issue a Rewind command. This is commonly used to erase a tape that has old data or to retension the tape on the tape reel.

SECURITY ERASE



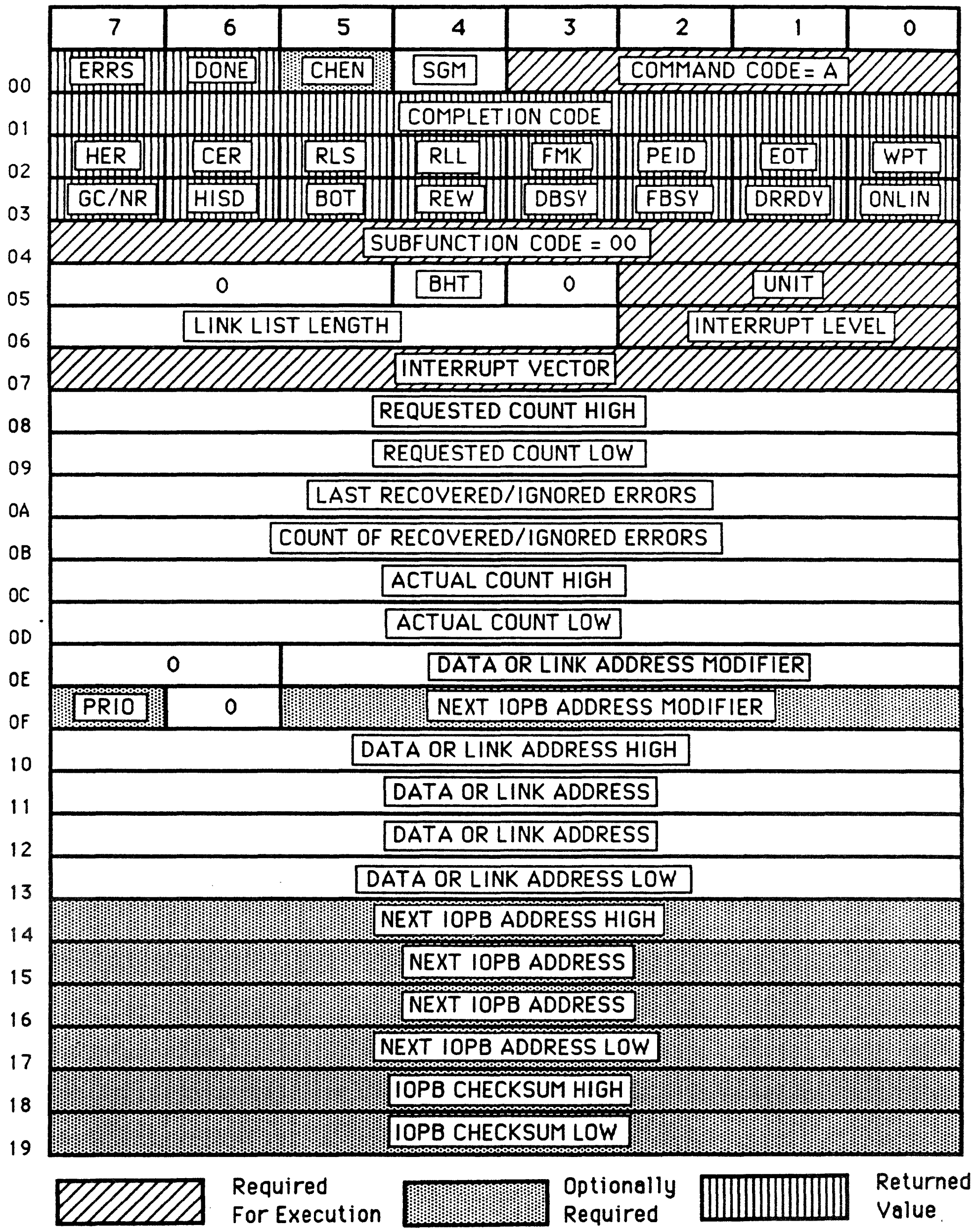
	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 9			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION CODE = 41							
05	0			BHT	0	UNIT		
06	LINK LIST LENGTH					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	REQUESTED COUNT HIGH							
09	REQUESTED COUNT LOW							
0A	LAST RECOVERED/IGNORED ERRORS							
0B	COUNT OF RECOVERED/IGNORED ERRORS							
0C	ACTUAL COUNT HIGH							
0D	ACTUAL COUNT LOW							
0E	0		DATA OR LINK ADDRESS MODIFIER					
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	DATA OR LINK ADDRESS HIGH							
11	DATA OR LINK ADDRESS							
12	DATA OR LINK ADDRESS							
13	DATA OR LINK ADDRESS LOW							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

▨ Required For Execution
░ Optionally Required
▥ Returned Value

5.11 ABORT

The 772 aborts IOPBs by unit number and interrupt level. The IOPB must specify which unit number and interrupt level to abort. The 772 returns all IOPBs chained or queued with an Abort By Command error; it does not abort the IOPB currently in process. Use this command when error recovery procedures fail to clear a hard error condition.

ABORT



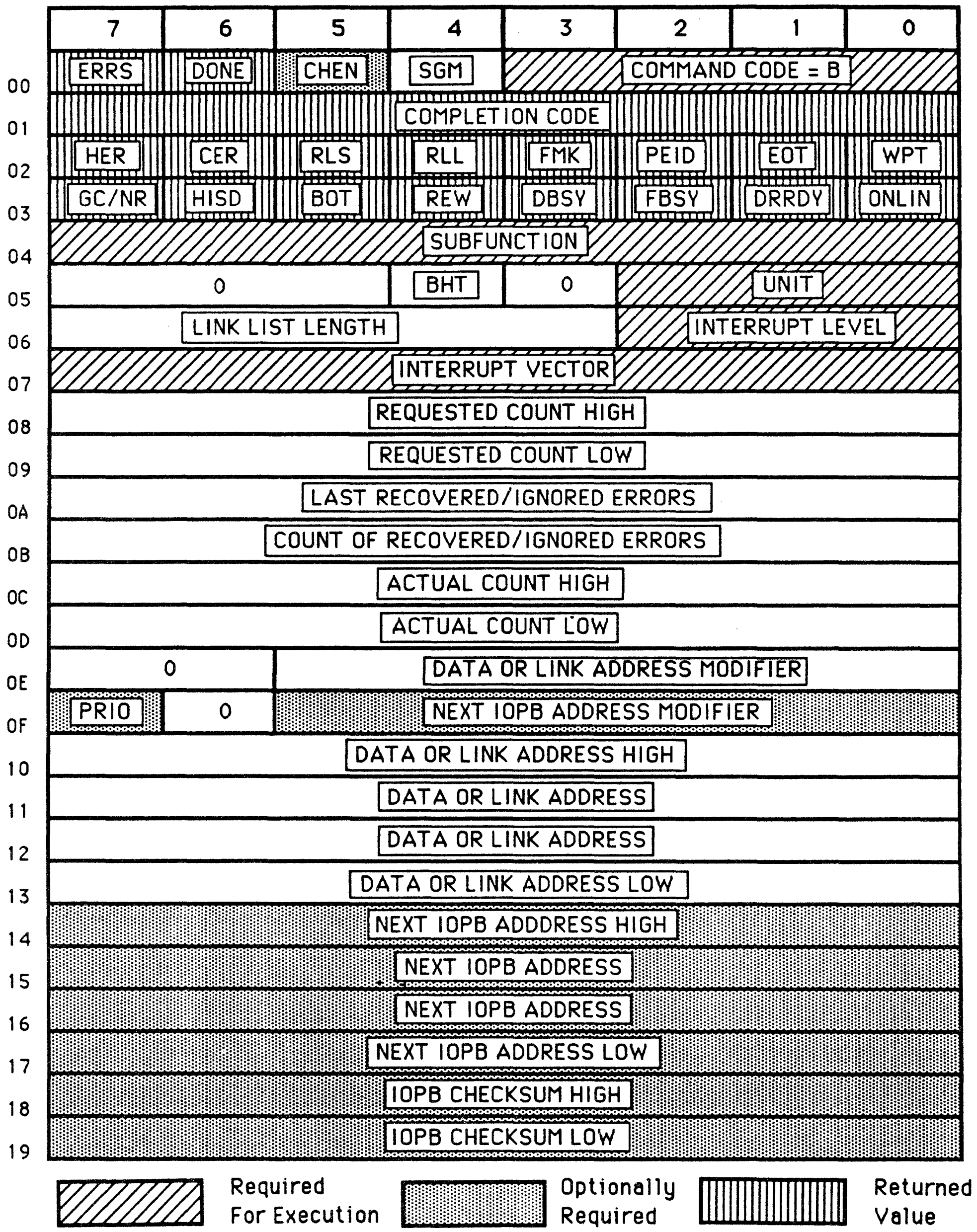
	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE= A			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION CODE = 00							
05	0			BHT	0	UNIT		
06	LINK LIST LENGTH					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	REQUESTED COUNT HIGH							
09	REQUESTED COUNT LOW							
0A	LAST RECOVERED/IGNORED ERRORS							
0B	COUNT OF RECOVERED/IGNORED ERRORS							
0C	ACTUAL COUNT HIGH							
0D	ACTUAL COUNT LOW							
0E	0		DATA OR LINK ADDRESS MODIFIER					
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	DATA OR LINK ADDRESS HIGH							
11	DATA OR LINK ADDRESS							
12	DATA OR LINK ADDRESS							
13	DATA OR LINK ADDRESS LOW							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

▨ Required For Execution
░ Optionally Required
▥ Returned Value

5.12 SET DRIVE PARAMETERS

This command allows you to change a single drive parameter, via Subfunction Codes, without having to set up all parameters as in the Write Parameters command. The Subfunction Codes use the parameter information already present in the IRAM that were initially written with the Write Drive Parameters Command.

SET DRIVE PARAMETERS



	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = B			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION							
05	0			BHT	0	UNIT		
06	LINK LIST LENGTH					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	REQUESTED COUNT HIGH							
09	REQUESTED COUNT LOW							
0A	LAST RECOVERED/IGNORED ERRORS							
0B	COUNT OF RECOVERED/IGNORED ERRORS							
0C	ACTUAL COUNT HIGH							
0D	ACTUAL COUNT LOW							
0E	0		DATA OR LINK ADDRESS MODIFIER					
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	DATA OR LINK ADDRESS HIGH							
11	DATA OR LINK ADDRESS							
12	DATA OR LINK ADDRESS							
13	DATA OR LINK ADDRESS LOW							
14	NEXT IOPB ADDDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

5.12.1 Set Drive Parameters Subfunction Codes

Code	Description
40	DRIVE NOP: supplies Tape Drive Status Bytes 2 and 3 with information that is not normally returned in a controller NOP command. This command is useful for determining drive status during Rewind or Off-line/Unload commands.
42	SET LOW DENSITY: selects low density for drives that use the tape interface signal P1-36 for selecting density. The DSB bit in Byte 8 of the Write Drive Parameters IOPB must be set for this feature to work. The definition of low density is manufacturer-dependent.
43	SET HIGH DENSITY: selects high density for drives that use the tape interface signal P1-36 to select density. The DSB bit in Byte 8 of the Write Drive Parameters IOPB must be set for this feature to work. The definition of high density is manufacturer-dependent.

The following Subfunction Codes select combinations of tape speed and interrecord gap length. Typical tape speeds are combinations of 12.5 IPS, 25 IPS, 50 IPS, 75 IPS, 100 IPS, 125 IPS and 200 IPS; the manufacturer normally supports a selection of two tape speeds. Normal interrecord gap length (IRG) is a function of the density selected. For example, 1600 BPI has a normal IRG of .6 inches; 6250 BPI is .3 inches. Long IRG is typically double the normal size; consult your drive manual.

Code	Description
48	SET LOW SPEED AND NORMAL GAP.
49	SET HIGH SPEED AND NORMAL GAP.
4A	SET LOW SPEED AND LONG GAP.
4B	SET HIGH SPEED AND LONG GAP.

The Set BPI commands use the values written into the IRAM from the last Write Drive Parameters command.

Code	Description
44	SET 800 BPI.
45	SET 1600 BPI.
46	SET 3200 BPI.
47	SET 6250 BPI.

5.13 COMMAND PASS THROUGH TO DRIVE

This command allows the 772 to support any manufacturer's method of selecting a feature. The 772 allows you to directly interface the tape drive command lines.

COMMAND PASS THROUGH TO DRIVE

	7	6	5	4	3	2	1	0
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = C			
01	COMPLETION CODE							
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN
04	SUBFUNCTION CODE = 40							
05	0					UNIT		
06	0					INTERRUPT LEVEL		
07	INTERRUPT VECTOR							
08	0						BYTE COUNT	
09	0							
0A	TAPE COMMAND BYTE 1							
0B	TAPE COMMAND BYTE 2							
0C	TAPE COMMAND BYTE 3							
0D	TAPE COMMAND BYTE 4							
0E	0							
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER					
10	0							
11	0							
12	0							
13	0							
14	NEXT IOPB ADDRESS HIGH							
15	NEXT IOPB ADDRESS							
16	NEXT IOPB ADDRESS							
17	NEXT IOPB ADDRESS LOW							
18	IOPB CHECKSUM HIGH							
19	IOPB CHECKSUM LOW							

▨ Required For Execution

░ Optionally Required

▥ Returned Value

SECTION 6: ERROR PROCESSING

6.0 GENERAL

This section describes how the 772 handles error conditions and suggests error recovery procedures for the device driver.

6.1 ERROR REPORTING

The 772 posts assorted controller and tape drive status information in each completed IOPB. After successfully completing a command, the 772 only updates Bytes 0 through 3 if Auto-update (AUD) is clear. Byte 0 indicates whether the controller completed the command and/or whether an error occurred. Byte 1 contains a Completion Code. Bytes 2 and 3 contain tape status information. If an error occurs, the 772 updates the entire IOPB, regardless of AUD's status. When the 772 reports an error in the Completion Code, do not assume that the reported error is the only failure that occurred. Bytes 2 and 3 contain additional error and status information that is useful in recovering from the error. Depending on the type of command, the 772 updates other parameters upon completion, i.e., actual count, data address, etc.

The 772 issues an interrupt (if enabled) after completing a command. Check the Fatal Error (FERR) bit in the CSR. If FERR is set, the controller probably did not DMA the command properly due to a hardware failure or address alignment error (read the Fatal Error Register to determine the cause of the error). If FERR is clear, you can examine the completed command. Determine if the 772 executed the IOPB (DONE), and if an error occurred (ERR). If ERR is set, read the Completion Code and two Tape Status bytes, and execute the appropriate recovery procedure. If ERR is clear, you still might want to examine these bytes to know the non-error tape status (i.e., BOT, PEID, etc.).

6.1.1 IOPB Byte 1 (Status Byte 1)

Completion Codes follow a convention that indicates the action required by the software driver (some Completion Codes indicate the need for manual intervention). The upper nibble of the Completion Code byte is the recovery code and the lower nibble is the actual error code (see Table 6-1). Table 6-2 lists the Completion Codes **(all codes not listed in this table are reserved).**

6.1.1 IOPB Byte 1 (Status Byte 1) (continued)

Recovery Code	Recovery Procedure
0	No Action - Status Only
1-2	Non-retryable Programming Error
3	Successfully Recovered Soft Error
4-5	Hard Error - Retry
6	Hard Error - Reset and Retry
7	Hardware Error
8	Miscellaneous Error
9	Requires Manual Intervention
A	You're Lost
B-F	Reserved

Table 6-1. Recovery Codes

Action	Code (Hex)	Description
No Action / Status Only	00	Successful Completion
Non-retryable Programming Errors	10	Density Change; Not At BOT
	11	Illegal Parameters Combination
	12	Cont. Cmd. Odd Addr. or Byte Count Error
	13	Count Zero
	14	Illegal Command
	1C	Illegal Scatter/Gather Length
	1E	Next IOPB Address Alignment Error
	21	Illegal Black Hole Transfer Address
Successfully Recovered Soft Errors	30	Corrected Data
Hard Errors - Retry	40	Hard Tape Error
	41	End Of Tape Detected
	42	File Mark Write Fault
	43	Operation Timeout
	44	DMAC Timeout
	45	Tape Parity Error
	46	FIFO Buffer Parity Error
	47	Record Length Long
	48	Record Length Short
	49	Data Late Detected
	4A	Fatal DMAC Error
	4B	VMEbus Error
	4C	Continue Reload Error

Table 6-2. Summary of Completion Codes

6.1.1 IOPB Byte 1 (Status Byte 1) (continued)

Action	Code (Hex)	Description
Hard Errors - Reset and Retry	60	Drive Fault (Pertec FS Series Only)
	61	Drive Not Ready
Hardware Error - No Retry	71	Firmware Failure
Miscellaneous Errors	81	IRAM Checksum Error
	82	IOPB Aborted By Command
	83	IOPB Aborted by Error
Requires Manual Intervention	90	Tape Reel Write-protected
	91	Drive Off-line
You're Lost	A0	Reverse Into BOT
	A1	File Mark Detected On Read

Table 6-2. Summary of Completion Codes (continued)

6.1.1.1 Completion Code Descriptions

Code(H)	Description
00	SUCCESSFUL COMPLETION -- Not an error; indicates the command is complete and the IOPB may be removed from the queue.
10	DENSITY CHANGE NOT AT BOT -- Software attempted to change the drive density and the drive was not at BOT. Rewind to BOT and retry density change command.
11	ILLEGAL PARAMETERS COMBINATION -- Software attempted to set conflicting controller or drive parameters.
12	CONTINUE COMMAND ODD ADDRESS OR BYTE COUNT ERROR -- An odd DMA address or byte count was used with the Read and/or Write And Continue command.
13	COUNT ZERO -- Software issued the 772 an IOPB that required a non-zero count, but the count was zero. Position commands require a valid count.
14	ILLEGAL COMMAND -- The Command or Subfunction Code is not valid.

6.1.1.1 Completion Code Descriptions (continued)

Code(H)	Description
1C	ILLEGAL SCATTER/GATHER LENGTH — The total byte count of each element in the link list does not match the total number of requested bytes (IOPB byte count).
1E	NEXT IOPB ADDRESS ALIGNMENT ERROR — The Next IOPB Address did not start on a 16-bit boundary; the 772 does not execute the next IOPB.
21	ILLEGAL BLACK HOLE TRANSFER ADDRESS — During a Black Hole Transfer, the data address did not start on a word boundary when the 772 was in Word mode (or it did not start on a longword boundary when the 772 was in Longword mode).
30	CORRECTED DATA — The tape drive error correction hardware corrected a single track error during a Read command. The 772 sets ERR, but does not stop IOPB chaining.
40	HARD TAPE ERROR — A data error occurred on a Read or Write command. Retry the operation; the tape media may be damaged.
41	END OF TAPE DETECTED — An EOT marker was passed in the forward direction. It is possible to write or read data beyond EOT. This status remains valid for all subsequent commands in the forward direction. The EOT bit in Status Byte 2 remains set for any operation beyond EOT.
42	FILE MARK WRITE FAULT — A file mark was not detected following a Write File Mark command.
43	OPERATION TIMEOUT — The 772 did not complete the requested operation within the DBSY timeout window.
44	DMAC TIMEOUT — The 772 DMAC controller chip did not complete its operation within its timeout. Host memory (DTACK) may not have responded in time. This error only occurs if EDT is set with a Write Controller Parameters command.
45	TAPE PARITY ERROR — The 772 detected a tape parity error during a Read or Write operation.
46	FIFO BUFFER PARITY ERROR — The transfer failed; the 772 detected a buffer parity error.

6.1.1.1 Completion Code Descriptions (continued)

Code(H)	Description
47	RECORD LENGTH LONG — The record read was longer than the requested record byte count; the 772 only transfers the requested count. Readjust the byte count and retry.
48	RECORD LENGTH SHORT — The record read was shorter than the requested record byte count; the 772 only uses part of the read buffer.
49	DATA LATE DETECTED — The 772 FIFO buffer overflowed during a Read or underflowed during a Write command.
4A	FATAL DMAC ERROR — The DMAC stopped for no apparent reason. The count did not overflow, the address did not overflow, and there was no bus error.
4B	VMEbus ERROR — The VME BERR* signal was asserted while the 772 was bus master. BERR* is asserted by the VMEbus timer if either DS1* or DS0* remains active on the bus and DTACK* does not go active for longer than the allotted time.
4C	CONTINUE RELOAD ERROR — During a Read/Write Continuous operation, the next IOPB did not reach the 772 in time to reload the tape byte counter. The 772 completes the former transfer as a normal Read or Write operation (IRG written).
60	DRIVE FAULTED — Certain tape manufacturers report Drive Fault errors; this error is the same as Hard Tape error.
61	DRIVE NOT READY — The 772 did not receive the Drive Ready signal from the selected tape drive. The drive cables may be improperly connected.
71	FIRMWARE FAILURE — Flag settings or counter values are inconsistent with the firmware routines being executed.
81	IRAM CHECKSUM FAILURE — The calculated checksum from the IRAM and its stored value did not match during the Self Test or read parameters command. The parameters that are in error are not necessarily in the parameters read by this IOPB; they may be elsewhere in the IRAM. Recheck all the programmable parameters. Any write parameters command resets the checksum, and any subsequent read parameters will be error free. A soft bit in the IRAM, static, or probing the board with the power on can cause this error. See Section 6.7.

6.1.1.1 Completion Code Descriptions (continued)

Code(H)	Description
82	IOPB ABORTED BY COMMAND — An Abort command terminated the IOPB.
83	IOPB ABORTED BY ERROR — The 772 aborted the IOPB(s) because the previous IOPB errored. This code returns all IOPBs and IOPB addresses for the unit number and interrupt level currently in the command buffer. All further AIO requests are blocked until the 772 returns all aborted IOPBs.
90	TAPE REEL WRITE-PROTECTED — A Write operation was attempted on a write-protected tape. Install the write enable ring and try again.
91	DRIVE OFF-LINE — The selected tape drive is off-line. Check the drive's on-line indicator and the tape reel.
A0	REVERSE INTO BOT — A BOT marker was detected while moving in the reverse direction; tape motion ceases.
A1	FILE MARK DETECTED ON READ — A file mark was detected during a Read operation.

6.2 RECOVERY PROCEDURES

This section describes the Completion Codes and recovery procedures in detail. See Section 5 for code numbers.

6.2.1 Non-retryable Programming Errors

These errors are caused by illegal use of command parameters and are reported back to assist you in debugging the device driver. These errors are not retryable; you must change your program.

6.2.2 Successfully Recovered Soft Errors

The 772 sets ERR for this class of error, but does not stop IOPB chaining. These are status codes only and typically do not require any action. These errors are related to the tape media; you may want to log them as they may indicate a developing media flaw. If retries are enabled, Byte B contains the actual number of retries necessary to correct the defect.

6.2.3 Hard Errors Requiring Retry

6.2.3.1 Hard Tape Error

Each drive manufacturer individually defines the cause of this error. For many drives this error is a media defect that can potentially be corrected with a retry. With retries enabled during a Read, the 772 rereads the record with the error up to four times before reporting the error. Xylogics suggests always enabling retries unless your application requires otherwise.

If retries are enabled during a Write, the 772 executes the following sequence: after encountering a hard error, it reverses the tape to the beginning of the record in question and issues an Erase command (which erases three inches of tape), and retries the Write. The controller repeats this sequence four times, erasing up to 12-inches of tape. It is still possible that the hard error is beyond the retry; at this point you must issue individual Erase commands until the error is erased (see Figure 6-1). (Use this procedure if retries are not enabled.) The 772 "sees" an erased section of tape as an interrecord gap; it is programmer-transparent.

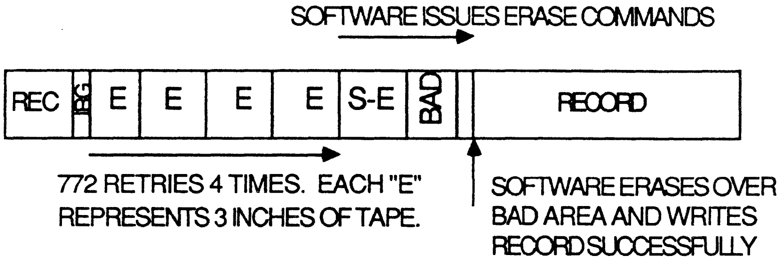


Figure 6-1. Write Error Beyond Retry

6.2.3.2 End of Tape Detected

This is one of the lowest priority Completion Codes; there is also a bit that indicates EOT. EOT is the physical end of tape marker; it indicates that all further Read or Write operations should be terminated or limited to a small number. Since there is approximately 25-feet of tape remaining after EOT on which you can record, only a small number (and size) of records can be handled. Be careful, the 772 cannot keep you from running off the end of the tape reel. Although the 772 reports an error when it encounters EOT, it completes the entire transfer (which means your record is straddling the EOT marker). Once past EOT, the 772 completes any command successfully (unless another error condition occurs) with an EOT error status. Since EOT does not necessarily indicate the end of recorded data, Xylogics suggests writing at least two consecutive file marks to indicate the logical end of tape.

6.2.3.3 File Mark Write Fault

The 772 returns this code if a hard error condition occurs during a Write File Mark operation. Like writes, this operation can be retried up to four times by erasing. Retry failures are unlikely, unless the media is in very poor condition.

6.2.3.4 Operation Timeout

An Operation Timeout indicates that the signal Data Busy (DBSY) from the tape drive did not go active within the controller's set time period. Retry the operation. If the same error occurs, it is possible that the tape drive is malfunctioning. Most non-cached tape drives time out DBSY within .25 seconds; if an Operation Timeout occurs with this type of drive it is likely the drive has a problem. Tape drives with cache memories can also cause this error. These drives delay Data Busy when flushing the cache or utilizing retry algorithms, causing the 772 to time out. Setting the 772 Data Busy Timer to a higher value avoids this condition.

6.2.3.5 DMAC Timeout

The 772 DMA controller timed out during the tranfer. The same rules that apply to the VMEbus error apply to the DMAC Timeout (the difference is the 772 is doing the detection, not the bus monitor. See Section 6.2.3.12).

6.2.3.6 Tape Parity Error

The tape drive reported that one of the bytes of data transferred was bad. The 772 completed the entire transfer but the data integrity is suspect. Parity errors can be caused by marginal tape media or foreign matter on the media or heads. Xylogics recommends first rereading/rewriting (or just retrying) the record. If the error persists, try cleaning the tape drive heads.

Many tape manufacturers enable read data and parity during Write commands. This is not a problem, except certain manufacturers define these lines as invalid during Write operations. In this case, enable the IPOW bit with a Drive Parameters command; this turns off parity checking during Writes.

6.2.3.7 FIFO Parity Error

The 772 detected a parity error during a data transfer to or from the FIFO buffer; it completes the entire transfer, but the data integrity is suspect. Retry the transfer. If the error persists, it is likely there is a FIFO hardware malfunction.

6.2.3.8 Record Length Long

This error only occurs during Read operations. The record being read is larger than the byte count issued in the command. The 772 can report this error in both the Completion Code and Tape Status Byte 1 (RLL). Since the 772 only transfers the requested number of bytes, you must reread the entire record. First, position the tape to the beginning of the record with a Skip Record Reverse command. Next, readjust the byte count to the maximum allowable byte count because you may not be sure of the record's size. Issue the command, and expect to get a Record Length Short error (make sure no other error occurs). The actual count byte field indicates the size of the record transferred. This helps you determine where the next buffer begins. Use this procedure when reading tapes containing records of unknown size; it won't work if the record is larger than 64KB (then you must use the Read Continuous command).

6.2.3.9 Record Length Short

This error only occurs during Read operations. The record being read is smaller than the byte count issued in the command. The 772 can report this error in both the Completion Code and Tape Status Byte 1 (RLS). Since the entire record was read, it is not necessary to retry the Read operation. You may want to adjust the

6.2.3.9 Record Length Short (continued)

data address of the next Read to keep your buffers contiguous, or, if all the records are of similar size, readjust the byte count field to match the actual count. If you know the byte count is correct, and the 772 reports a Record Length Short error, the tape heads may need cleaning.

NOTE

> If the record read contains an odd number of bytes, the last byte transferred is duplicated and written to memory. This is done intentionally due to certain hardware requirements. Writing this extra byte should not affect you (you initially allocated a larger buffer and the 772 does not report this byte in the actual count).

6.2.3.10 Data Late Detected

During a Read operation, this error indicates that the 772 FIFO buffer overflowed. This means the DMA was unable to keep up with the tape drive's data rate. The entire record must be reread if this error occurs: position the tape to the beginning of the record with a Skip Record Reverse command, then reissue the Read.

During a Write operation, this error indicates that the 772 FIFO buffer underflowed. This means the 772 received a Write command, but the data from memory did not arrive in the FIFO, and the tape started; in this case, set the Write Wait DMA (WWD) bit with a Write Controller Parameters command. Setting WWD delays starting the tape until data reaches the FIFO. Another condition could be that some, but not all, of the data for the record did arrive in time (before the FIFO emptied). Either way, the 772 writes some data to tape, requiring a Skip Reverse before retrying the Write.

If this condition persists, there is a bottleneck occurring on the DMA. This happens if the 772 DMA throttle value is too small, or if other DMA devices tie up the bus.

6.2.3.11 Fatal DMAC Error

The DMAC reported a 16-bit address overflow when not expected or did not overflow when expected. This is a 772 malfunction. Retry the operation. If the error persists, issue a Controller Reset and retry the operation. If a Controller Reset does not clear the condition, then there may be a hardware malfunction.

6.2.3.12 VMEbus Error

A VMEbus error occurred while the 772 was bus master. The bus transfer did not complete because the Address, or Address Modifier was wrong (no memory at the address specified), or a longword transfer was attempted to word memory. Retry the operation. If the condition persists, issue a Controller Reset and retry. If a Controller Reset does not clear the condition, then a system reset is necessary or some other piece of system hardware is failing.

6.2.3.13 Continue Reload Error

Software's inability to keep commands coming in before they are necessary causes this error. The 772 treats the last successful Continuous command as a standard read or write. This error should not occur if Continuous commands are properly chained or queued.

6.2.4 Hard Errors Requiring Reset and Retry

6.2.4.1 Drive Fault

Certain drive manufacturers report this error; the tape drive is reporting a malfunction. Issue a Drive Reset command and retry the operation. If the error persists, consult the drive manual for possible causes and diagnostics to run.

6.2.4.2 Drive Not Ready

The selected tape drive is not ready. Issue a Drive Reset command and retry the operation. If the condition persists, verify the drive is loaded, on-line, and that the cables are good, and connected properly.

6.2.4.3 Firmware Failure

Retry the operation. If the error persists, it is possible that the EPROM firmware is corrupt.

6.2.5 Miscellaneous Errors

6.2.5.1 IRAM Checksum Error

If this error occurs during a Read Controller or Read Drive Parameters command, then the IRAM has not been initialized or the battery is failing. First try initializing the IRAM with the parameters you require. If the error persists, the IRAM may require replacement.

6.2.5.2 IOPB Aborted by Command

The 772 aborted the IOPB by command. For example, software may determine that a particular Unit Number is continuously failing and terminate any further commands to that unit.

6.2.5.3 IOPB Aborted by Error

The 772 aborts this IOPB because the previous IOPB errored. The 772 returns all IOPBs and IOPB addresses for that Unit Number and interrupt level with this code. Initiate a recovery procedure for the initial IOPB hard error, reinitialize the IOPBs aborted by error, and restart the chain.

6.2.6 You're Lost

You are not where think you are on the tape or you do not know the record format on the tape.

6.2.6.1 Reverse Into BOT

The BOT marker was encountered during a Reverse command other than Rewind. Tape motion stops and the tape remains at BOT until the next Forward or Unload command is issued. Most likely, you have fewer records or file marks than you thought. Since no data transfers take place in reverse it is not necessary to retry.

6.2.6.2 File Mark Detected On Read

An unexpected File Mark was detected during a Read or Space Records command. Most likely, you did not know how many records were in a particular file. No retry is necessary.

6.3 IGNORING ERRORS

Certain applications require ignoring errors when Reading or Writing data. Typically, this is done in real-time data collection applications where the controller and software do not have the time to handle tape errors.

If the Ignore Errors feature is enabled, the 772 does not report Corrected Tape, Tape Parity, or Uncorrectable Tape errors on Read or Write commands. The 772 reports the number of errors encountered in a record in special byte fields if AUD is enabled.

6.4 FATAL ERROR CODE DESCRIPTIONS

Code	Description
E0	IRAM CHECKSUM FAILURE — The IRAM checksum did not match the expected checksum following bus initialization.
E1-EF	POWER-UP SELF TEST — The 772 failed the Power-up Self Test. See Section x.x.
F0	IOPB CHECKSUM MISCOMPARE — The generated checksum did not match the appended checksum. See Section 8.8.
F1	IOPB DMA FATAL — The 772 did not complete the DMA within the prescribed timeout period.
F2	IOPB ADDRESS ALIGNMENT — The IOPB address did not start on a 16-bit boundary.
F3	FIRMWARE ERROR — Flag settings or counter values are inconsistent with the firmware routines being executed; the IOPB cannot DMA the appropriate error status.
F4	CABLE TEST FAILURE — The loopback cable test failed.
F5	ILLEGAL MAINTENANCE MODE TEST NUMBER — The command is invalid, or the Maintenance mode jumper is not in.
F6	ACFAIL ASSERTED — The VMEbus signal ACFAIL is asserted, causing the 772 to stop. Correct the problem asserting ACFAIL and then reset the 772.

6.5 ERRORS DURING CHAINED OR QUEUED OPERATIONS

The 772 handles chaining and queueing errors in the same manner. If an error occurs, all further IOPBs are marked with Abort On Error. Any further action depends on your retry algorithms.

6.6 ABORTING

Abort commands and Abort errors inhibit AIO processing; no further IOPBs can be added to the queue. The 772 processes the AIO queue normally, but aborts IOPBs that are on the same drive at the abort interrupt level; it marks these IOPBs as aborted by command or aborted by error. The 772 re-enables AIO processing after completing the AIO queue and the main IOPB chain.

6.7 IRAM CHECKSUM

Each time the 772 executes a read parameters command, it compares a generated checksum with the stored checksum. This checksum encompasses the area that contains all the parameters, not just the ones being read. When this error occurs, the checksums did not match; rewrite or check all the parameters. Any write parameters command generates and stores a new checksum.

6.8 ERROR REPORTING HIERARCHY

Figure 6-2 illustrates the 772 firmware error checking path(s).

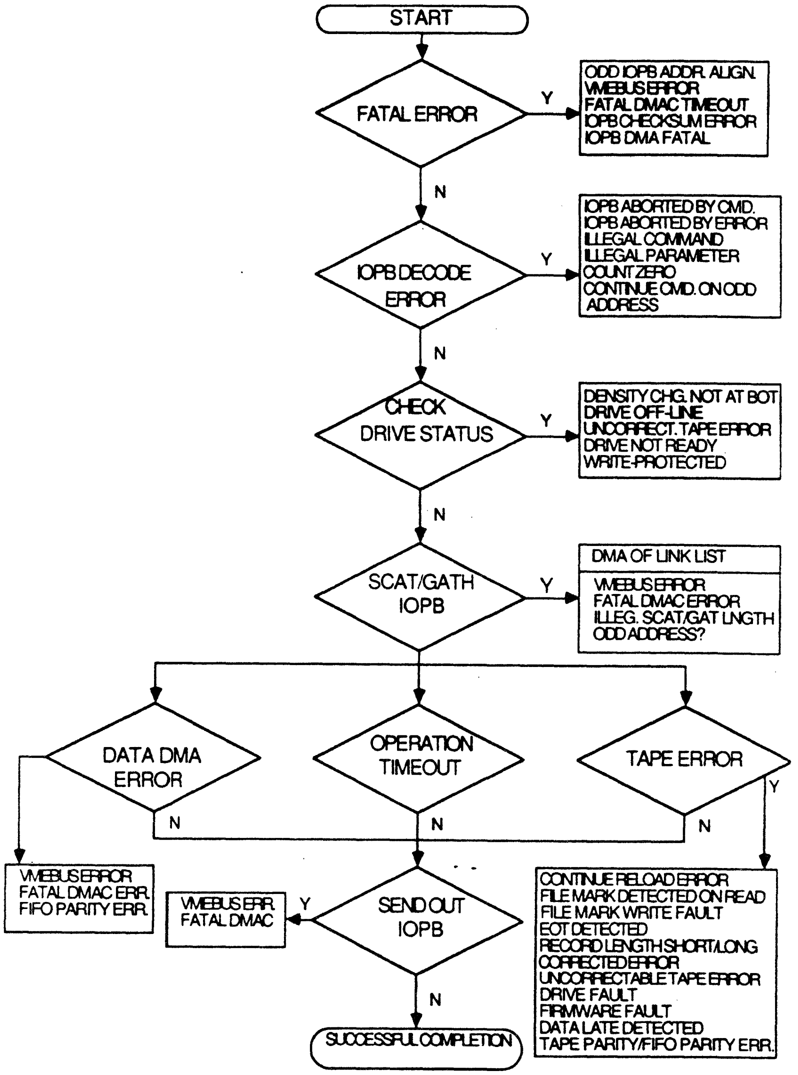


Figure 6-2. Error Reporting Hierarchy

SECTION 7: A TUTORIAL IN PROGRAMMING THE 772

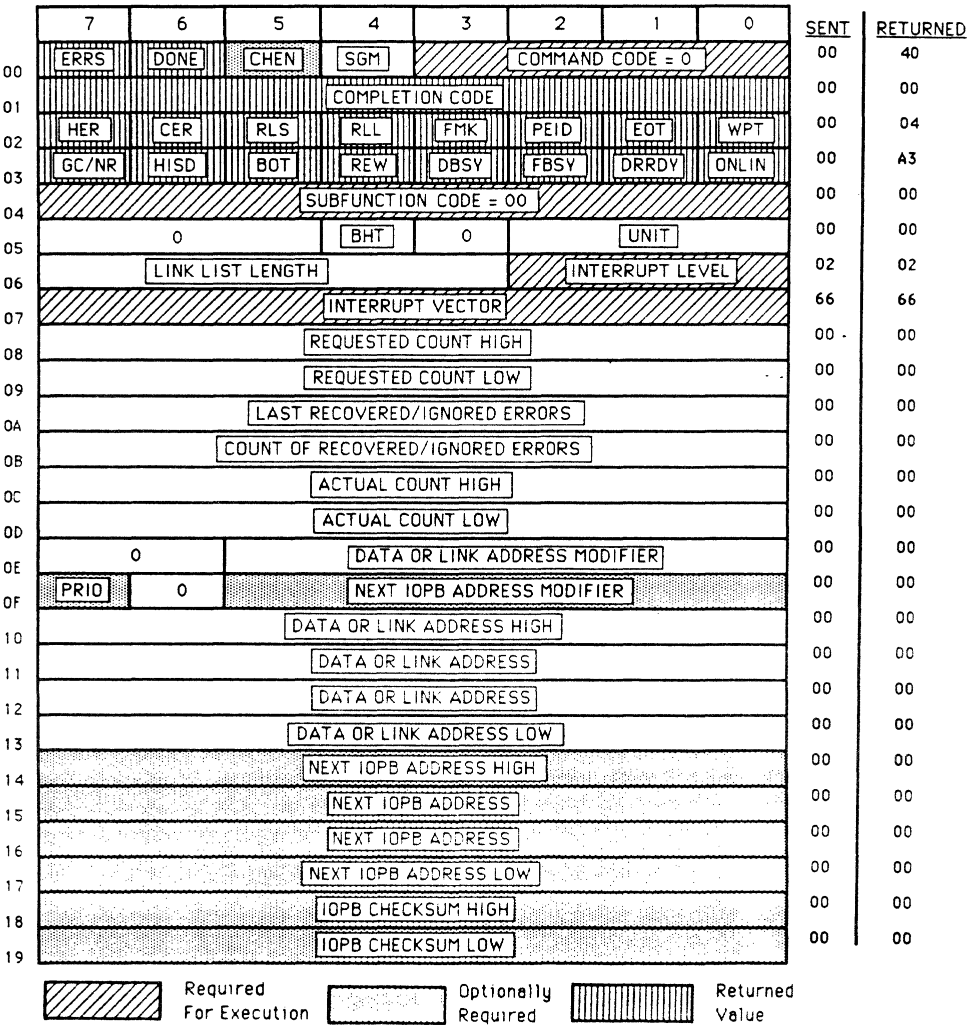
7.0 GENERAL

This section describes programming the 772 for basic use. This tutorial programming procedure begins with a single NOP IOPB and progresses to Normal Read and Write commands. Each section builds on the previous section's information.

7.1 NO OPERATION (NOP)

The NOP command allows you to become familiar with the 772 programming interface.

NOP



	7	6	5	4	3	2	1	0	SENT	RETURNED
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 0				00	40
01	COMPLETION CODE								00	00
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT	00	04
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN	00	A3
04	SUBFUNCTION CODE = 00								00	00
05	0			BHT	0	UNIT			00	00
06	LINK LIST LENGTH					INTERRUPT LEVEL			02	02
07	INTERRUPT VECTOR								66	66
08	REQUESTED COUNT HIGH								00	00
09	REQUESTED COUNT LOW								00	00
0A	LAST RECOVERED/IGNORED ERRORS								00	00
0B	COUNT OF RECOVERED/IGNORED ERRORS								00	00
0C	ACTUAL COUNT HIGH								00	00
0D	ACTUAL COUNT LOW								00	00
0E	0		DATA OR LINK ADDRESS MODIFIER						00	00
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER						00	00
10	DATA OR LINK ADDRESS HIGH								00	00
11	DATA OR LINK ADDRESS								00	00
12	DATA OR LINK ADDRESS								00	00
13	DATA OR LINK ADDRESS LOW								00	00
14	NEXT IOPB ADDRESS HIGH								00	00
15	NEXT IOPB ADDRESS								00	00
16	NEXT IOPB ADDRESS								00	00
17	NEXT IOPB ADDRESS LOW								00	00
18	IOPB CHECKSUM HIGH								00	00
19	IOPB CHECKSUM LOW								00	00

▨ Required For Execution
░ Optionally Required
▥ Returned Value

Figure 7-1. Sample NOP IOPB

7.1.1 Allocating Memory For An IOPB

First, allocate space in host memory to store the IOPB. This allocation is a function of the operating system or the currently executing program. Next, set up the IOPB to execute a simple NOP command (see Figure 7-1).

7.1.2 Point the 772 to the IOPB

The IOPB is now in host memory. Point the 772 to the IOPB by loading the IOPB address and address modifier into the appropriate 772 registers. **Make sure the address compensates for any memory mapping that may be done between virtual and physical addressing in your system.** The 772 looks for the IOPB at the physical address to which the registers point.

NOTE

Always access the registers in Byte or Word mode. Register bytes are ordered low to high (unlike IOPB bytes which are ordered high to low).

7.1.3 Starting the Operation

The 772 now points to the IOPB in host memory. Setting the AIO bit in the CSR directs the 772 to process the IOPB.

7.1.4 772 Operation

At this point, the 772 performs the following functions:

1. Clears AIOP and sets BUSY.
2. Reads the IOPB from host memory.
3. Decodes the command.
4. Performs the operation (NOP).
5. Sets the DONE bit.
6. Updates the IOPB.
7. Puts the completed IOPB's address into the registers.
8. Sets RIO.
9. Clears BUSY.

7.1.5 Command Completion

Software has been polling RIO (since interrupts are not enabled [Interrupt Level = 0]). Software knows that the 772 sets RIO when it is done. Software should get the completed IOPB's address from the registers, and then clear RIO. This completes the NOP command. **(Do not poll the DONE bit in the IOPB. The 772 sets DONE while the rest of the IOPB is still updating.)**

7.1.6 Returned Values

DONE is set in the returned IOPB. Status Bytes 2 and 3 reflect the status of Tape Drive 0.

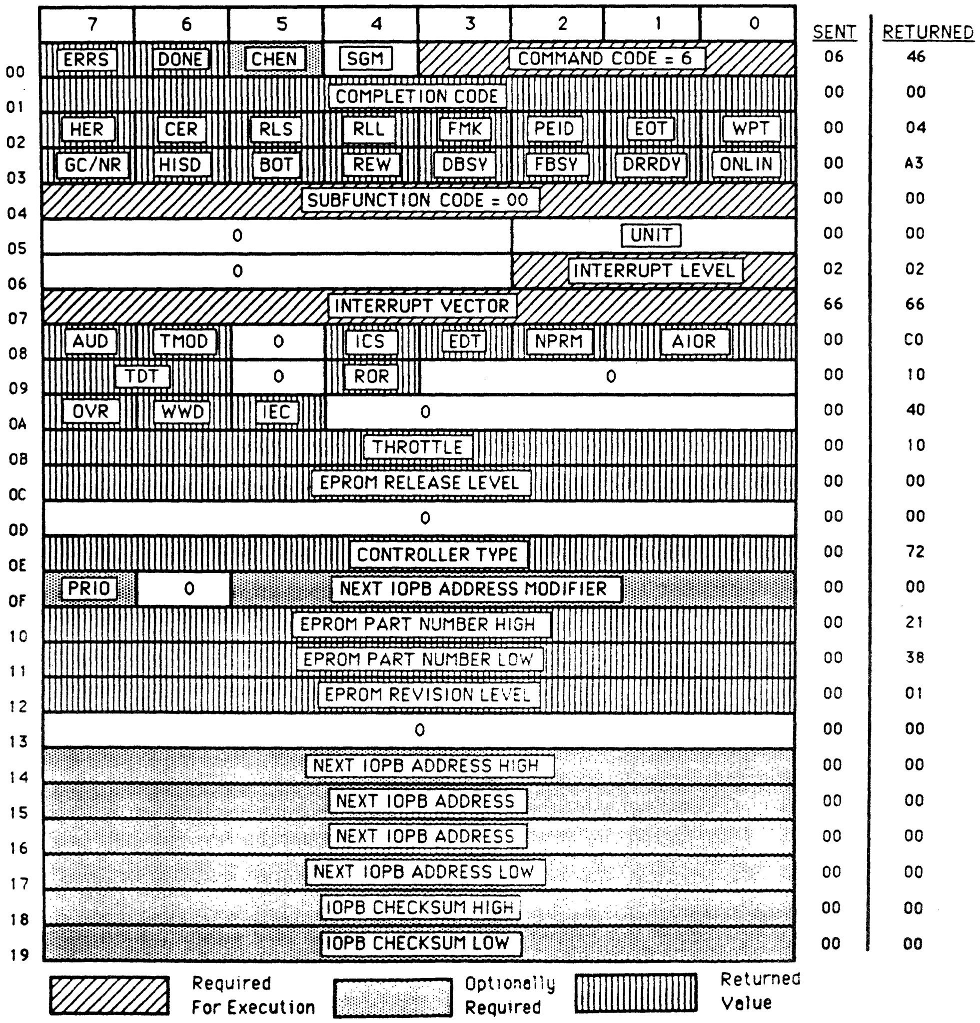
7.2 READ CONTROLLER PARAMETERS

Next, implement the Read Parameters command with a Controller Parameters subfunction (see Section 5.7.1). This command returns several controller parameters in the updated IOPB (see Figure 7-2).

7.2.1 Execute the IOPB

Set up the IOPB in host memory; point the 772 to the IOPB. Setting AIO directs the 772 to begin executing this IOPB.

READ CONTROLLER PARAMETERS



	7	6	5	4	3	2	1	0	SENT	RETURNED
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 6				06	46
01	COMPLETION CODE								00	00
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT	00	04
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN	00	A3
04	SUBFUNCTION CODE = 00								00	00
05	0				UNIT				00	00
06	0				INTERRUPT LEVEL				02	02
07	INTERRUPT VECTOR								66	66
08	AUD	TMOD	0	ICS	EDT	NPRM	AIOR		00	C0
09	TDT		0	ROR	0				00	10
0A	OVR	WWD	IEC	0					00	40
0B	THROTTLE								00	10
0C	EPROM RELEASE LEVEL								00	00
0D	0								00	00
0E	CONTROLLER TYPE								00	72
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER						00	00
10	EPROM PART NUMBER HIGH								00	21
11	EPROM PART NUMBER LOW								00	38
12	EPROM REVISION LEVEL								00	01
13	0								00	00
14	NEXT IOPB ADDRESS HIGH								00	00
15	NEXT IOPB ADDRESS								00	00
16	NEXT IOPB ADDRESS								00	00
17	NEXT IOPB ADDRESS LOW								00	00
18	IOPB CHECKSUM HIGH								00	00
19	IOPB CHECKSUM LOW								00	00

▨ Required For Execution
░ Optionally Required
▥ Returned Value

Figure 7-2. Sample Read Controller Parameters IOPB

7.2.2 772 Operation

The controller operation changes slightly from the example in Section 7.1.5:

The 772 performs the Read Controller Parameters operation. The controller gets the parameters from its internal store, and puts them in the proper IOPB locations. The 772 fully updates the IOPB, including the returned values.

While reading the controller parameters, the 772 calculates a new Internal RAM (IRAM) checksum and compares it to the previous value. The 772 returns the appropriate Completion Code if the values do not match.

7.2.3 The Returned IOPB

The values in the returned IOPB describe the last setting of the software-programmable parameters. Determine if each value works for your application (see Section 5.7). After making any necessary changes, write the parameters back to the 772.

Specific bytes have known values. The Controller Type byte contains a 72H; the PROM Part Number bytes contain 21H and 38H. See Section 4.3 for more information.

7.3 WRITE CONTROLLER PARAMETERS

Next, write the controller parameters. Xylogics recommends reading the current parameters, modifying the ones in question, and then writing them back to the 772. This method allows you to change only those parameters that affect your system (see Figure 7-3).

7.3.1 772 Operation

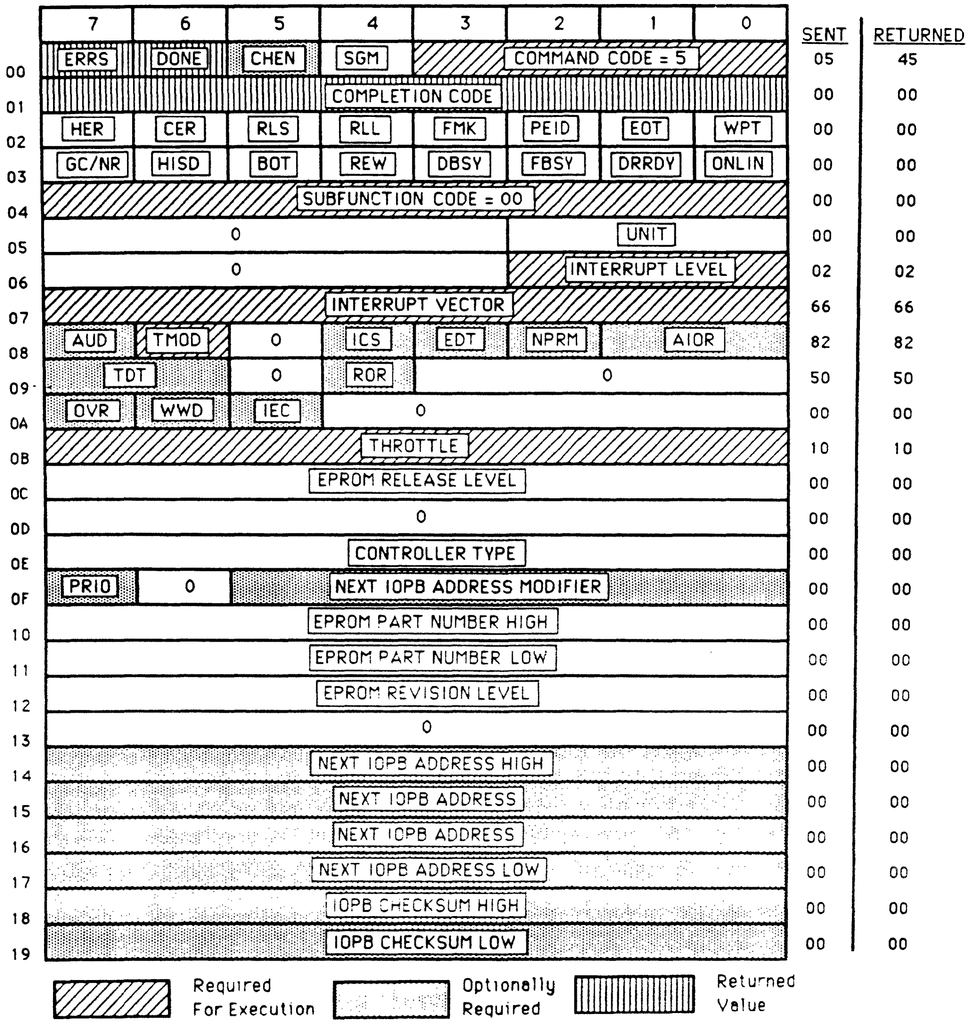
The 772 executes the IOPB slightly different than in Sections 7.1.5 and 7.2.2:

The 772 performs the function by taking the values of all programmable parameters out of the IOPB and setting the appropriate flags and variables in its internal RAM.

The 772 also calculates a new checksum in the IRAM and stores it for use in the next reading of any parameters (see Section 5.6).

7.3.1 772 Operation (continued)

WRITE CONTROLLER PARAMETERS



	7	6	5	4	3	2	1	0	SENT	RETURNED
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 5				05	45
01	COMPLETION CODE								00	00
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT	00	00
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN	00	00
04	SUBFUNCTION CODE = 00								00	00
05	0					UNIT			00	00
06	0					INTERRUPT LEVEL			02	02
07	INTERRUPT VECTOR								66	66
08	AUD	TMOD	0	ICS	EDT	NPRM	AIOR		82	82
09	TDT		0	ROR	0				50	50
0A	OVR	WWD	IEC	0					00	00
0B	THROTTLE								10	10
0C	EPROM RELEASE LEVEL								00	00
0D	0								00	00
0E	CONTROLLER TYPE								00	00
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER						00	00
10	EPROM PART NUMBER HIGH								00	00
11	EPROM PART NUMBER LOW								00	00
12	EPROM REVISION LEVEL								00	00
13	0								00	00
14	NEXT IOPB ADDRESS HIGH								00	00
15	NEXT IOPB ADDRESS								00	00
16	NEXT IOPB ADDRESS								00	00
17	NEXT IOPB ADDRESS LOW								00	00
18	IOPB CHECKSUM HIGH								00	00
19	IOPB CHECKSUM LOW								00	00

Figure 7-3. Sample Write Controller Parameters IOPB

7.4 READ/WRITE DRIVE PARAMETERS

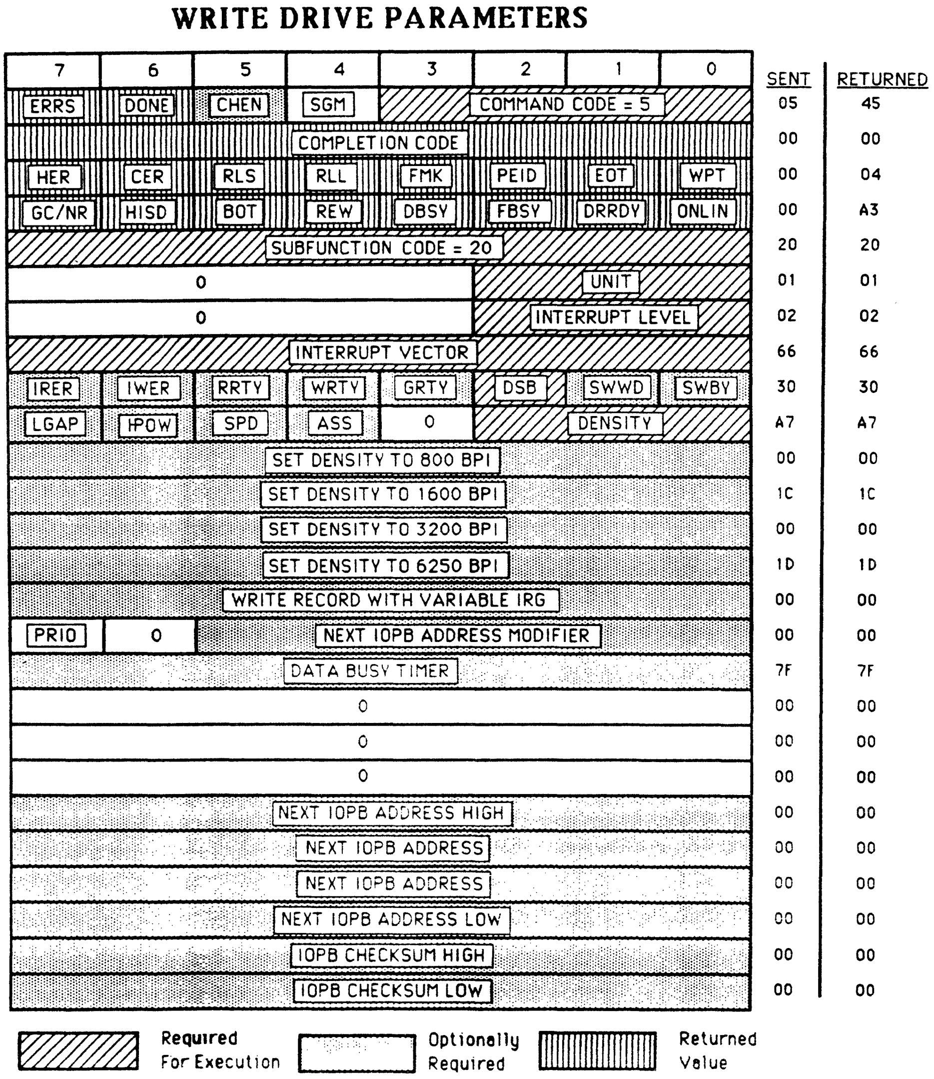
The Drive Parameters commands allow you to configure the 772 to your drive's parameters. Sections 5.6.1 and 5.7.1 describe the configuration variables that may be modified with these commands. The operation is similar to the Controller Parameters command (see Figure 7-4).

7.4.1 772 Operation

First, issue a Read Drive Parameters command; this indicates the current drive parameters for the selected unit. It is not necessary to issue the Write Drive Parameters command if the returned parameters match the drive you are using.

7.4.2 Write Drive Parameters

On a Write Drive Parameters command, the 772 performs an operation similar to that of the Write Controller Parameters command. Use the Write Drive Parameters command to globally change drive parameters on a per unit basis.



WRITE DRIVE PARAMETERS

	7	6	5	4	3	2	1	0	SENT	RETURNED
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 5				05	45
01	COMPLETION CODE								00	00
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT	00	04
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN	00	A3
04	SUBFUNCTION CODE = 20								20	20
05	0					UNIT			01	01
06	0					INTERRUPT LEVEL			02	02
07	INTERRUPT VECTOR								66	66
08	IRER	IWER	RRTY	WRTY	GRTY	DSB	SWWD	SWBY	30	30
09	LGAP	HPOW	SPD	ASS	0	DENSITY			A7	A7
0A	SET DENSITY TO 800 BPI								00	00
0B	SET DENSITY TO 1600 BPI								1C	1C
0C	SET DENSITY TO 3200 BPI								00	00
0D	SET DENSITY TO 6250 BPI								1D	1D
0E	WRITE RECORD WITH VARIABLE IRG								00	00
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER						00	00
10	DATA BUSY TIMER								7F	7F
11	0								00	00
12	0								00	00
13	0								00	00
14	NEXT IOPB ADDRESS HIGH								00	00
15	NEXT IOPB ADDRESS								00	00
16	NEXT IOPB ADDRESS								00	00
17	NEXT IOPB ADDRESS LOW								00	00
18	IOPB CHECKSUM HIGH								00	00
19	IOPB CHECKSUM LOW								00	00

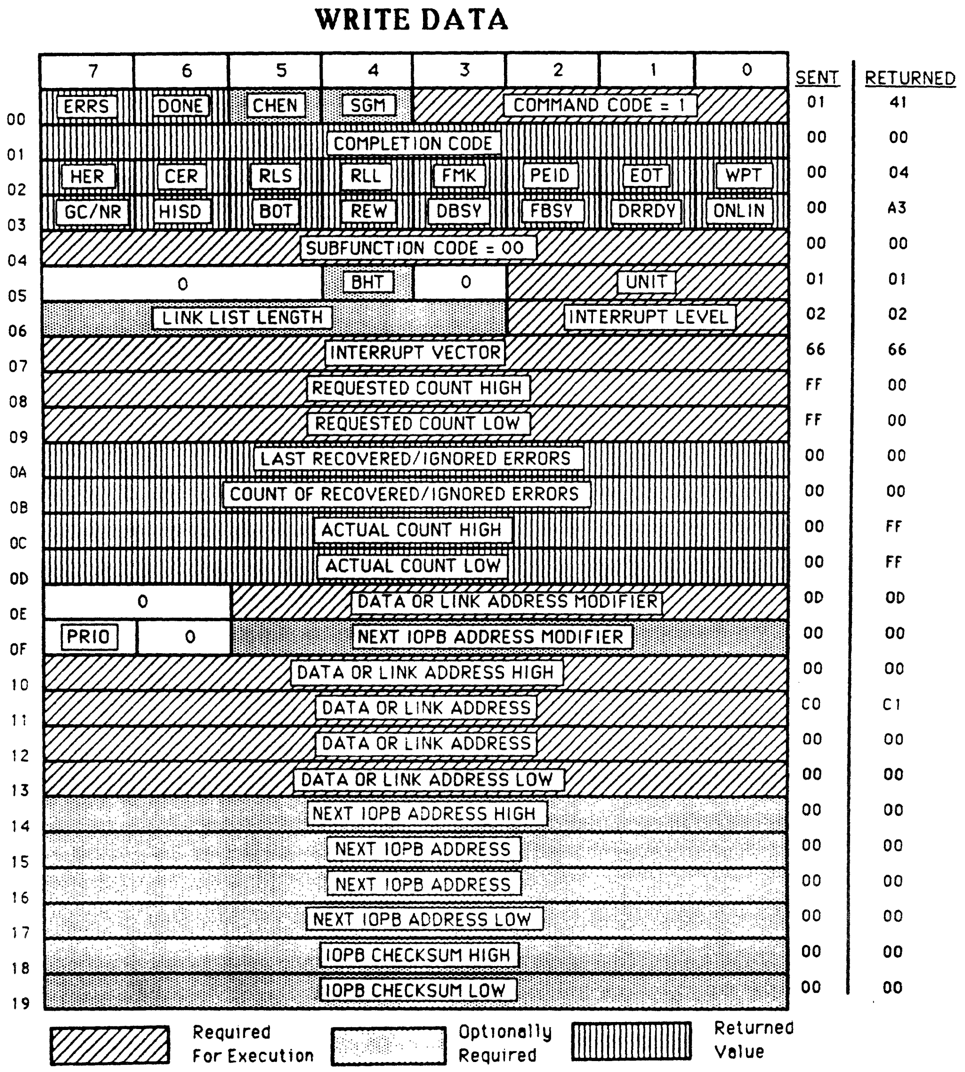
▨ Required For Execution
☐ Optionally Required
▥ Returned Value

Figure 7-4. Sample Write Drive Parameters IOPB

7.5 WRITE DATA

This subsection describes a Write operation, and the following subsection describes reading back the data. Allocate space in host memory for the buffer, and set up a data pattern in this buffer; an incrementing count in the buffer will suffice.

Up to this point, the tape drive has not been accessed. The tape should be at BOT. Issue a Write command of 65,535 bytes (see Figure 7-5).



WRITE DATA

	7	6	5	4	3	2	1	0	SENT	RETURNED
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 1				01	41
01	COMPLETION CODE								00	00
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT	00	04
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN	00	A3
04	SUBFUNCTION CODE = 00								00	00
05	0			BHT	0	UNIT			01	01
06	LINK LIST LENGTH					INTERRUPT LEVEL			02	02
07	INTERRUPT VECTOR								66	66
08	REQUESTED COUNT HIGH								FF	00
09	REQUESTED COUNT LOW								FF	00
0A	LAST RECOVERED/IGNORED ERRORS								00	00
0B	COUNT OF RECOVERED/IGNORED ERRORS								00	00
0C	ACTUAL COUNT HIGH								00	FF
0D	ACTUAL COUNT LOW								00	FF
0E	0		DATA OR LINK ADDRESS MODIFIER						0D	0D
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER						00	00
10	DATA OR LINK ADDRESS HIGH								00	00
11	DATA OR LINK ADDRESS								C0	C1
12	DATA OR LINK ADDRESS								00	00
13	DATA OR LINK ADDRESS LOW								00	00
14	NEXT IOPB ADDRESS HIGH								00	00
15	NEXT IOPB ADDRESS								00	00
16	NEXT IOPB ADDRESS								00	00
17	NEXT IOPB ADDRESS LOW								00	00
18	IOPB CHECKSUM HIGH								00	00
19	IOPB CHECKSUM LOW								00	00

▨ Required For Execution
░ Optionally Required
▥ Returned Value

Figure 7-5. Sample Write Data IOPB

7.5.1 772 Operation

The 772 operation is similar to the previous examples; the differences are in DMAing data into the FIFO, and writing data to the tape.

The 772 starts the DMA from host memory to the FIFO after issuing the Go command to the tape drive. The tape starts first due to mechanical delays.

NOTE

> Mechanical delays may not be present and Data Late errors may occur when using a cache tape drive. In this case, do not start the tape until the DMA reaches the FIFO. This is enabled by WWD in the Controller Parameters IOPB.

The 772 transfers data from the FIFO when the tape is ready to receive it. The 772 supplies the tape interface with a data byte for each tape drive-supplied write strobe. When the last byte is transferred, the 772 sends Last Word to the tape, terminating the transfer of that record. At this point, the tape drive writes an interrecord gap.

7.5.2 Command Completion

The command is complete as soon as the tape drive drops Data Busy (DBSY). The 772 checks for error conditions, puts the ending values into the internal IOPB, and performs an appropriate update.

7.6 READ DATA

This subsection describes reading back the data and verifying it. You must allocate a data buffer for the 772 to write the data in memory. After allocation, use the Write Data command to fill the buffer with a known pattern that differs from the expected data. Read the record you wrote in Section 7.5. First, issue a Rewind or Space Records Reverse command with a count of 1 to put yourself in front of the record. Now issue a Read command with a count of 65,535 (see Figure 7-6).

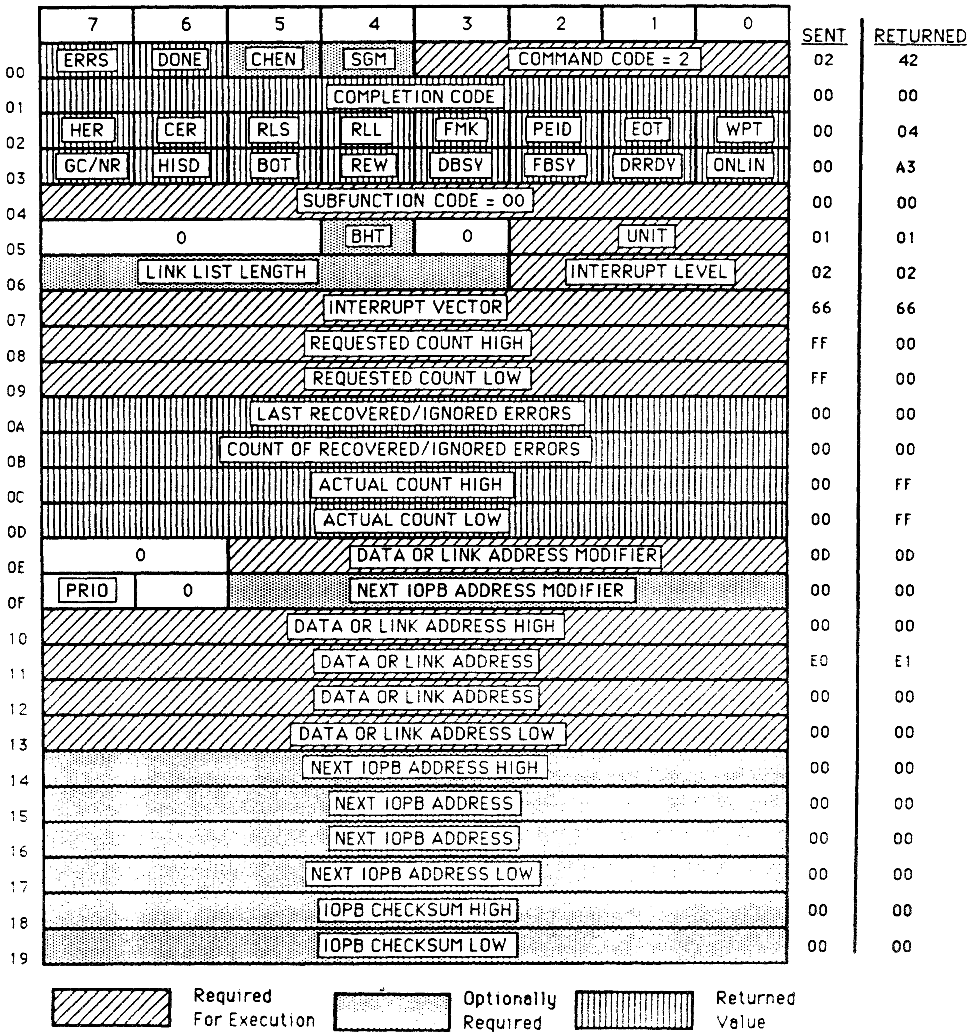
7.6.1 772 Operation

The 772 treats this command like the previous operations, except in the way it writes the data into the FIFO and to host memory.

7.6.1 772 Operation (continued)

The tape drive supplies the tape interface with a data byte for each tape drive-supplied read strobe. The 772 then transfers the data into the FIFO. As soon as data is available, the DMA controller DMAs the data from the FIFO to host memory. The transfer is done when the DMA controller completes the DMA.

READ DATA



	7	6	5	4	3	2	1	0	SENT	RETURNED
00	ERRS	DONE	CHEN	SGM	COMMAND CODE = 2				02	42
01	COMPLETION CODE								00	00
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT	00	04
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRRDY	ONLIN	00	A3
04	SUBFUNCTION CODE = 00								00	00
05	0			BHT	0	UNIT			01	01
06	LINK LIST LENGTH					INTERRUPT LEVEL			02	02
07	INTERRUPT VECTOR								66	66
08	REQUESTED COUNT HIGH								FF	00
09	REQUESTED COUNT LOW								FF	00
0A	LAST RECOVERED/IGNORED ERRORS								00	00
0B	COUNT OF RECOVERED/IGNORED ERRORS								00	00
0C	ACTUAL COUNT HIGH								00	FF
0D	ACTUAL COUNT LOW								00	FF
0E	0		DATA OR LINK ADDRESS MODIFIER						0D	0D
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER						00	00
10	DATA OR LINK ADDRESS HIGH								00	00
11	DATA OR LINK ADDRESS								E0	E1
12	DATA OR LINK ADDRESS								00	00
13	DATA OR LINK ADDRESS LOW								00	00
14	NEXT IOPB ADDRESS HIGH								00	00
15	NEXT IOPB ADDRESS								00	00
16	NEXT IOPB ADDRESS								00	00
17	NEXT IOPB ADDRESS LOW								00	00
18	IOPB CHECKSUM HIGH								00	00
19	IOPB CHECKSUM LOW								00	00

▨ Required For Execution
░ Optionally Required
▥ Returned Value

Figure 7-6. Sample Read Data IOPB

7.6.2 Command Completion

The 772 completes the command when the DMA to memory is complete.

7.6.3 Verify Data

First, make sure the buffer was modified. If it was not modified, either an error occurred, or software specified the wrong buffer address. Next, compare the data written with the data read; they should match.

7.7 LARGE RECORD TRANSFERS

You can repeat the steps in Sections 7.5 and 7.6 using various record sizes. The 772 can transfer records sizes from 1 to 65,536 bytes. Be sure to allocate enough buffer space for the increased record size.

7.8 SUMMARY

This section was an excercise in testing the 772's functionality in your system. The steps are basically the same when the software driver controls the 772. (Operating systems always allocate the buffers.)

SECTION 8: 772 SPECIAL FUNCTIONS

8.0 GENERAL

This section describes how to implement the various 772 special functions.

8.1 MAINTENANCE MODE

Firmware supports a non-IOPB driven Maintenance mode. It allows you to perform basic testing within the 772 by setting Control bits in the CSR and entering the desired test number and data through the address registers. This mode also provides a window through which internal registers may be examined or modified.

8.1.1 Register Use in Maintenance Mode

The function code in the Test Number Register determines whether or not the 772 uses the Input Data Byte and Output Data Byte Registers. You should be familiar with the Control and Status Register before reading this section (see Section 3.3).

Register	Description
1	Test Number or Function Code
3	Input Address Low
5	Input Address High
7	Input Data Byte (If Required)
9	Output Data Byte (If Required)
B	Control and Status Register
D	Fatal Error Register

Table 8-1. Register Use in Maintenance Mode

8.1.2 Maintenance Mode Protocol

8.1.2.1 Executing a Maintenance Command or Entering the Maintenance Mode

First, set the Maintenance Mode (MM) and Add IOPB (AIO) bits. This forces entry into the maintenance kernel; the kernel initializes the CSR and Poll mask and sets the Remove IOPB (RIO) bit. Next, set the Clear RIO (CRIO) bit.

The kernel expects the Input Address Low Register to contain a maintenance test number or function code for execution. Data may be expected or may be returned (see register layout).

8.1.2.1 Executing a Maintenance Command or Entering the Maintenance Mode (continued)

BUSY and AIO are configured for polling. Setting the Register Maintenance Mode (RMM) bit selects the register image test; clearing BUSY returns control to the maintenance kernel.

AIO causes the maintenance firmware to read and decode the command string from the Input Address Registers. After successfully decoding the command string, the firmware echoes it (command, address, and data) to the Output Address Registers and clears AIO. This acknowledges receipt of and attempts to execute the requested command. After completing the requested command, the 772 updates the Output Address Registers with test-pertinent data and sets RIO. The AIO/RIO protocol is identical to Normal mode.

RIO indicates the end of firmware involvement and valid contents in the Output Address Registers.

Since each test and its expected results are different in nature, the Output Address Registers hold the test result information (address, data, etc.). In any case, firmware sets RIO upon command completion; it sets the Fatal Error bit if a failure occurs or if host software issues an illegal command.

8.1.2.2 Exiting the Maintenance Mode

To exit the Maintenance mode, clear MM and RIO, and set AIO. This returns control to the Normal mode kernel. The 772 acknowledges by setting RIO.

8.1.2.3 Diagnostic Considerations

The Input/Output Address Register Verify is the first test the diagnostic should execute.

Firmware flags the Power-up Test failures by setting the Fatal Error bit while leaving the Maintenance mode bit set. Firmware saves the Self Test error numbers internally until it verifies the Input and Output Address Registers.

8.1.2.4 Register Tests

You must request entry into the Maintenance mode to invoke the Register test. After firmware acknowledges the request, you should set RMM. BUSY remains set during this test.

8.1.2.4 Register Tests (continued)

NOTE

> You must enter the Maintenance mode as a separate step because the Normal mode firmware does not allow setting BUSY (defined as RMM when Maintenance mode is enabled).

Setting the Input Address Registers, followed by AIO, signals firmware to copy the data to the Output Address Registers. Firmware sets RIO when it completes the copy. Host software should then clear RIO.

Clearing Busy exits this test and returns the 772 to Maintenance mode.

8.1.2.5 Test Variables

Some of the internal tests require the address and data to perform their particular function. On-board memory has space allocated for this data. These locations are loaded with default values for initial use. However, you may alter these variables through the Manual mode. (As the internal tests are defined, the protocol and results expected will be made available.)

8.2 MULTIPROCESSOR SUPPORT

The 772 has several options that make multiprocessor environments easier to support: the programmable interrupt vector, interrupt level, register address modifiers, and busy semaphore.

8.2.1 Interrupts

Each IOPB specifies the interrupt level and vector for that command. In a multiprocessor environment, each processor can have its own assigned interrupt level and vector.

8.2.2 Register Busy Semaphore

RBS allows multiple processors to share the registers without colliding. Hardware supports the Register Busy Semaphore (RBS) bit. The register access protocol involves reading the CSR.

8.2.2 Register Busy Semaphore (continued)

If RBS is clear, the host has control of the register, and retains control until it clears RBS in the Control Register. If the first read to the Status Register indicates that RBS is set, then another host has control of the register and this host must wait until RBS clears.

The 772 sets RBS immediately after a host reads the CSR. If a host attempts a read, and RBS is clear, then the 772 sets RBS; any successive reads by other hosts will "see" that RBS is set. When the host using the registers is done, it must clear RBS. Clearing RBS and setting AIO can occur in the same register write. Clearing RBS without having control of the registers violates the register protocol.

8.2.3 Address Modifiers

The address modifiers can be used to assign separate address space for each of the processors.

8.3 SOFTWARE CONTROL

The 772 has many parameters that can be modified by software control. The parameters can be set in bulk by having an IOPB with all the correct information, and executing a Write Parameters command.

8.3.1 Modifying a Single Parameter

The best method of modifying a parameter is to first execute a Read Parameters command for the associated parameter block, modify the single parameter and then write the parameter block back to the controller.

8.3.2 Modifying a Group of Parameters

Use the same method as in Section 8.3.1, but modify your multiple parameters. An alternate method does not require prereading the parameters, but does require setting all the parameters in the specific IOPB. The 772 sets all parameters to the new values contained in the IOPB.

8.3.3 Parameter Reference Point

After the 772 is working as intended, read the parameters and save the information (in an appropriate parameters table) for future use.

8.3.4 Setting Parameters at Boot Time

It is not necessary to reload the parameters at each boot since the parameters are stored in a battery backed-up RAM. It is a good idea to reload them each time if you are not sure how the board was last used.

8.3.5 Validate Current Parameters

The parameters are all protected by a checksum, and any Read Parameters command performs a checksum test. The Read Parameters terminates with an error if the generated parameter checksum is different than the stored checksum. See Section 6 for more detail on the IRAM Checksum error.

8.4 SCATTER/GATHER

The 772 is able to execute Scatter Reads and Gather Writes. In a Scatter Read, the 772 transfers the data from tape to up to 32 blocks of memory. Gather Write gathers data from up to 32 blocks of memory and writes it to the tape as one record. The size of each memory block must be an even byte count and the total count must be less than or equal to 64K-bytes long. The blocks may be scattered throughout memory.

8.4.1 Scatter/Gather Link List

You can determine the length of the linked list by multiplying the number of elements in the list by eight (each element is 8-bytes long). All data addresses must be on word boundaries, and the byte count must be even. For reads and writes, enter the number of elements in the linked list into bits 3 through 7 of IOPB Byte 6.

Link Number	Byte	Description
1	00-01	Byte Count (Multiples of 2)
	02	Reserved
	03	Data Address Modifier
	04-07	Data Address (Word Boundaries Only)
2	08-09	Byte Count (Multiples of 2)
	0A	Reserved
	0B	Data Address Modifier
	0A-0D	Data Address (Word Boundaries Only)
	:	:
	:	:
	:	:
N	XX-XX	Data Address Modifier

Table 8-2. Scatter/Gather Link List

8.4.1 Scatter/Gather Link List (continued)

Link Field Value (H)	Decimal Equivalent
0	32
1	1
2	2
:	:
9	9
A	10
B	11
:	:
1E	30
1F	31

Table 8-3. Link List Field Values

8.4.2 Setting Up a Scatter/Gather Transfer

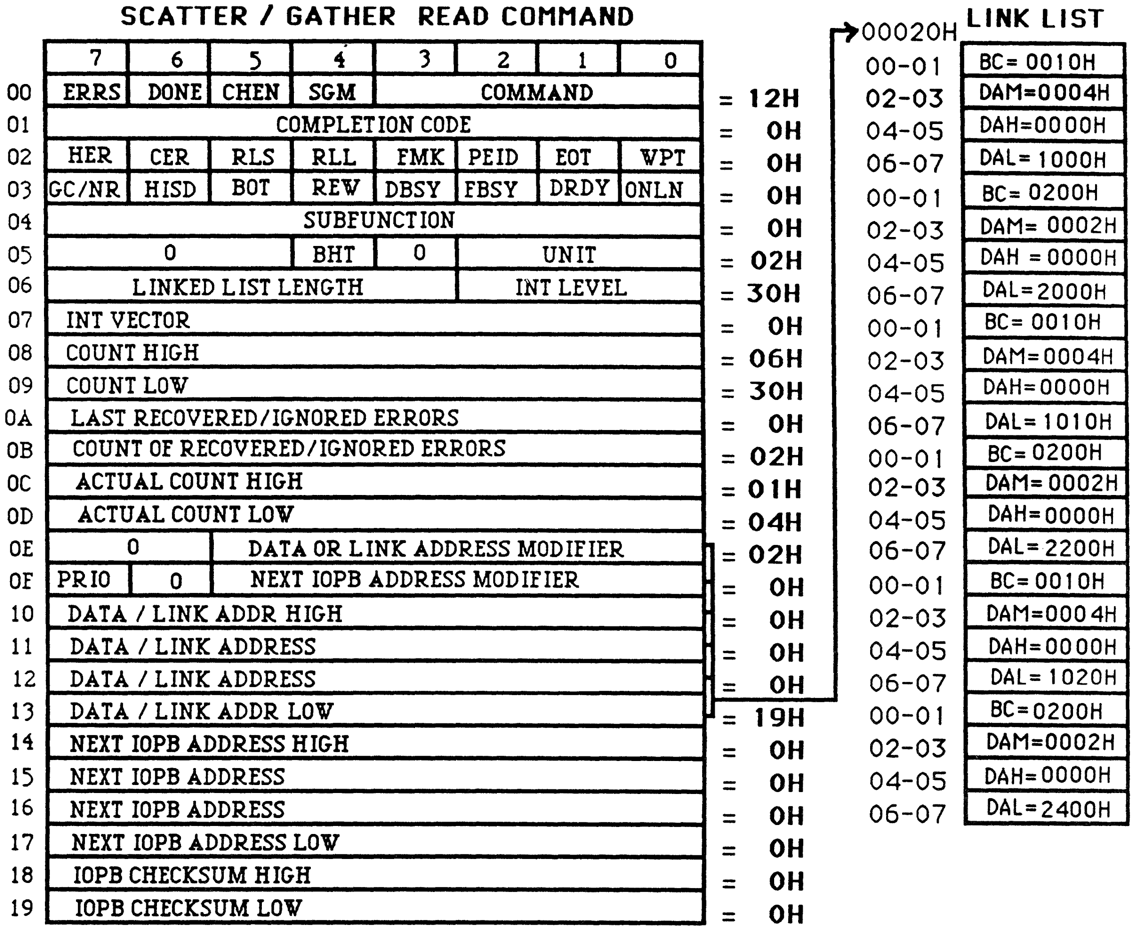
The Data Address and Modifier bytes in the IOPB should now point to the start of the linked list. The linked list length field should give the total number of element descriptors on the list.

Elements of memory descriptors comprise the linked list. Each element describes the starting address and the length, in bytes, of the memory block.

The IOPB and linked list in Figure 8-1 illustrate a Read transfer to 6 blocks of memory. The record size in this case is 528 bytes; we are transferring 3 records of information. The 772 transfers the first 16 bytes of data from each record to a separate data buffer. It scatters the bulk of the data, 512-bytes per record, into memory as 3 blocks having 512 bytes each.

Set SGM and execute the IOPB in Figure 8-1.

8.4.2 Setting Up a Scatter/Gather Transfer (continued)



SCATTER / GATHER READ COMMAND

	7	6	5	4	3	2	1	0	
00	ERRS	DONE	CHEN	SGM	COMMAND				= 12H
01	COMPLETION CODE								= 0H
02	HER	CER	RLS	RLL	FMK	PEID	EOT	WPT	= 0H
03	GC/NR	HISD	BOT	REW	DBSY	FBSY	DRDY	ONLN	= 0H
04	SUBFUNCTION								= 0H
05	0			BHT	0	UNIT			= 02H
06	LINKED LIST LENGTH					INT LEVEL			= 30H
07	INT VECTOR								= 0H
08	COUNT HIGH								= 06H
09	COUNT LOW								= 30H
0A	LAST RECOVERED/IGNORED ERRORS								= 0H
0B	COUNT OF RECOVERED/IGNORED ERRORS								= 02H
0C	ACTUAL COUNT HIGH								= 01H
0D	ACTUAL COUNT LOW								= 04H
0E	0		DATA OR LINK ADDRESS MODIFIER						= 02H
0F	PRIO	0	NEXT IOPB ADDRESS MODIFIER						= 0H
10	DATA / LINK ADDR HIGH								= 0H
11	DATA / LINK ADDRESS								= 0H
12	DATA / LINK ADDRESS								= 0H
13	DATA / LINK ADDR LOW								= 19H
14	NEXT IOPB ADDRESS HIGH								= 0H
15	NEXT IOPB ADDRESS								= 0H
16	NEXT IOPB ADDRESS								= 0H
17	NEXT IOPB ADDRESS LOW								= 0H
18	IOPB CHECKSUM HIGH								= 0H
19	IOPB CHECKSUM LOW								= 0H

00020H LINK LIST

00-01	BC= 0010H
02-03	DAM=0004H
04-05	DAH=0000H
06-07	DAL= 1000H
00-01	BC= 0200H
02-03	DAM= 0002H
04-05	DAH = 0000H
06-07	DAL=2000H
00-01	BC= 0010H
02-03	DAM=0004H
04-05	DAH=0000H
06-07	DAL= 1010H
00-01	BC= 0200H
02-03	DAM= 0002H
04-05	DAH=0000H
06-07	DAL= 2200H
00-01	BC= 0010H
02-03	DAM=0004H
04-05	DAH=0000H
06-07	DAL= 1020H
00-01	BC=0200H
02-03	DAM=0002H
04-05	DAH=0000H
06-07	DAL=2400H

Figure 8-1. Scatter/Gather Transfers

8.4.3 772 Operation

The 772 proceeds as if doing a normal read until it starts the data transfer into memory. The contents of the linked list now controls the DMA processor; it gives the DMA processor the byte count and address for each element on the list. The DMA processor takes the data out of the FIFO and transfers it to memory as described in each element on the list.

8.5 DMA THROTTLE / THROTTLE DEAD TIME

The 772 always transfers IOPBs in 16-bit Word mode; it uses the last specified values for the throttle and throttle dead time.

Host software can set the Throttle Dead Time (TDT) field in the Controller Parameters IOPB. This value defines the time that the 772 waits before attempting to regain control of the bus between throttle bursts. There are four valid TDT values.

TDT Value	Time
0	0 microseconds
1	3.2 "
2	6.4 "
3	12.8 "

Table 8-4. Throttle Dead Time Values

8.6 BLACK HOLE TRANSFERS

In certain applications, the data to be transferred has to go to a single memory location. This single location is usually a graphics controller with a single port on the bus. The Normal DMA mode increments the bus address on each transfer so that the data is put into contiguous memory space. When Black Hole Transfers are implemented, the 772 does not increment the bus address between each data transfer.

Any transfer that includes a DMA to a single location should have BHT set in Byte 5 of the IOPB. This causes only the data transfer portion of the command to not have its bus address incremented. The IOPB DMA still occurs in Normal mode (i.e., the 772 increments the address).

The data address must be properly aligned: word aligned for word transfers, and longword aligned for longword transfers. The 772 cannot do dynamic mode switching with this option.

8.7 PRIORITY IOPBs

The 772 processes Priority IOPBs in advance of any other IOPBs in its queue. This feature works on both a single IOPB and an IOPB chain.

8.7.1 Executing a Priority IOPB

To execute a priority IOPB, set PRIO in both the IOPB Address Modifier Register and the Next IOPB Address Modifier byte in the IOPB. Set the rest of the IOPB Address Registers to point to the IOPB (do not reset PRIO in the Address Modifier Register when loading it). Set AIO as you normally would.

8.7.2 Executing a Priority Chain

To execute a Priority chain, follow the directions in 8.7.1. All IOPBs in the chain must have PRIO set in the Next IOPB Address Modifier byte.

8.7.3 772 Response to a Priority IOPB (Chain)

The 772 finishes executing the IOPB that is currently active (if any). The next IOPB to execute is the priority IOPB (or the first in the priority chain). If the 772 starts a chain of priority IOPBs, it completes one at a time until it completes the chain, and then goes back to processing the IOPBs in its queue. All IOPBs in a priority chain must have PRIO set.

8.8 IOPB CHECKSUM

While debugging the driver, you may choose to append the checksum to the IOPB. The checksum is the sum of Bytes 0 through 17 in the IOPB, and is expressed as a 16-bit quantity. The 772 generates a checksum with the data from the IOPB and compares it to the appended checksum; a miscompare causes a fatal error. If AUD and ICS are set, the 772 appends a new checksum as it updates the IOPB. If you want to disable the checksum, the Write Controller Parameters IOPB must have a valid checksum.

8.9 AUTOMATIC STREAMING: RING BUFFERS

A ring buffer is a multiple-cell data buffer; it comprises two, four, or eight cells depending on throughput requirements. Using ring buffers helps match disk systems with low transfer rates (400-20 kilobytes per second [KBS]) to the tape drive rate so that the tape drive always operates in streaming mode. Ring buffers reduce the total data transfer time even at rates lower than 20 KBS; the same time savings occur when transferring data from the tape drive back to the disk system (see Figure 8-2).

8.9 AUTOMATIC STREAMING: RING BUFFERS (continued)

When using ring buffers:

1. Only empty a buffer when it is full.
2. Only fill a buffer when it is empty.
3. During repositioning or stopping, all buffers must be full before the next tape operation.

During a data transfer to tape, if the input rate to the buffers is lower than the output rate, the tape drive outruns the buffers. Therefore, fill all the buffers before the tape drive starts emptying them. Refill all the buffers while the tape drive is repositioning.

When transferring data from tape to disk:

1. Only empty a buffer when it is full.
2. Only fill a buffer when it is empty.
3. During repositioning or stopping, all buffers must be empty before the next tape operation.

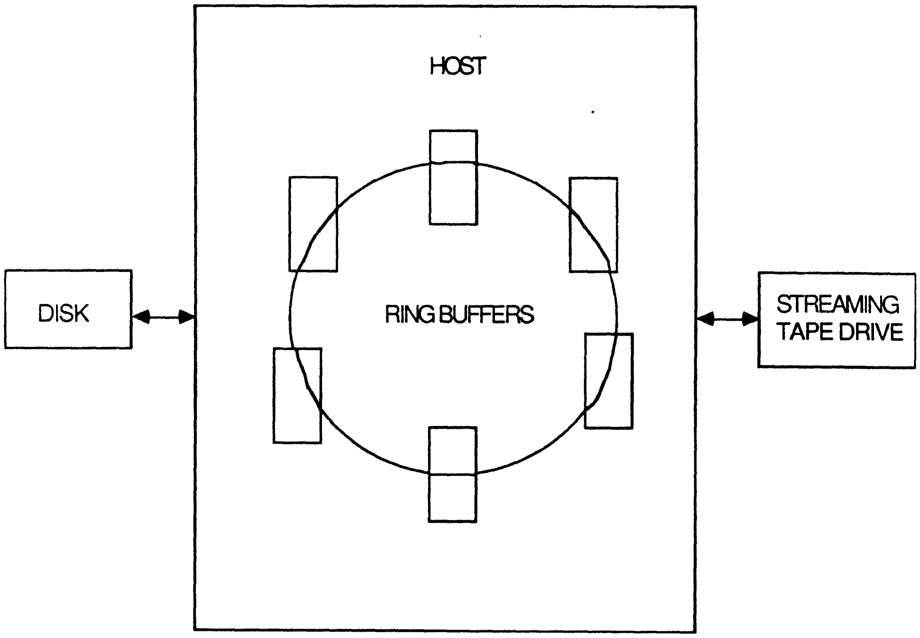


Figure 8-2. Disk to Tape Transfer Using Ring Buffers

8.10 INTERRUPT AT END OF CHAIN

IEC prevents the 772 from interrupting after completing each IOPB in a chain. The 772 executes the entire chain and then interrupts (using the interrupt level and vector from the first IOPB in the chain). If a non-retryable error occurs in the middle of a chain, the 772 returns the remaining IOPBs at the same interrupt vector and level as Aborted by Error. The controller completes all the IOPBs and interrupts once. It may complete IOPBs at different interrupt levels and vectors normally. When IEC is clear, the 772 interrupts after completing each IOPB (providing the interrupt level is not zero).

8.11 RELEASE ON REQUEST

When ROR is enabled, the 772 tests the VMEbus between each throttle for other pending bus requests. If another request is pending, the 772 releases the bus. If there are no bus requests, the 772 remains bus master. The throttle value determines how often the 772 tests the bus. Lower throttle values slow down the DMA; higher throttle values cause the 772 to test the bus less frequently.

SECTION 9: THEORY OF OPERATION

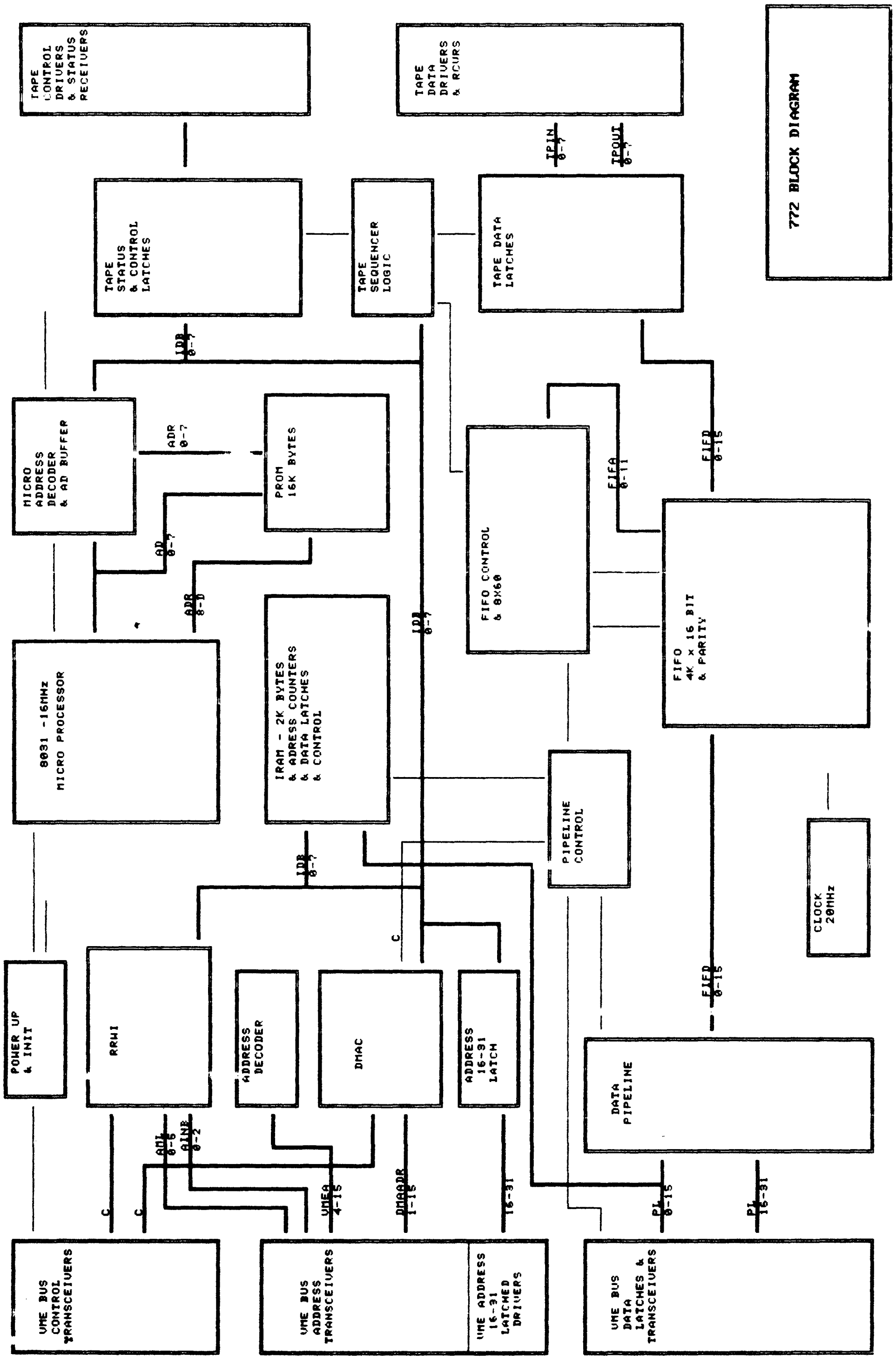


Figure 9-1. Block Diagram

SECTION 10: DRIVE INTERFACE

10.0 GENERAL

This section describes the 772 tape drive interface.

10.1 PERTEC INTERFACE SIGNALS

The 772 supports the industry standard Pertec-formatted Interface. Signal mnemonics may differ from one manufacturer to the next, but typically the function of the signal remains the same. This subsection defines a matrix of signals. Consult the manufacturer's interface specification for further explanation.

Name	Cable	Signal Pin	Ground Pin	Description	Used By 772
FBY	P1	2	1	Formatter Busy	Y
LWD	P1	4	3	Last Word	Y
WD4	P1	6	5	Write Data 4	Y
GO	P1	8	7	Initiate Command	Y
WD0	P1	10	9	Write Data 0 (MSB)	Y
WD1	P1	12	11	Write Data 1	Y
SPARE	P1	14	13	Reserved	Y
LOL	P1	16	15	Load On-line	Y
REV	P1	18	17	Reverse/Forward	Y
REW	P1	20	19	Rewind	Y
WDP	P1	22	21	Write Data Parity	Y
WD7	P1	24	23	Write Data 7	Y
WD3	P1	26	25	Write Data 3	Y
WD6	P1	28	27	Write Data 6	Y
WD2	P1	30	29	Write Data 2	Y
WD5	P1	32	31	Write Data 5	Y
WRT	P1	34	33	Write/Read	Y
LGAP	P1	36	35	Long Gap	Y
EDIT	P1	38	37	Edit	Y
ERASE	P1	40	39	Erase	Y
WFM	P1	42	41	Write File Mark	Y
THR	P1	44	43	High Clip	Y
TAD0	P1	46	45	Transport Address	Y
RD2	P1	48	47	Read Data 2	Y
RD3	P1	50	49	Read Data 3	Y
RDP	P2	1	5	Read Data P	Y
RD0	P2	2	5	Read Data 0 (MSB)	Y
RD1	P2	3	5	Read Data 1	Y
LDP	P2	4	5	Load Point	Y
RD4	P2	6	5	Read Data 4	Y
RD7	P2	8	7	Read Data 7	Y
RD6	P2	10	9	Read Data 6	Y

10.1 PERTEC INTERFACE SIGNALS (continued)

Name	Cable	Signal Pin	Ground Pin	Description	Used By 772
HER	P2	12	11	Hard Error	Y
FMK	P2	14	13	File Mark	Y
ID	P2	16	15	PE ID Burst	Y
FEN	P2	18	17	Formatter Enable	Y
RD5	P2	20	19	Read Data 5	Y
EOT	P2	22	21	End of Tape	Y
OFL	P2	24	23	Off-line/Unload	Y
GCR	P2	26	25	Density Status	Y
RDY	P2	28	27	Ready	Y
RWD	P2	30	29	Rewinding	Y
FPT	P2	32	31	File-protect	Y
RSTR	P2	34	33	Read Strobe	Y
WSTR	P2	36	35	Write Strobe	Y
DBY	P2	38	37	Data Busy	Y
HSPD	P2	40	39	Speed	Y
CER	P2	42	41	Corrected Error	Y
ONL	P2	44	43	On-line	Y
TAD1	P2	46	45	Transport Address 1	Y
FAD	P2	48	47	Formatter Address	Y
HISP	P2	50	49	High Speed Select	Y

10.2 SPECIAL SIGNAL DEFINITIONS

Certain manufacturers define tape interface signals differently; this subsection lists these special definitions. (Refer directly to your drive manual for more information.)

Connector	Pin --->	P1: 14	16	36	44	P2: 16	26
CDC	92181	—	LOL	LGAP	—	PEID	—
	92185	—	LOL	LGAP	THR1	PEID	GCR
Cipher	F880	—	—	—	—	PEID	—
	M890	—	—	—	—	PEID	—
	M990	—	—	—	—	PEID	—
Fujitsu	2242	—	—	LGAP	—	PEID	GCR
Kennedy	9400	—	LOL	LGAP	THR1	ID/CCG	NRZ
	9600	—	LOL	—	LGAP	ID/CCG	NRZ
Megatape	MT500	—	—	—	—	ID	—

10.2 SPECIAL SIGNAL DEFINITIONS (continued)

Connector Pin --->		P1: 14	16	36	44	P2: 16	26
Pertec	FS1000	SGL	LOL	THR1	THR2	PEID	NRZ
	FS2000	FAULT	LOL	HIDEN	LGAP	PEID	GCR/DIAG
STC	2920	—	LOL	—	—	PEID	GCR
Telex Shamrock		—	—	DEN	—	PEID	GCR
Thorn	9600	DGM	LOL	HIDEN	DBLGAP	ID/CCG	NRZ
	9900	DGM	LOL	HIDEN	DBLGAP	PEID	NRZ

10.3 VMEbus INTERFACE SIGNALS

Mnemonic	Conn.	Pin	Used By 772	Description
A01	P1A	30	Y	Address Bus
A02	P1A	29	Y	
A03	P1A	28	Y	
A04	P1A	27	Y	
A05	P1A	26	Y	
A06	P1A	25	Y	
A07	P1A	24	Y	
A08	P1C	30	Y	
A09	P1C	29	Y	
A10	P1C	28	Y	
A11	P1C	27	Y	
A12	P1C	26	Y	
A13	P1C	25	Y	
A14	P1C	24	Y	
A15	P1C	23	Y	
A16	P1C	22	Y	
A17	P1C	21	Y	
A18	P1C	20	Y	
A19	P1C	19	Y	
A20	P1C	18	Y	
A21	P1C	17	Y	
A22	P1C	16	Y	
A23	P1C	15	Y	
A24	P2B	4	Y	
A25	P2B	5	Y	
A26	P2B	6	Y	
A27	P2B	7	Y	
A28	P2B	8	Y	
A29	P2B	9	Y	
A30	P2B	10	Y	
A31	P2B	11	Y	

10.3 VMEbus INTERFACE SIGNALS (continued)

Mnemonic	Conn.	Pin	Used By 772	Description
AM0	P1B	16	Y	
AM1	P1B	17	Y	
AM2	P1B	18	Y	Address Modifier
AM3	P1B	19	Y	
AM4	P1A	23	Y	
AM5	P1C	14	Y	
D00	P1A	1	Y	
D01	P1A	2	Y	
D02	P1A	3	Y	
D03	P1A	4	Y	
D04	P1A	5	Y	
D05	P1A	6	Y	
D06	P1A	7	Y	
D07	P1A	8	Y	
D08	P1C	1	Y	
D09	P1C	2	Y	
D10	P1C	3	Y	
D11	P1C	4	Y	
D12	P1C	5	Y	
D13	P1C	6	Y	
D14	P1C	7	Y	
D15	P1C	8	Y	Data Bus
D16	P2B	14	Y	
D17	P2B	15	Y	
D18	P2B	16	Y	
D19	P2B	17	Y	
D20	P2B	18	Y	
D21	P2B	19	Y	
D22	P2B	20	Y	
D23	P2B	21	Y	
D24	P2B	23	Y	
D25	P2B	24	Y	
D26	P2B	25	Y	
D27	P2B	26	Y	
D28	P2B	27	Y	
D29	P2B	28	Y	
D30	P2B	29	Y	
D31	P2B	30	Y	
Strobes				
AS*	P1A	18	Y	Address Strobe
DS0*	P1A	13	Y	Data Strobe Zero
DS1*	P1A	12	Y	Data Strobe One
DTACK*	P1A	16	Y	Data Transfer Acknowledge

10.3 VMEbus INTERFACE SIGNALS (continued)

Mnemonic	Conn.	Pin	Used By 772	Description
Clocks				
SERCLK	P1B	21	N	Serial Clock
SYSCLK	P1A	10	N	System Clock
DMA				
BBSY*	P1B	1	Y	Bus Busy
BCLR*	P1B	2	N	Bus Clear
BERR*	P1C	11	Y	Bus Error
BG0IN*	P1B	4	Y	
BG1IN*	P1B	6	Y	Bus Grant In
BG2IN*	P1B	8	Y	
BG3IN*	P1B	10	Y	
BG0OUT*	P1B	5	Y	
BG1OUT*	P1B	7	Y	Bus Grant Out
BG2OUT*	P1B	9	Y	
BG3OUT*	P1B	11	Y	
BR0*	P1B	12	Y	
BR1*	P1B	13	Y	Bus Request
BR2*	P1B	14	Y	
BR3*	P1B	15	Y	
Interrupts				
IRQ1*	P1B	30	Y	
IRQ2*	P1B	29	Y	
IRQ3*	P1B	28	Y	Interrupt Request Levels
IRQ4*	P1B	27	Y	
IRQ5*	P1B	26	Y	
IRQ6*	P1B	25	Y	
IRQ7*	P1B	24	Y	
IACK*	P1A	20	Y	Interrupt Acknowledge
IACKIN*	P1A	21	Y	Interrupt Acknowledge In
IACKOUT*	P1A	22	Y	Interrupt Acknowledge Out

10.3 VMEbus INTERFACE SIGNALS (continued)

Mnemonic	Conn.	Pin	Used By 772	Description
Miscellaneous				
ACFAIL*	P1B	3	Y	AC Failure
LWORD*	P1C	13	Y	Longword
RESERVED	P2B	3	N	Reserved
SERDAT*	P1B	22	N	Serial Data
SYSRESET*	P1C	12	Y	System Reset
WRITE*	P1A	14	Y	Write
Power				
+5V	P1A,P1B,P1C	32	Y	+5 VDC
+5V	P2B	1,13,32	Y	+5 VDC
+5V STDBY	P1B	31	N	+5 VDC Standby
+12V	P1C	31	N	+12 VDC
-12V	P1A	31	N	-12 VDC
GND	P1A	9,11,15,17,19	Y	Signal Ground
GND	P1B	20,23	Y	Signal Ground
GND	P2B	2,12,22,31	Y	Signal Ground
GND	P1C	9	Y	Signal Ground

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