60455580

CONTROL DATA CORPORATION

CDC® 834 INTELLIGENT SMALL DISK (ISD) SUBSYSTEM

7255-1 DISK ADAPTER
10471-1 ICI OPTION
834-11 MASS STORAGE SUBSYSTEM
834-12 DISK STORAGE UNIT OPTION
10395-11 CONTROL MODULE OPTION

GENERAL DESCRIPTION
OPERATION
PROGRAMMING

HARDWARE REFERENCE MANUAL

REVISION RECORD

REVISION	DESCRIPTION
A (08-05-83)	Manual released.
B (12-30-83)	Manual revised; includes Engineering Change Order 46388, which includes numerous changes. Because of the number of changes, no dots or change bars are used and each page reflects the current revision level. This edition obsoletes all previous editions.
C (09-14-84)	Manual revised; includes Engineering Change Order 46389. Because of the number of changes, no dots or change bars are used and each page reflects the current revision level. This edition obsoletes all previous editions.
D (10-22-84)	Manual revised; includes Engineering Change Order 46539. Front Cover, 1-1, 1-2, 1-5, 1-6, 2-4, 3-2 through 3-4, 3-6, 3-9, 3-11, 3-15, and E-2 are revised.

Publication No.
60455580

REVISION LETTERS I, O, Q, S, X AND Z ARE NOT USED.

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Publications and Graphics Division
4201 North Lexington Avenue
St. Paul, Minnesota 55112

or use Comment Sheet in the back of this manual.

LIST OF EFFECTIVE PAGES

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INTRODUCTION

The Intelligent Small Disk (ISD) Subsystem is a random-access, medium-capacity data storage device that operates with the CDC Network Operating System (NOS) in the CYBER 180 Models 810 and 830 and the CYBER 170 Models 815 and 825 Computer Systems. The ISD subsystem contains the following modules, equipments, or options (refer to figure 1-1).

Description	Product Number
Integrated Controller Interface (ICI) (C170 - 815/825 only)	10471-1
Disk Adapter†	7255-1
Mass Storage Subsystem††	834-11
Fixed Small Disk Storage Unit (FSD)††† (optional)	834-12
Control Module (CM) (optional)	10395-11
Intelligent Storage Interface (ISI)	Supplied cables
Standard Device Interface (SDI)	Supplied cables

The ICI is a special input/output (I/O) channel used for autoloading the subsystem and for controlling high-speed data transfers.

The adapter and CM are logic modules. The adapter is mounted in the mainframe backpanel and functions as an interface between the I/O channel and the CM. The CM is contained in the disk drive cabinet and functions as a disk drive controller.

The ISI and SDI are interface cables linking the ISD equipments.

The Mass Storage Subsystem contains two disk drives and one CM. Up to three additional disk drives may be installed (optional 834-12 Disk Storage Units). One additional CM may also be installed.

Refer to the glossary (appendix A) for definitions of terms used in this manual.

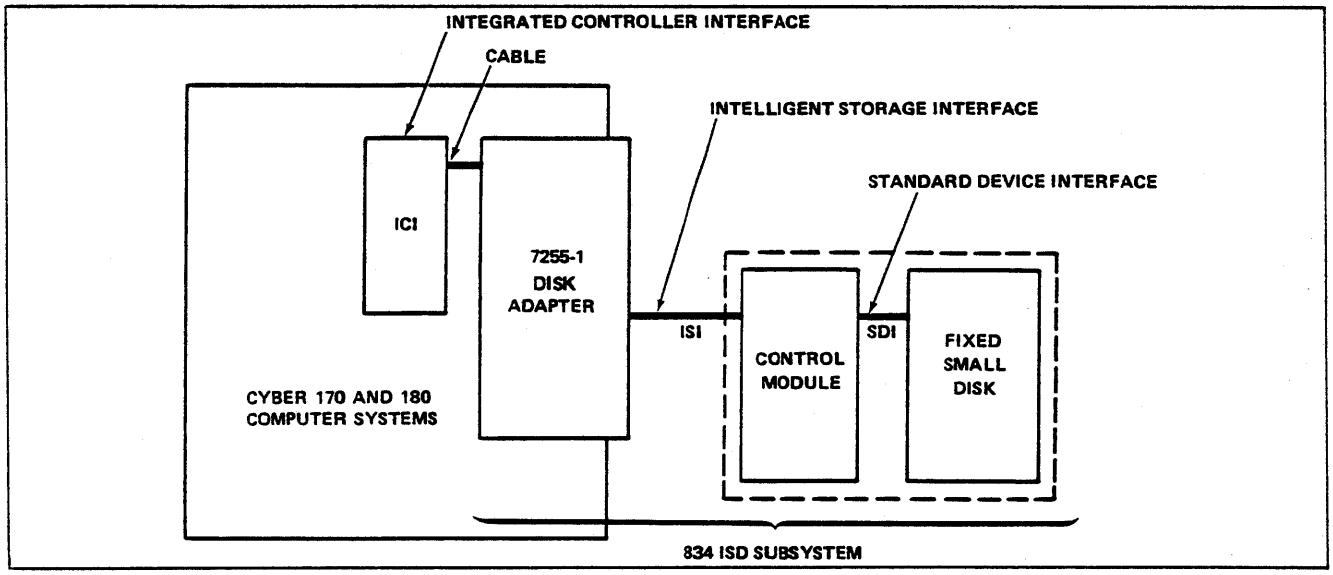


Figure 1-1. ISD Subsystem

†The Disk Adapter is referred to as adapter in this manual.
††Includes two FSDs and one CM.
†††The FSD is referred to as disk drive in this manual.

ISD HARDWARE PRODUCTS

Table 1-1 provides a brief description of products available in the ISD subsystem.

Table 1-1. ISD Hardware Products

Product Number	Description
7255-11	Adapter circuit board. Plugs into mainframe I/O channel. Controls operations between host and CM/drive. Contains resident microcode/firmware and self-diagnostics.
834-11	Consists of CM, two disk drives, ISD cabinet, and supplemental hardware. The CM contains a command operating system (COS) and self- diagnostics for both the CM and disk drive.
834-12	Disk drive add-on and supplemental hardware.
10395-11	CM option with COS and supplemental hardware.
10471-1	ICI I/O Channel Option.

HARDWARE

The ISD hardware is described briefly as follows.

ADAPTER

The 7255-1 Adapter interfaces the CYBER 180 or 170 mainframe to the CM in the ISD cabinet. The adapter contains an MC68000 microprocessor, random-access memory (RAM), and a read-only memory (ROM). Microcode resident in these memories converts external CYBER functions into commands usable by the microprocessor in the CM. The adapter contains its own maintenance diagnostics. For the CYBER 170 I/O channel, the adapter converts 12-bit CYBER functions to 16-bit CM functions.

CONTROL MODULE (CM)

The CM provides overall control of disk drive operations. A request for data transfer from the adapter results in the following events:

- Determines disk drive to be connected.
- Establishes data and control paths between adapter and disk drive.
- Executes COS in CM microcode to satisfy requested PP functions.
- Performs data error detection and correction.

The CM contains self-diagnostics.

DISK DRIVE(S)

The functional elements of the disk drive(s) (figure 1-2) are described briefly as follows.

Element	Description
Disk drive interface	Provides signal lines between control module and drive.
Read/write electronics	Translates digital data waveforms to write current and converts read current to digital data waveforms.
Seek logic	Controls movements of head positioning mechanism together with servo logic.
Head assembly	Contains several read/write heads, each of which converts current to magnetic flux changes on the rotating disk, and vice versa.
Head positioner	Positions head assembly to the disk drive cylinder specified by CM commands.
Disks (nonremovable)	Provides surfaces for recording data as magnetic flux changes.

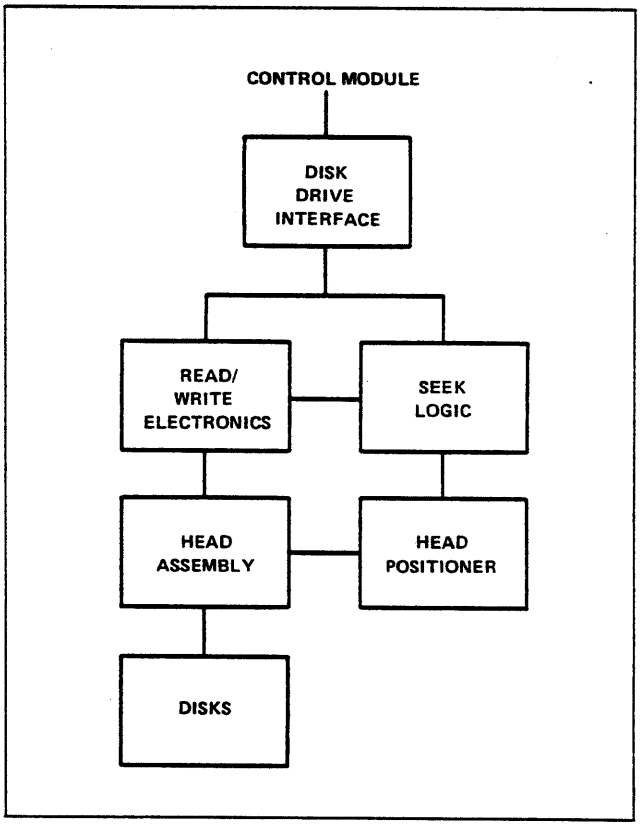


Figure 1-2. Drive Functional Elements

STORAGE THEORY

All rotating magnetic data storage devices apply the principle that electric current flowing near a recording medium changes the magnetic flux of the medium. Conversely, when motion exists between a conductor and a nearby medium containing magnetic flux changes, current flows in the conductor.

For a drive, the conductor is a read/write head and the medium is the disk surfaces. The drive's read/write electronics convert data to write current, and extract data from detected read current.

DATA ORGANIZATION

As the disks rotate, current-induced flux changes trace circular paths around the disk. These flux changes are grouped into sectors, tracks, and cylinders.

- A sector is an arc of contiguous flux changes traced by a head.
- A track is the circle of flux changes traced by a head or head group at one head position.
- A cylinder is all of the tracks at one stop of the head positioner.

A complete disk address consists of a cylinder number, a track number, and a sector number. Figure 1-3 shows the relationship of sector, track, and cylinder.

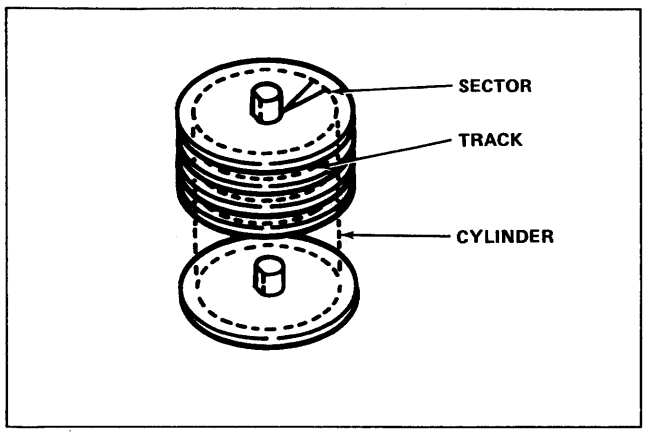


Figure 1-3. Data Organization

SECTOR FORMAT

Each sector contains the following fields:

AM	H	DF1	DF2

AM Address mark (3 bytes of erasure)

H Header consisting of:

1	Sync byte (9_{16})
1	Flag byte
4	Address bytes
2	Defect pointer bytes
4	Error correction code bytes

DF1

1	Sync byte (9_{16})
256	Data bytes
8	Error correction code bytes

DF2

1	Sync byte (9_{16})
256	Data bytes
8	Error correction code bytes

INTERLACING

Interlace is the ratio of number of sectors processed to number of sectors actually passing the head(s). Thus, a 1:1 interlace operation processes every sector passing the head. The disk drive has 1:1 interlace.

TYPICAL OPERATION

A PP performs an operation (such as a read or a write) by issuing a series of functions to the CM. The following sequence shows functions used by a PP during a typical read operation from disk to the ICI:

Activity	Function(s)
Connect CM and check subsystem status	General status, detailed status
Select data path and initiate head positioning	Seek
Wait for drive to become on-cylinder	General status, seek
Transfer one sector of data from drive to CM	Read
Check for read errors	General status, detailed status
Release CM	Operation complete

FUNCTIONAL SPECIFICATIONS

Table 1-2 provides data capacities and functional specifications for the drive. The data capacities listed include storage space used for factory data, autoload data, and maintenance patterns. Typically, this space is much less than one percent of the space available on a cylinder. Also, the data capacities listed for the drive do not include flawed sectors or tracks. The data capacities as listed generally do not change when sectors are flawed.

The CYBER 180 I/O channel is 16 bits wide and transfers 16-bit words to the drive. On the CYBER 170, the PP receives 12-bit bytes from central memory during a sector write and zero-fills the upper 4 bits of each word transferred. One sector of data from the PP channel consists of 322 12-bit words (two header words are added by the PP). The adapter zero-fills the portion of the sector not sent by the PP, and transfers 256 16-bit words to the disk drive via the CM.

Table 1-2. Disk Drive Data Capacity

Number of	Sector	Track	Per Cylinder	Disk Pack
8-Bit Bytes	483	15 456	154 560	125 966 400
Sectors	1	32	320	260 800
Tracks	-	1	10	8 150
Cylinders	-	-	1	815

OPERATIONAL CHARACTERISTICS

The ISD Subsystem is a high-density, medium-capacity disk storage device. The subsystem operates with a dedicated I/O channel. The PP program provides external control of the disk subsystem. Resident microcode in the adapter module converts PP functions into commands which activate the COS in the CM. The COS controls the attached disk drives.

The adapter provides general and detailed status to NOS of current operations. All internal diagnostics are resident in memory after the adapter microcode is loaded and can be executed by issuing a maintenance function.

Information concerning an unrecovered error is stored in the system error log. The CM can retry data transfers or perform error correction. The NOS driver and microcode interact to recover from detected errors. The CM contains internal diagnostics that can detect and isolate errors to field-replaceable units (FRU). Initiation and control of the internal diagnostics is provided by mainframe maintenance software.

PERFORMANCE SPECIFICATIONS

The following lists provide information on the performance capabilities of the disk subsystem. Refer to the FSD/SDI hardware maintenance manual listed in the preface for more information.

Disk Drive Specifications:

- Burst data rate (Mbit/sec) - 9.7
- Seek time (ms, average) - 36
- Formatted capacity (Mbyte from PP) - 126
- Cylinders available per drive - 815
- Sectors per track - 32
- Tracks per inch - 551
- Tracks per cylinder - 10
- Average latency (ms) - 8.33
- Maximum latency (ms) - 16.83
- Recording density (inner track) - 9492 bpi
- Recording density (outer track) - 6117 bpi
- Number of disks per drive - 6
- Number of heads per drive - 10
- Disk speed - 3600 rev/min

Control Module (CM) Hardware/Microcode:

- ISI data transfer rate - 2 Mbyte/s at 15 meters.
- Buffering capacity - 16 384 bytes.
- Up to one byte per sector handled by CM flaw-handling technique.
- Error Correction Code (ECC) corrects errors up to 25 bits in length.
- One spare sector/track, which may be used during the original formatting.
- Capability to scan all disk units on a daisy chain while remaining selected to a given disk unit.

Adapter Hardware/Microcode:

- Translates 12-bit codes to 16-bit codes.
- Translates CM status to NOS status.
- 2-K by 16-bit buffering.
- Self-test diagnostics.
- 8-K by 16-bit RAM.
- 2-K by 16-bit ROM.
- Dynamically switchable from 12 to 16 bits on ICI.

PHYSICAL CONFIGURATIONS

The ISD Subsystem cabinet is shown in figure 1-4. Configurations for the ISD Subsystem are shown in figures 1-5 through 1-7. Two maximum configurations are shown. One configuration allows more throughput by the addition of a CM for each disk drive unit.

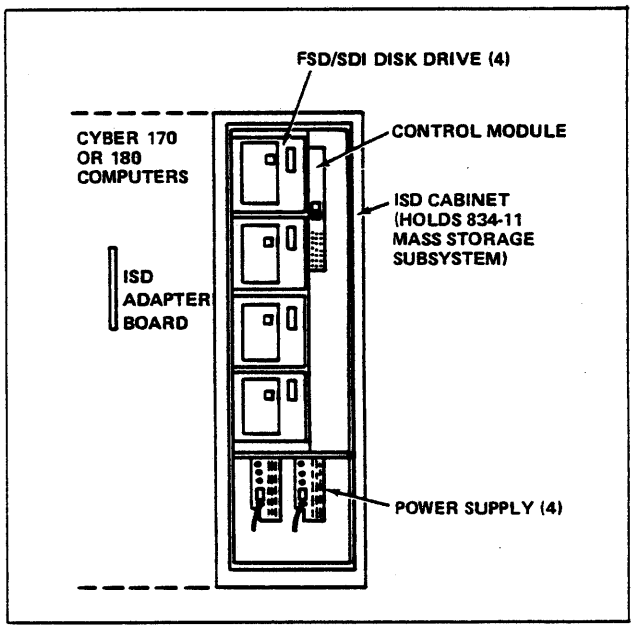


Figure 1-4. ISD Subsystem Cabinet

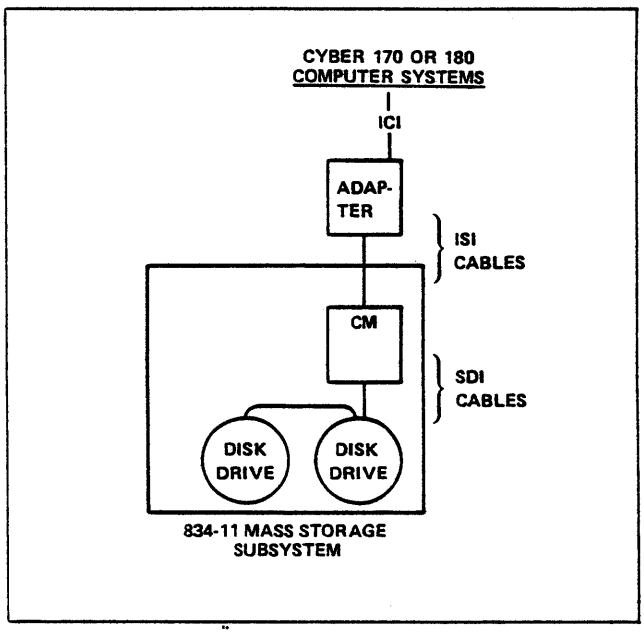


Figure 1-5. ISD Subsystem - Minimum Configuration

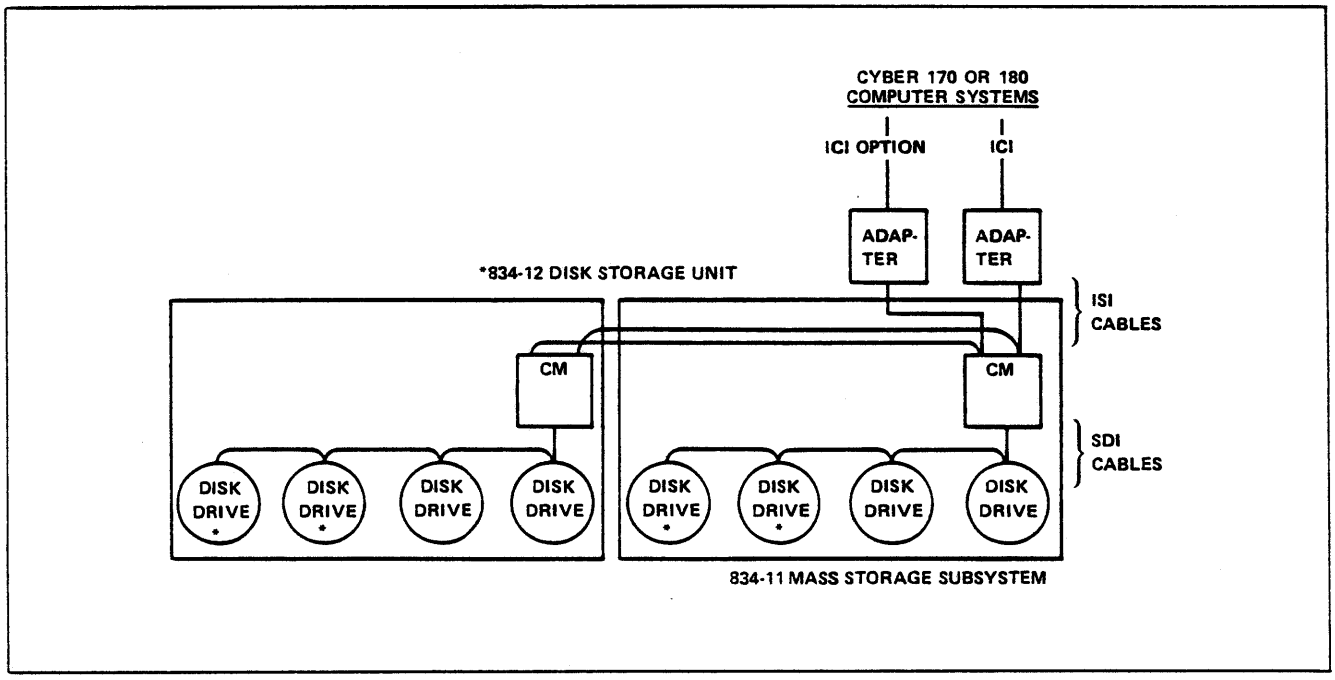


Figure 1-6. ISD Subsystem - Maximum Configuration - Version 1

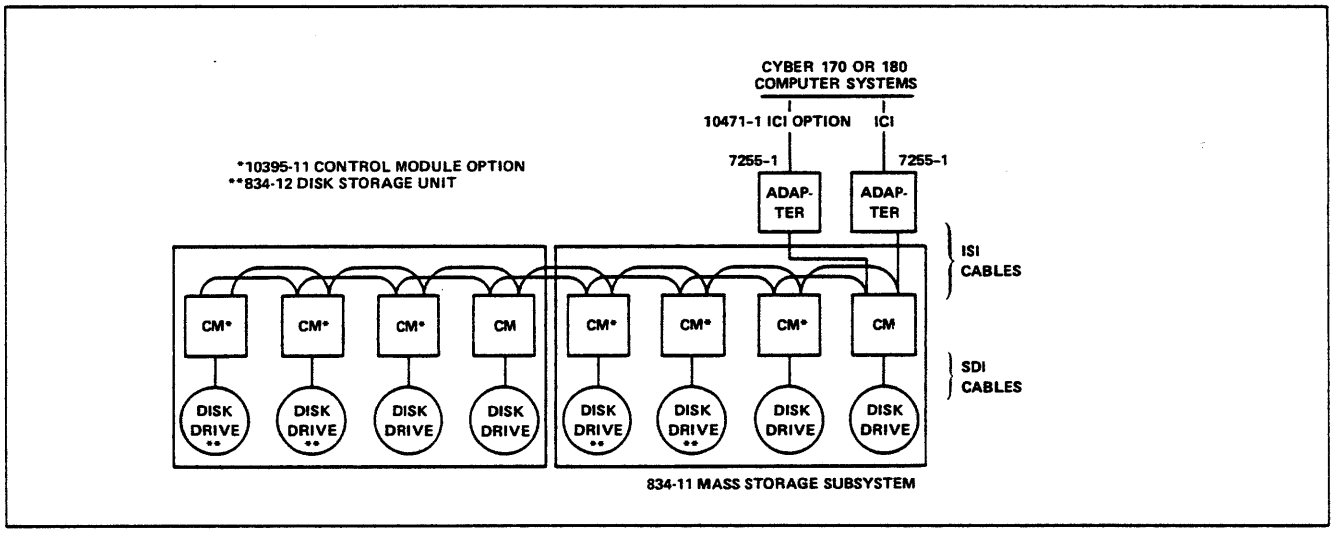


Figure 1-7. ISD Subsystem - Maximum Configuration - Version 2

POWER APPLICATION

Power is applied to or removed from the disk drive as follows.

POWER-ON PROCEDURE

Power is available to the drive if circuit breaker CB1 on the drive is in the ON position (refer to figure 2-2). For normal operation, the local/remote switch should be in the REM (remote) position. To apply power to the disk drive:

1. Press START switch to Start position.
2. Ensure FAULT indicator is off.

POWER-OFF PROCEDURE

Normally, the operating system will power off (spin down) the drive. To manually remove power from the disk drive:

1. Press START switch to release it from the start position.
2. Observe Ready indicator (located in the START switch) is flashing, indicating power down is in progress.
3. Observe Ready indicator goes off within 15 seconds, indicating power down is complete.

SWITCHES AND INDICATORS

ADAPTER

There are no switches or indicators on the adapter.

CONTROL MODULE (CM)

The CM contains the Unit Address Switches and an Error Code Display located on the front edge of the CM (figure 2-1).

Unit Address Switches

This three-position dual inline process (DIP) switch selects the unit address of the ISD device. Up to eight CMs may be daisy-chained on one ISI channel and each must be assigned a unique address.

Error Code Display

This is a two-digit, hexadecimal light-emitting diode (LED) display used by the CM to report diagnostic test failures. The display is cleared during power up, and when level 1 or 2 diagnostics detect a power failure. The LED display is used to report to the host those failures that cannot be reported due to a hardware malfunction.

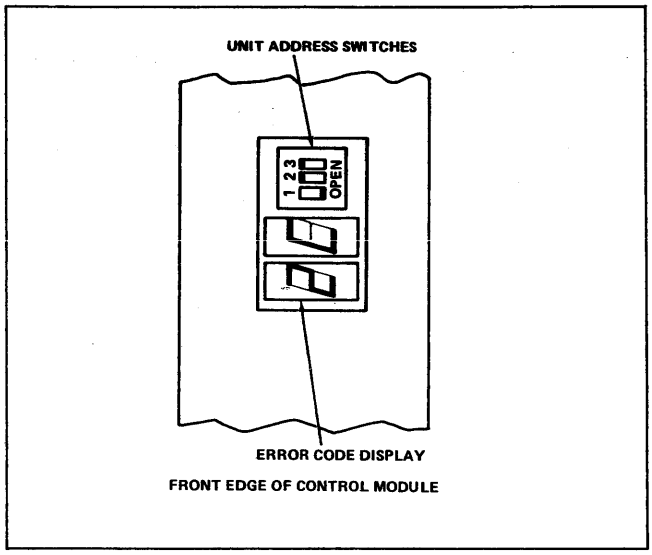


Figure 2-1. CM Switches and Hexadecimal Indicator

DISK DRIVE

Switches and indicators are present in four locations on the disk drive: power supply, front panel, control board, and I/O board. These controls are shown in figure 2-2. Refer to table 2-1 for the function of each switch and indicator.

Table 2-1. Disk Drive Switches and Indicators (Sheet 1 of 2)

Switch or Indicator	Function
	Power Supply
CB1 (ON/OFF) Circuit Breaker	Applies site ac power to external power supply, which supplies the dc operating voltages to the drive.
CB2 (-24) Circuit Breaker	Protects the -24-V supply.
CB3 (+24) Circuit Breaker	Protects the +24-V supply.
CB4 (-5) Circuit Breaker	Protects the -5-V supply. The +5- and -40-V supplies are protected by current limiting circuitry in the power supply.
	Front Panel
Logic Plug	Activates switches that establish the logical address of the device. A set of logic plugs, numbered 0 through 3, is supplied with unit.
START Switch/ Ready Indicator	Pressing the START switch (alternately in for Start and out for Stop) to the Start position activates the power-up sequence. The Ready indicator flashes until the disks are up-to-speed, the heads are loaded, and there are no fault conditions. The Ready indicator is a steady light with power up complete. Popping out the START switch from the Start position causes the Ready indicator to flash until disk rotation has stopped. **NOTE** The power up sequence will not start until the drive receives a power sequence signal from the CM, when in Remote Mode.
FAULT Indicator/ FAULT Clear Switch	The FAULT indicator, inside the FAULT Clear switch, lights if a fault exists within the drive and is turned off by any of the following (provided that the error condition or conditions exist): • Pressing the FAULT Clear switch. • FAULT Clear command from the control module. • A drive power-up operation.
WRITE PROTECT Switch/Indicator	Places the drive in the write protected mode (preventing write operations) and lights the WRITE PROTECT indicator.
	Control Board
NORM/W PROT (Normal/Write Protect) Switch	Prevents the drive from performing write operations when placed in the W PROT position. The switch must be returned to the NORM position to enable write operations.
1st SEEK Indicator	Indicates drive failed first seek/load attempt.
R/W.$\overline{OC}$ Indicator	Indicates write or read conditions existed during a seek operation (an off-cylinder condition).

Table 2-1. Disk Drive Switches and Indicators (Sheet 2 of 2)

Switch or Indicator	Function
WRT Indicator	Indicates a write fault has occurred.
RD.WRT Indicator	Indicates a simultaneous write and a read command.
VOLT Indicator	Indicates below normal voltage.
	I/O Board
LOC/REM (local/ remote) Switch	Controls whether or not the drive can be powered up from the drive (LOC) or control module (REM). In both switch positions, power up requires turning ON CB1 and pressing the START switch; however, in REMOTE position, a power sequence signal must come from the control module.

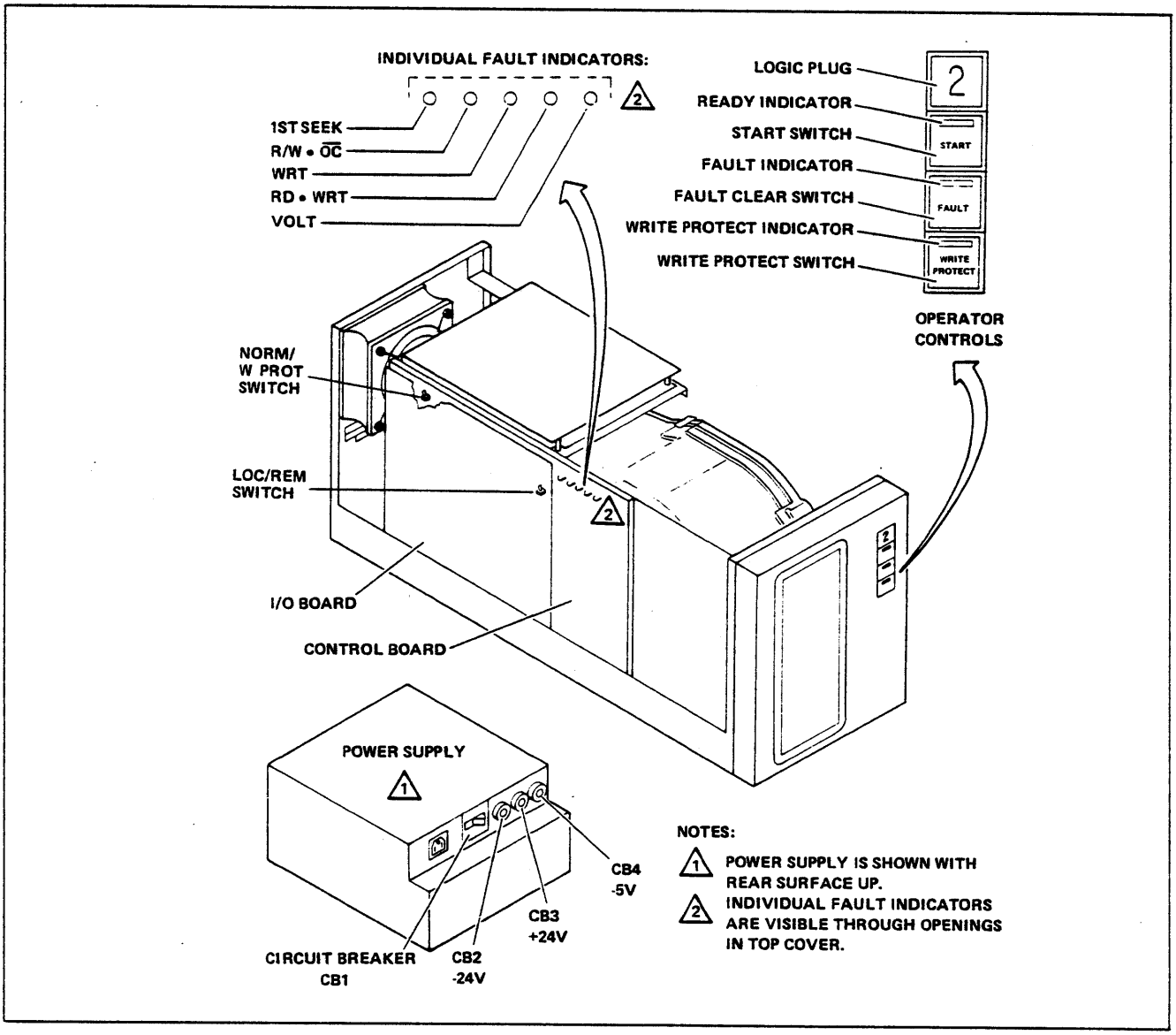


Figure 2-2. Disk Drive Controls

ISD INITIALIZATION

The adapter must be autoloaded with microcode before the ISD can execute the complete function set. Refer to section 3 for function codes and further information. Refer to the CIP User's Handbook (listed in the preface) for complete autoloading instructions.

GENERAL CONSIDERATIONS

The programmer should be familiar with the following information.

SUBSYSTEM MICROCODE/COS INITIALIZATION

Deadstart master clear or Autoload (0414 or 01UD) starts the adapter processor executing at address 400 in ROM. An instruction test and a ROM checksum test are then executed. If the diagnostics execute without error and an Autoload from PP function is not present, a release is issued to all CMs. If an error occurs, the processor stops. The ROM firmware then jumps to an idle loop which scans for functions from the PP.

Microcode in the adapter and COS in the CM must be loaded before all functions can be executed. Adapter firmware can execute the following functions prior to loading microcode:

- General Status
- Dump Adapter Memory
- Manipulate Processor
- Input Adapter Memory
- Autoload from PP
- Autoload Microcode/COS from Disk
- Input Processor Status

The Autoload from PP function can be used to load adapter microcode. The Autoload CM from PP function can be used to load COS from the higher level processor. To coldstart from disk, the 01UD function can be used to load adapter microcode and COS.

AUTOLOAD FROM PP (0414)

This function is decoded and replied to by the ROM firmware. The lower 8 bits of each consecutive word output by the PP are transferred to 8-bit byte positions in adapter memory. Thus, two words of PP memory are utilized to load each 16-bit adapter memory word. The adapter remains in autoload mode until the PP disconnects the channel.

A partial autoload of four or fewer words can be performed to recover from channel time-out errors. Program execution is returned to the idle loop following the partial autoload. The ROM firmware begins storing autoload data at address 2000. If a full autoload is being executed, adapter processor firmware does a memory test after the fifth word is received from the channel. Memory test results are saved, then processor firmware completes the autoload. If the memory test was successful, processor firmware calculates a checksum from the data loaded. If the checksum is correct, internal adapter diagnostics execute. These are part of the downloaded microcode. If any of the diagnostics fail, general status is 5XXX, where XXX is an error code. Refer to appendix C (ISD Diagnostics). If there was no error, a release is issued to all CMs and general status is set to zero. The processor then goes into an idle loop which looks for functions from the PP.

AUTOLOAD MICROCODE/COS FROM DISK (01UD)

This function loads COS into the CM and microcode into the adapter from disk. COS and microcode must have been previously written on disk. The Write COS function (0051) and the Write Microcode function (0021) can be used to install COS and microcode on the disk.

When the 01UD function is received, an instruction test and a ROM checksum test are executed. The adapter then drops the reserve to all CMs it is connected to and begins executing its memory test. A selective reset is issued to the CM, causing it to execute its power-on tests. A power-up spindle command is then issued, causing drive power-on tests to be executed. The function word contains the CM number, U, and the drive number, D. When the power-up spindle command is complete, the adapter issues a command to the CM, causing COS to be loaded from a reserved cylinder on disk. When this completes, the adapter positions the drive to cylinder 816, and reads microcode from 32 consecutive sectors, beginning at track 0 sector 1, into adapter memory. If all tests and commands execute without error, and the COS and microcode checksum correctly, the 01UD function is replied to. If an error occurs, the function is not replied to.

AUTOLOAD CM FROM PP (0071)

The autoload CM from PP function allows the PP to load COS into a CM. This function must be preceded by a Connect function to reserve the CM to be loaded. The 3-bit drive identification number specified in the parameter word for the connect is not used.

When the adapter receives the 0071 function, it issues a selective reset to the CM. When selective reset completes, an interface test between the adapter and CM is executed when the interface test completes, and data is transferred from the PP to the adapter to CM memory. If an error occurs during the selective reset or data transfer, the adapter disconnects the channel and general status is 5XXX. After transferring COS to CM, CM verifies that COS is correct. Busy status of 0002 is returned during this verification. The PP should repeat taking general status until status indicates not busy. A general status of zero indicates the autoload completed without error.

I/O CHANNEL INTERFACE

The ISD adapter is driven by PPs. All communication between a PP and the adapter is initiated by functions from the PP. Since the adapter is the only equipment on a channel, all 16 bits are used for function bits. To avoid hanging the channel, due to a hardware logic failure, all functions must have a timeout limit of 500 ms. The adapter replies to all legal function codes described in this manual.

Table 3-1 numerically lists adapter function codes. The upper 4 bits of all functions and parameters or data words sent by the PP must be zero-filled. Certain functions require supporting parameters or data. The PP must activate the channel prior to its input/output of parameters or data. It must disconnect the channel after all outputs of parameters or data. The adapter inactivates the channel after all PP inputs. Disk data transfer errors to or from the PP in which not all words were transferred are terminated by the microcode. Any other error conditions in which the channel remains connected and active for 6 to 10s are inactivated by adapter hardware. Refer to appendix B for timing details for function replies, parameters, and data.

READ/WRITE ERROR RECOVERY PROCEDURE

The PP can initiate standard error recovery procedures after the adapter detects a hardware malfunction. The adapter notifies the PP through general status (Abnormal Termination and Recovery in Progress status) whenever a malfunction occurs for which error recovery is possible. The PP should respond by requesting detailed status for subsequent error file logging, after which a Continue function should be issued by the PP to initiate the next logical error recovery procedure.

A data transmission operation, including error recovery procedures, is processed as follows: The PP issues a Seek function which results in the adapter selecting the designated drive, and initiating head motion to position the read/write heads at the specified cylinder. If directed by the PP, the adapter can perform seek operations on other drives concurrently with a data transfer to effect seek overlap. After issuing all necessary Seek functions, the PP must wait for a drive to become on-cylinder. The appropriate data transfer function must then be issued.

READ FUNCTION ERROR RECOVERY SEQUENCE

	PP Action	Comments
1.	Issue Seek function.	
2.	Take general status.	
3.	If bit 1 or 3 is set, the CM or drive is busy. Repeat at step 1 as required.	
4.	Take detailed status for error logging if bit 11 is set. Repeat at step 1. Abort the operation if errors continue.	
5.	Proceed if general status = 0.	
6.	Issue Read function.	The adapter terminates the block transfer if an error occurs and the channel is active.
7.	Save word count.	
8.	Take general status.	
9.	Go to step 6 as long as more sectors are to be read if general status = 0000 and the remaining word count is zero. Exit the sequence if all sectors have been read.	
10.	Take detailed status, issue the Continue function, then go to step 7 if bits 8 and 11 are set.	
11.	Take detailed status for error logging if bits 9 and 11 are set. Repeat at step 1. Abort the operation if errors continue.	
12.	Repeat at step 1 if remaining word count is nonzero. Abort the operation if errors continue.	

WRITE FUNCTION ERROR RECOVERY SEQUENCE

	PP Action	Comments
1.	Issue Seek function.	
2.	Take general status.	
3.	If bit 1 or 3 is set, the CM drive is busy. Repeat at step 1 as required.	
4.	Take detailed status for error logging if bit 11 is set. Repeat at step 1. Abort the operation if errors continue.	
5.	Proceed if general status = 0.	
6.	Issue Write function.	If this is the last sector of a block of sectors to be written, do one of the following: 1) Issue Write Last Sector function code instead of Write function code. 2) Follow Write function with two General Status functions. The adapter terminates the block transfer if an error occurs and the channel is active.
7.	Save the word count.	
8.	Take general status.	
9.	Go to step 6 as long as more sectors are to be written if general status = 0000 and the remaining word count is zero.	
10.	Go to step 15 (if this was the last sector to be written) if general status = 0000 and the remaining word count is zero.	
11.	Take detailed status for error logging.	
12.	Go to step 7 if bits 8 and 11 are set.	
13.	Repeat at step 1 if the entire block of sectors or the last 32 sectors can be rewritten. Abort the operation if errors continue.	
14.	Abort the write operation.	
15.	Exit sequence if Write Last Sector function was used.	
16.	Take general status.	
17.	Exit the write sequence if general status = 0000.	
18.	To to step 11.	

DEADMAN TIMER

There are two deadman timers, ICI and ISI.

ICI DEADMAN TIMER

Adapter hardware logic incorporates an ICI deadman timeout feature which prevents the channel from hanging for an extended period of time. The deadman timer is enabled whenever the I/O channel is activated by a PP. Each time a full or empty signal is transferred across the channel, the deadman timer is reset to zero and the time-out period is reinitiated. When the PP inactivates the channel the deadman timer is set to zero and does not start counting again until the PP activates the channel. If a data transfer stops, the time-out period of 5 s to 16 s expires, and an inactive signal is sent to the PP if the channel is connected.

For Read/Write functions to the disk, Buffer Write, Buffer Read, CM Buffer Write, and CM Buffer Read, the microcode prevents deadman timeouts. If the data transfer does not complete or the channel does not get inactivated for these functions, the microcode inactivates the channel. General and detailed status describe the error.

For the remaining functions which transfer words between the PP and control module, the deadman timer is utilized. A general status of 5000 and deadman time-out status in Detailed Status word 20 are returned for the following functions if the deadman timer inactivates the channel:

- Connect
- Seek
- Format Pack
- Block Transfer Buffer Write
- Write Microcode on Disk
- Write COS
- Write Diagnostics
- Power-Up Spindle
- Power-Down Spindle
- Execute Adapter Diagnostics
- Execute CM Diagnostics
- Autoload CM from PP

ISI DEADMAN TIMER

To prevent the processor from hanging when attempting to access a CM, the adapter has an ISI deadman timer. It expires if a sync out has been issued and the associated sync in is not received within 4 ms to 16 ms. If this timer expires, general status is 5000 and Detailed Status word 19 bit 0 is set.

PARITY ERROR DETECTION AND PROCESSING

There are four types of parity errors:

- ICI
- Adapter Memory
- ISI
- CM Memory

ICI PARITY ERRORS

The following three items describe the parity error detection and processing procedure for an adapter connected to an ICI option.

1. Parity Error on Function from PP - The adapter does not reply to a function having a parity error. It counts it, sets general status to 5016, and saves the function in memory for examination with the Dump Adapter Memory function. The PP must time out the function to avoid hanging the channel. After detecting the time out, the PP should disconnect the channel and resend the function. If parity errors continue, the operation should be aborted.

2. Parity Error on PP Write - The PP completes its transfer normally. It then must do a General Status function (0012). The adapter microcode prepares the status words in its memory, then clears the parity error condition. Refer to items 1 and 3 if a parity error occurs while doing a General or Detailed Status. General status is 5000 and bit 5 word 20 of Detailed Status is set denoting the write parity error. To recover from the parity error, the function and parameters (or data) should be resent. If parity errors continue, the operation should be aborted.

3. Parity error on PP Read (Parameters or Data) - The PP should test the error flag after the block input. This must be done prior to sending the next function. The adapter microcode has no way of detecting a parity error on a PP read. Thus, a general status reflects only what has happened in the adapter. One of the following PP actions is suggested:

    - Resend the function and read the parameters again.
    - Reseek and read the sector.
    - Reseek and read the block of sectors.
    - Abort the operation if parity errors continue.

ADAPTER MEMORY PARITY ERRORS

All memory in the adapter has byte parity. Parity errors can occur in the ROM, buffer, or program memory.

If the parity error occurs in ROM the processor interrupts to an address in ROM. If the processor gets another parity error while processing the first one, the processor stops. If the processor does not get another parity error, the channel is inactivated, if active, and general status is set to 5014.

If the parity error occurs in the buffer while writing to or reading from disk, the transfer goes to completion. General status after the transfer is 5000 for a read and 4400 for a write. In both cases Detailed Status word 20 bit 8 is set to indicate the memory partity error occurred.

If the parity error occurs in program memory the processor interrupts to an address in ROM. If the processor gets another parity error while processing the first one, the processor stops. If the location getting the parity error is 20C0 through 58FF and the length of the error is 8 or fewer bits, the error is corrected. General status is set to 4400 if the function being processed is 0005 or 0035, otherwise, status is 5013. If the location getting the parity error is 2002 through 2011, 2014 through 20A1, or 5900 through 5FFF, the failing byte is loaded with zeros. General status is set to 4400 if the function being processed is 0005 or 0035, otherwise status is 5013. If a parity error occurs in the remaining 34 bytes, general status is 5002, which indicates the adapter must be reloaded.

ISI PARITY ERRORS

The adapter checks parity on all bytes sent and received. If the adapter detects the parity error, general status is 4400 if the function was 0005 or 0035. Otherwise, status is 5000. Detailed status word 19 bit 3 is set to indicate the parity error occurred.

If the CM detects the parity, it sets check end and stores a manual intervention code of 63 hexadecimal in its status buffer. General status returned to the PP is 4400 if the function was 0005 or 0035. Otherwise, status is 5000.

CM MEMORY PARITY ERRORS

The CM has byte parity in its data buffer and program memory where COS is loaded. A memory parity error in the data buffer results in general status of 5000 for a read and 4400 for a write. Detailed status indicates check end and a manual intervention code of 65.

A memory parity error in program memory results in a general status of 5017. A reload of COS is required after this error occurs.

EXTERNAL FUNCTION CODES

All communication between the PP and the adapter is initiated by PP functions. These instructions load and then activate resident microcode in the adapter module and the CM. Refer to figure 3-1 for a block diagram of the adapter. Refer to table 3-1 for a list of function codes.

The following functions are used for data transfer. (Autoload functions are described earlier in this section.)

CONNECT (0000)

The Connect function and its associated one-word output parameter permits a PP to reserve a CM. The CM remains reserved until the PP issues either an Operation Complete (0010) or Drive Release (0020) function.

For a Connect function in which bit 11 of the parameter word is set, the CM is reserved with the priority override bit set. This causes the CM to drop the reserve from the other channel (if reserved) and grant access to the overriding channel.

One-Word Parameter Format:

Bit 11	Priority override.
Bits 6-10	Not used.
Bits 3-5	CM number.
Bits 0-2	Drive number.

SEEK 1:1 INTERLACE (0001)

The Seek function initializes the adapter for a 1:1 interlace for subsequent data transmission on the specified drive (that is, consecutive physical sectors are processed during data transmission). When necessary, the Seek function also initiates head motion.

A PP can determine if the specified drive is on-cylinder by checking general status from the adapter. When the general status word is zero, the specified drive is on-cylinder, and the seek operation has completed normally. When the selected drive's heads are in motion or the CM is busy, general status is 0002.

Since the general status word changes only after the microcode processes a function, a PP waiting for a specific seek operation to complete should use the following sequence:

1. Issue Seek function and address.
2. Issue General Status function and input status word.
3. Go to step 1 if bit 1 of the general status word is set.
4. Continue if status word is zero.

The subsystem supports seek overlap by allowing the PP to initiate disk head motion on several drives prior to initiating data transmission on one selected drive. Thus, head positioning on other drives can occur concurrently with data transmission to/from the selected drive.

A Seek function must be issued by the PP initially to position heads of the specified drive to the required cylinder, and establish the starting track and sector numbers for the ensuing data transfer. A function such as Read or Write must be issued by the PP for each sector which is to be transmitted to/from the PP. The subsystem automatically advances the cylinder, track, and sector numbers, as required, after each successful transmission of a sector of data. The PP must issue another Seek function only when:

- A nonconsecutive sector is to be transmitted.
- Switching I/O functions (Example: Read after Write, Write after Read, and so forth). Thus, it is possible to issue one Seek function to a drive and transmit one complete cylinder of data without issuing intervening Seek functions.

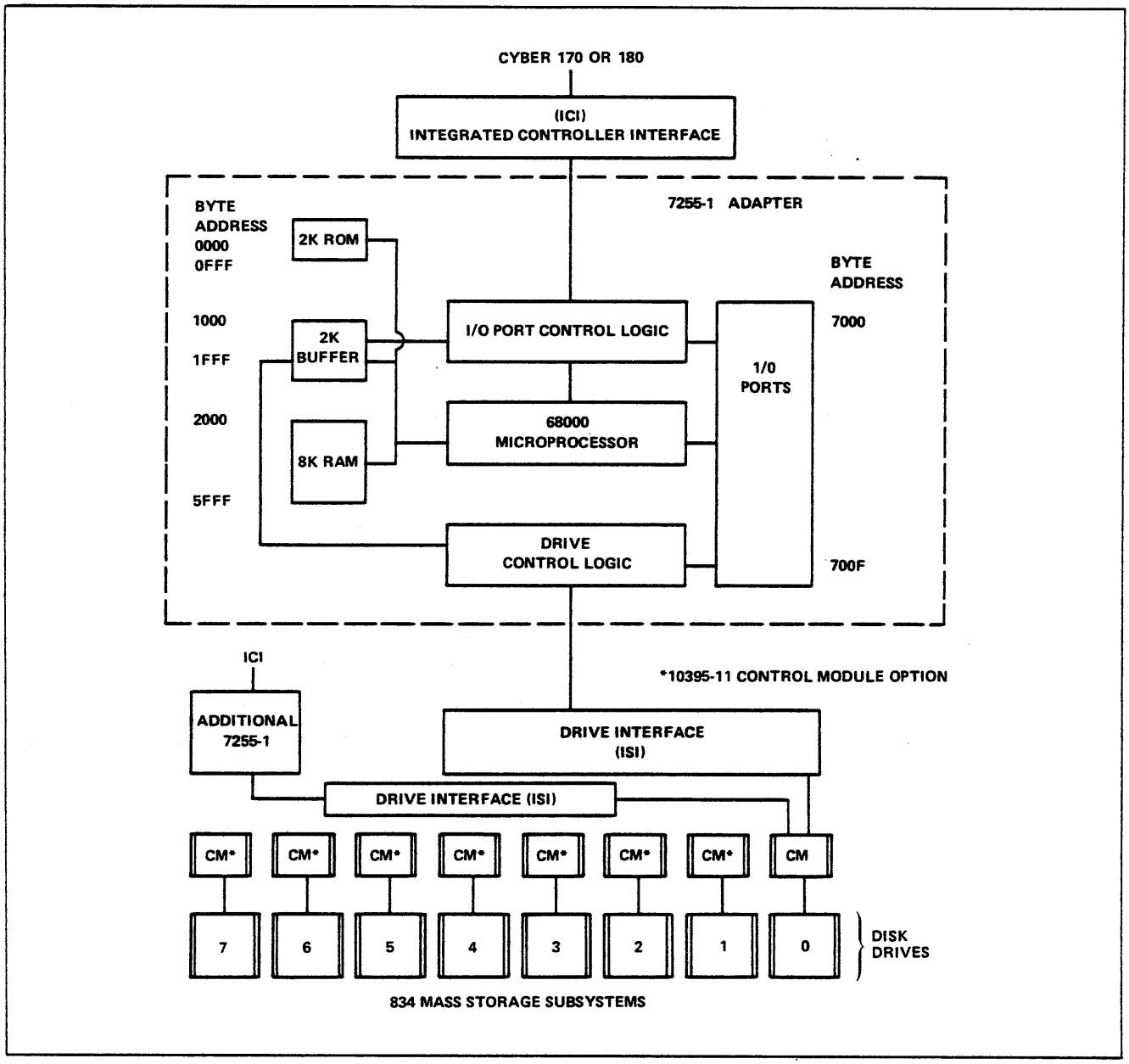


Figure 3-1. Adapter/ISD Subsystem - Block Diagram

Table 3-1. Adapter Functions (Sheet 1 of 2)

Function Code	PP Words Output	PP Words Input	General Status Required	Function Name
0000	1		yes	Connect
0001	4		yes	Seek 1 to 1 Interlace
0004		322	yes	Read
0005	322		yes	Write
0010			no	Operation Complete
0011			no	Disable Drive Reserve
0012		1	no	General Status
0014	†	††	yes	Continue
0016	5		yes	Format Pack
0020			no	Drive Release
0021	†††		yes	Write Microcode on Disk
0023		20	no	Detailed Status
0032		322	no	Block Transfer Buffer Read
0033	322		yes	Block Transfer Buffer Write
0034		322	yes	Read Protected Sector
0035	322		yes	Write Last Sector
0037	322		yes	Write Protected Sector
0040		176	yes	Read Data and ECC
0041	176		yes	Write Data and ECC
0043		322	yes	Buffer Read
0044	322		yes	Buffer Write
0045		322	yes	Read CM Buffer
0046	322		yes	Write CM Buffer
0047			yes	Generate Defect Log
0050		10752	yes	Read COS
0051	10752		yes	Write COS
0052		10752	yes	Read Diagnostics
0053	10752		yes	Write Diagnostics
0054		104	yes	Read Error Log
0055	1		yes	Power-Up Spindle
0056	1		yes	Power-Down Spindle

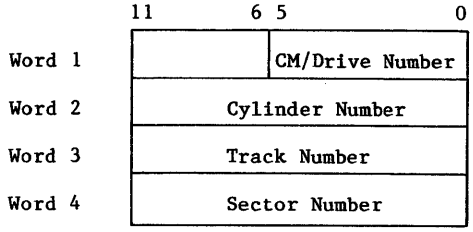
†For Write functions only.
††For Read functions only.
†††Variable length. The data transfer terminates when the PP disconnects the channel.

Table 3-1. Adapter Functions (Sheet 2 of 2)

Function Code	PP Words Output	PP Words Input	General Status Required	Function Name
0060		83	no	Input Processor Status
0061		16384	no	Dump Adapter Memory
0062	5		no	Manipulate Processor
0063		64	no	Input Adapter Memory
0064	1		yes	Execute Adapter Diagnostics
0065	6		yes	Execute CM Diagnostics
0066		512	yes	Dump CM Command/Status Buffer
0067	†		yes	Reload Adapter
0070		16384	yes	Dump CM Data Buffer
0071	10752		yes	Autoload CM from PP
0072		64	yes	Input CM Command/Status Buffer
01UD			no	Autoload COS/Microcode from Disk
03UD/05UD		1 to 322	no	Disk Deadstart
0414			yes	Autoload from PP

†Variable length. The data transfer terminates when the PP disconnects the channel.

Four-Word Parameter Format:



Word 1 References parameter format under Connect function.

Word 2 Specifies the starting cylinder number (0 through 816).

Word 3 Specifies the starting track number (0 through 9).

Word 4 Specifies the starting sector number (0 through 31).

READ (0004)

The Read function results in data transfer from the selected disk sector (specified by a prior Seek function) through the CM and adapter buffer memories to the PP memory. The adapter can buffer up to one sector of data from the disk and simultaneously transfer it to PP memory at the speed of the channel. The adapter can process only one data transfer at a time, although seek operations initiated on other drives proceed concurrently with a data transfer (seek overlap).

The PP must initiate a single sector block input after issuing the Read function to the adapter. A Read function is effective for one sector of data. The adapter advances the track, and/or sector numbers, as required, after each successful transmission of a sector of data.

The data transfer procedure for one sector of data is described in the Error Recovery Procedures earlier in this section.

WRITE (0005)

The Write function results in data transfer from PP memory through the adapter and CM buffer memories to the selected disk sector. The adapter can buffer up to one sector of data from the PP at the speed of the channel and simultaneously transfer it to disk. The adapter can process only one data transfer at a time, although seek operations initiated on other drives proceed concurrently with a data transfer (seek overlap).

The PP must initiate a single sector block output after issuing the Write function. A Write function is effective for one sector of data. The PP must initiate a single sector block output for each sector of data to be written during transmission of the data block. This procedure must continue until the entire data block has been written. The data transfer procedure for one sector of data is described in the Read/Write Error Recovery Procedure earlier in this section. The adapter advances the cylinder, track and/or sector number, as required, after each successful transmission of a sector of data.

OPERATION COMPLETE (0010)

The Operation Complete function releases the last CM referenced by the adapter. If all commands to the CM to be released have not been completed, a bit is set in a table in adapter memory. This function (0010) is replied to and the CM is released at completion of all commands. If the CM is reserved again before the release occurs, the release does not occur. An example of a command that is not complete is a seek that was started, but has not yet come on cylinder.

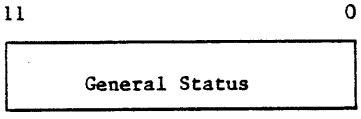
DISABLE DRIVE RESERVE (0011)

The Disable Drive Reserve function performs no operation. The opposite access of a CM can be cleared with the Connect function (0000).

GENERAL STATUS (0012)

The General Status function enables the PP to receive an overall status indication after it has issued one of the adapter functions. Table 3-1 specifies which adapter functions must be followed by general status. Normal function completion results in a zero-filled General Status word. If the General Status word is nonzero, check bit 11 to determine if the operation was abnormally terminated. Refer to appendix B, Adapter General Status, for a detailed list of General Status words returned.

The 12-bit General Status word is structured as follows:



The following status conditions exist when the respective bits of the General Status word are set to one:

Bit 11 — Abnormal Termination - The preceding function terminated abnormally. When bit 11 is set, either bit 8 (Recovery in Progress) or bit 9 (nonrecoverable error) is always set.

Bit 10 — Not used.

Bit 9 — Nonrecoverable Error - All error recovery and error correction procedures were unsuccessful for the preceding function. Further recovery procedures cannot be initiated with a Continue function. Except after an Autoload or Execute Adapter Diagnostic function, detailed status should be obtained to determine the exact cause of abnormal termination. When bit 9 is set, bits 0 through 8 of general status can be an error code. Refer to appendix C for a description of error codes.

Bit 8 — Recovery in Progress - The adapter is ready to respond to a Continue (0014) function to attempt error recovery. Specific status of the condition is available in detailed status.

Bits 5-7 — Not used.

Bit 4 — Drive Malfunction - The drive is present, not ready, and no fault condition exists.

Bit 3 — CM Reserved - The CM requested by the PP is currently reserved by another adapter.

Bit 2 — Not used.

Bit 1 — Busy - The adapter, CM, or drive is busy performing a previous function issued by the PP.

Bit 0 — Not used.

CONTINUE (0014)

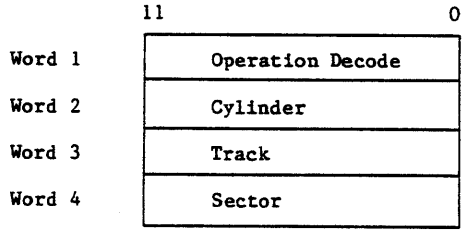
The Continue function enables a semiautomatic error recovery sequence to be performed by the adapter. A Continue function issued by the PP is valid only after the adapter has returned general status indicating Recovery in Progress. For read/write-type functions, the Continue function is sent instead of the Read/Write function. The data transfer normally performed after the Read/Write function is also performed at this time. Refer to Read/Write Error Recovery Sequence, earlier in this section, for a more detailed description.

FORMAT PACK (0016)

The Format Pack function reinitializes a disk pack for subsequent data transfer by writing new address fields. Existing data fields are destroyed. The subsystem is dedicated to the operation during disk pack formatting and cannot process functions directed to other drives. The adapter returns general status = 0002 during the format operation and general status = 0000 after the operation completes.

All disk packs are formatted at the factory. Extensive surface analysis is performed and defect management techniques are used to provide error free storage.

The Format Pack function should be preceded by a Connect function to reserve the CM and provide the adapter with a drive number. After the Format Pack function is received by the adapter, the adapter performs a four-word block input from the PP to receive the required parameters. The parameter array is as follows:



Word 1 = 0000 - Reallocate Sector

This operation causes the specified sector to be flagged as bad and header addresses to be automatically shifted accordingly. The spare sector on the track absorbs the extra generated sector. If the spare sector has already been used, no formatting occurs, and system intervention code 64 (hexadecimal) is reported.

Word 1 = 0001 - Format Specified Cylinder

This operation causes the CM to format the specified cylinder. The CM analyzes the cylinder with worst-case data patterns and uses defect skipping and sector reallocation techniques to hide any media errors.

This operation can be used to format the reserved cylinder by setting the cylinder number to 4000 (octal). The reserved cylinder contains COS, Level II diagnostics, and the error log. The CM restores COS, but Level II diagnostics and the error log are destroyed.

Word 1 = 0002 - Format and Certify Pack

This operation causes the CM to format the entire pack and must be used if cylinder reallocation is necessary.

DRIVE RELEASE (0020)

This function performs no operation (no-op).

WRITE MICROCODE ON DISK (0021)

The Write Microcode On Disk function must be used to write adapter microcode to disk in the format necessary so that adapter microcode can be loaded with the Autoload from Disk function. The microcode resides on cylinder 816 track 0 sectors 1 through 31, and track 1 sector 0.

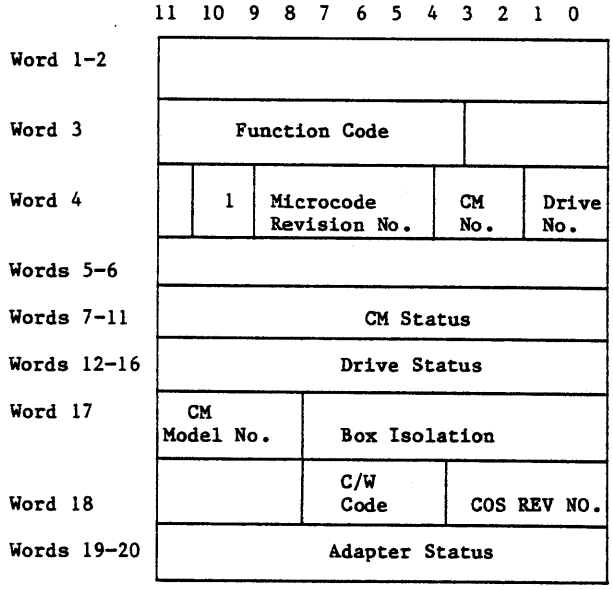
The PP should precede this function with a Connect function to reserve the CM and provide a drive number. When the adapter replies to the Write Microcode On Disk function, the PP should activate the channel and output the microcode. The format of the microcode is the same as described previously in Autoload from PP (0414). Since the length of the microcode is variable, the data transfer is terminated when the PP disconnects the channel. The adapter zero-fills the remaining area on disk.

DETAILED STATUS (0023)

The Detailed Status function causes the adapter to supply a 20-word Detailed Status block to the requesting PP. If the last referenced CM is reserved and general status is zero, the adapter, CM, and drive status in words 7 through 16, 19, and 20 are copied. Detailed Status word 4 and the microcode code in word 18 are always filled by the Detailed Status function. Otherwise, it is static status stored in adapter memory after the abnormal termination of an adapter function.

After abnormal termination of a function, a PP should obtain error logging information by issuing a Detailed Status function followed by a block input of 20 words. The PP may then attempt error recovery with a Continue (0014) function if Recovery in Progress was set in general status, or it may issue a new function.

The format of the Detailed Status is as follows:



The following procedure may be used to interrogate detailed status for additional information.

1. Is general status bit 11 set?
   - If no, there is no error to isolate.
   - If yes, go to step 2.
2. Are general status bits 0 through 7 zero?
   - If no, see appendix C for error code.
   - If yes, go to step 3.
3. Are detailed status word 3 bits 1 and 3 zero?
   - If no, see Detailed Status word 3 for a description of the status bits.
   - If yes, go to step 4.
4. Are bits 0 through 4 of Detailed Status word 17 all zero?
   - If no, see Detailed Status word 17 for a description of the error.
   - If yes, go to step 5.
5. Are bits 2, 5, 8, and 9 of Detailed Status word 20 all zero?
   - If no, see Detailed Status word 20 for a description of the status bits.
   - If yes, go to step 6.
6. Are bits 0, 3, 6, 9, and 10 of Detailed Status word 19 zero?
   - If no, see status word 19 for a description of the status bits.
   - If yes, go to step 7.
7. Is bit 3 of Detailed Status word 11 set?
   - If no, see Detailed Status word 11 for a description of the status bit.
   - If yes, go to step 8.
8. Are bits 6 and 10 of Detailed Status word 7 both set?
   - If yes, go to step 9.
   - If no, go to step 10.
9. Are bits 4 through 11 of Detailed Status word 9 equal to A6 (hexadecimal)?
   - If yes, see the CM Level 1 diagnostic† for a description of the code. The code is in bits 0 through 7 of Detailed Status word 8.
   - If no, refer to description of the error code.
10. Are bits 5 and 10 of Detailed Status word 7 both set?
    - If yes, go to step 11.
    - If no, see bits 0, 1, 3, 6, and 7 of Detailed Status word 20 for a description of the error.
11. Is the error code in bits 0 through 7 of Detailed Status word 10 equal to 6A (hexadecimal)?
    - If yes, see the CM Level 1 diagnostic for a description of the code. The code is in bits 0 through 3 of Detailed Status word 9, and bits 8 through 11 of Detailed Status word 10.
    - If no, go to step 12.
12. Is the error code in bits 0 through 7 of Detailed Status word 10 equal to 81 (hexadecimal) through 88 (hexadecimal)?
    - If yes, see bits 0, 1, 2, and 3 of Detailed Status word 15, and bits 10 and 11 of Detailed Status word 16 for more information.
    - If no, see bits 0 through 7 of Detailed Status bit 10 for the error code.

Words 1-2 Not used.

Word 3

Bits 4-11 This field contains the lower 8 bits of the PP function which caused this detailed status block to be created.

Bit 3 Parameters for the function code in Detailed Status word 3 are illegal.

Bit 2 Not used.

Bit 1 Multiple select - The adapter selected the wrong CM or more than one CM. If this bit is set, Detailed Status word 7 has the bit significant response from the CMs as follows:

Bits 8-11	Not used.
Bit 7	CM 7 selected.
Bit 6	CM 6 selected.
Bit 5	CM 5 selected.
Bit 4	CM 4 selected.
Bit 3	CM 3 selected.
Bit 2	CM 2 selected.
Bit 1	CM 1 selected.
Bit 0	CM 0 selected.

Bit 0 Not used.

†For access to this information, refer to Volume 2 of the CM Hardware Maintenance Manuals listed in the preface.

Word 4

Bit 11	Not used.
Bit 10	Indicates ISD Subsystem. Detailed Status word 18, bits 5 through 7 identify the microcode.
Bits 6-9	Microcode revision number.
Bits 3-5	CM number associated with this copy of detailed status.
Bits 0-2	Drive number associated with this copy of detailed status.

Words 5-6 Not used.

Words 7-11 CM Status

The following status is normally obtained directly from words 80 through 86 of the CM status block.

If Detailed Status word 3 bit 1 is one, word 7 has the bit significant response for all CMs attached to the daisy chain. See word 3 for a description of the bits.

Word 7

Bit 11	Normal End.
Bit 10	Check End.
Bits 7-9	Execution Status.
Bit 6	System Intervention Status Valid.
Bit 5	Manual Intervention Status Valid.
Bit 4	Delay Status Valid.
Bits 0-3	Drive Number.

Word 8

Bits 8-11	Command Block Number.
Bits 0-7	Level 1 Diagnostic Code.

Word 9

Bits 4-11	System Intervention Code.
Bits 0-3	Upper 4 bits of the Level II Diagnostic Code.

Word 10

Bits 8-11	Lower 4 bits of the Level II Diagnostic Code.
Bits 0-7	Manual Intervention Code.

Word 11

Bits 4-11	Delay Code.
Bit 3	Drive Ready.
Bit 2	Drive Present.
Bit 0-1	Not used.

Word 12 - 16 Drive Status

The following status is obtained directly from the CM device status block.

Word 12 Cylinder Address

Word 13

Bits 4-11	Track Address.
Bits 0-3	Upper 4 bits of sector address.

Word 14

Bits 8-11	Lower 4 bits of sector address.
Bits 0-7	Device ID.

Word 15

Bits 8-11	Device Capacity.
Bits 4-7	Device Model.
Bit 3	No Head Select.
Bit 2	Write Fault.
Bit 1	Write or Read and Off Cylinder.
Bit 0	Read and Write Fault.

Word 16

Bit 11	Voltage Fault.
Bit 10	Head Select Fault.
Bit 9	Seek Error.
Bit 8	Write Protect.
Bit 7	Address Mark Found.
Bit 6	Write Protect.
Bit 5	On Cylinder.
Bit 4	Unit Ready.
Bits 2-3	Not used.
Bit 1	Offset Active.
Bit 0	Check Diagnostic.

Word 17 CM Model Number Box Isolation Status

Bits 8-11 CM Model Number - This value is copied directly from word 83 of the CM status buffer.

If bit 11 of general status is set when detailed status is read by the PP, the adapter analyzes status and sets one bit to indicate the most likely failing equipment. Bits 0 through 7 are defined as follows:

Bits 7-0	Definition
100XXXXX	Adapter failure. No codes for XXXXX are defined.
010XXXXX	CM failure. Codes for XXXXX are as follows.
(01000001)	1. Compare error on data looped between adapter and CM.
(01000010)	2. Select active did not drop when a word sent to the CM had a parity error.
(01000011)	3. Attention status was not received after the adapter sent a word to the CM with a parity error.
(01000100)	4. Manual intervention status from the CM was not 63 hexadecimal after the adapter sent a word to the CM with a parity error.
001XXXXX	Drive failure. No codes for XXXXX are defined.

Word 18

Bits 8-11 Not used.

Bits 5-7 A code of zero indicates MA721 microcode, a code of one indicates MA722 microcode, and a code of two indicates MA462 microcode.

Bits 0-4 The rightmost 5 bits of the COS revision number. It is copied directly from bits 0 through 4 of word FF hexadecimal of the CM command buffer.

Word 19 Adapter ISI Status

Bit 11 Not used.

Bit 10 Attention bit not received from CM.

Bit 9 CM Busy. If pause is set longer than 100 ms during a Read (0004) or Write (0005 or 0035) function, general status is 4400 and this bit is set. If general status is 5000, this bit indicates that the CM has not completed the previous command.

Bit 8 Not used.

Bit 7 ISI Select Active.

Bit 6 ISI Pause.

Bit 5 Disable ISI Parity Error.

Bit 4 Force Sync In.

Bit 3 ISI Parity Error.

Bit 2 ISI Select Hold.

Bit 1 ISI Command Sequence.

Bit 0 ISI Deadman Time Out.

Word 20 Adapter ICI Status.

Bits 10-11 Not used.

Bit 9 Memory parity error detected by processor.

Bit 8 Adapter buffer memory parity error detected by buffer control logic.

Bit 7 Word Transfer in Progress.

Bit 6 Read not equal Write Address.

Bit 5 ICI Parity Error.

Bit 4 Not used.

Bit 3 ICI Full.

Bit 2 Channel Reserved.

Bit 1 Channel Deadman Time Out.

Bit 0 Channel Active.

READ PROTECTED SECTOR (0034)

The Read Protected Sector function is identical to the Read (Refer to 0004) function and is present for software compatibility.

WRITE LAST SECTOR (0035)

The operational procedure for the Write Last Sector function is identical to the Write function (0005). When writing in 1:1 interlace format, general status is returned to the PP after the data is in CM memory, but before it has been written on the disk. With the write last sector function, general status is returned after the sector is written on the disk. This means that the next physical sector cannot be written without missing a disk revolution. Therefore, the Write Last Sector function should be used only when writing the last sector of a block.

WRITE PROTECTED SECTOR (0037)

This function is the same as the Write Last Sector (0035) function. It is present for software compatibility.

POWER-UP SPINDLE (0055)

The Power-Up Spindle function followed by a one-word parameter output powers up the specified drive. The parameter word contains the drive number and is the same as the one for the Connect function (0000). The power up includes self-diagnostic tests. The self diagnostic tests are run even if the spindle is powered up. General status is updated once after the Power-Up Spindle function is issued. To determine when the power up has been completed, the PP should repeat the Power-Up Spindle and General Status functions until status indicates not busy and not reserved to another CM. If more than one CM exists, one drive per CM can be spun up in parallel. Since a CM is dedicated to a spin-up operation, drives on one CM cannot be spun up in parallel.

POWER-DOWN SPINDLE (0056)

The Power-Down Spindle function followed by a one-word parameter output powers down the specified drive. The parameter word is the same as for the Connect function. General status is updated once after the Power-Down Spindle function is issued. To determine when the power down has been completed, the PP should repeat the Power-Down Spindle and General Status functions until status indicates not busy and not reserved to another CM. If the drive is not ready, it is assumed that the spindle is already powered down and the command is not issued to the CM.

DISK DEADSTART (03UD/05UD)

The function code is defined as follows:

U = Control Module
D = Drive

A possible deadstart panel setting is as follows:

1. 75CC Disconnect Channel CC
2. 77CC Issue deadstart function to drive UD
3. 03UD
4. 74CC Activate Channel CC
5. 71CC Input on Channel CC to Address ADDR
6. ADDR

For the example deadstart panel setting, the deadstart channel must be 12 or 13 on a 12-channel system and 12, 13, 32, or 33 on a 24-channel system. When the microcode detects the deadstart function 03UD/05UD it runs adapter diagnostics, then issues the power-up spindle command to the CM. It then positions the drive to cylinder 816, and reads data on track 0 sector 0 into adapter memory. Word 1 of the data read contains the number of 12-bit words to be transferred. A maximum of 502 octal words is transferred. The CM released after the data has been transferred to the PP. If the adapter diagnostics detect an error, or the deadstart sector cannot be read without error, the adapter retries the read as long as the function is present.

Data in the deadstart sector can be written with the 0035 or 0037 functions.

The 05UD function does not issue the power-up spindle command to the CM if the drive is ready. Otherwise, it is identical to the 03UD function. The power-up spindle command executes drive diagnostics that take approximately 15 s.

MAINTENANCE FUNCTIONS

There are two paths through which data can be transferred between the PP and adapter memory. One path uses the processor and the other uses hardware buffer control logic. Function codes 0032, 0033, 0043, and 0044 describe functions that test these paths.

The following are maintenance functions for adapter self-diagnostics.

BLOCK TRANSFER BUFFER READ (0032)

The Block Transfer Buffer Read function allows the PP to read 322 words from the adapter buffer memory. The data is transferred by the adapter processor. This function can be used to read the data written with the 0005, 0033, or 0043 functions.

BLOCK TRANSFER BUFFER WRITE (0033)

The Block Transfer Buffer Write function allows the PP to write 322 words into the adapter buffer memory. The data is transferred by the adapter processor. Data transferred by the Write function (0005) is sent to the buffer memory in this same format. General status is 5000 if there was a channel parity error or less than 322 words were received. A general status of zero indicates the function completed without error.

READ DATA AND ECC (0040)

The Read Data and ECC function allows a PP to read the first half of a sector on disk and its ECC, 256 and eight 8-bit bytes, respectively. The PP can modify the data, write it back on disk with function 0041, then use the Read function (0004) to verify the subsystem's detection and correction capabilities.

Except for the transfer length, the operational and error recovery procedures for the Read Data and ECC function are the same as those for the Read function (0004).

The first 232 bits read with the Read Data and ECC function are zero-filled by the adapter as part of a Write (0005) function. Bits 233 through 2048 read with the Read Data and ECC function correspond to the first 1816 bits written with the Write (0005) function.

WRITE DATA AND ECC (0041)

The Write Data and ECC function allows a PP to write the first half of a sector on disk and its ECC, 256 and eight 8-bit bytes, respectively. This function may be used in conjunction with the Read Data and ECC function (0040) to simulate media flaws and verify the subsystem's ability to detect and correct data errors.

Except for the transfer length, the operational and error recovery procedures for the Write Data and ECC function are the same as those for the Write Last Sector (0035) function.

Bits 233 through 2048 written with this function correspond to the first 1816 bits written with the Write (0005) function. The first 232 bits of the sector on disk are zero-filled by the adapter as part of a Write (0005) function.

BUFFER READ (0043)

The Buffer Read function allows the PP to read 322 words from the adapter buffer memory. The data is transferred via the adapter's buffer control logic. This function can be used to read the data written with the 0005, 0033, or 0044 functions. A general status of zero indicates the function completed without error.

BUFFER WRITE (0044)

The Buffer Write function allows the PP to write 322 words into the adapter buffer memory. The data is transferred by the buffer control logic. The Block Transfer Buffer Write function (0033) allows the PP to output the same data. A general status of zero indicates the function completed without error.

READ CM BUFFER (0045)

The Read CM Buffer function allows the PP to read a portion of the CM's buffer memory. It is identical to the Read (0004) function except that the data originates in the CM buffer, not from disk. The Write CM buffer (0046) function can be used to write the CM buffer. The Read CM buffer function must be preceded by a Connect (0000) function to reserve the CM.

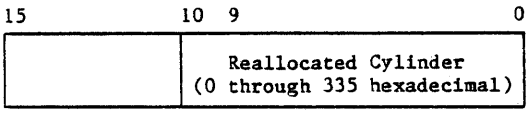
WRITE CM BUFFER (0046)

The Write CM Buffer function allows the PP to write a portion of the CM's buffer memory. It is identical to the Write (0005) function except that the data is not transferred from CM buffer memory to the disk. The Write CM buffer function must be preceded by a Connect (0000) function to reserve the CM.

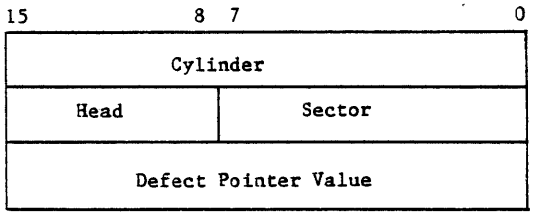
GENERATE DEFECT LOG (0047)

The Generate Defect Log function causes a defect log to be generated in the CM's buffer for the drive specified in the last Connect (0000) function issued by the PP. It is generated by reading the update ETF log on the drive. Busy general status (0002) is returned while the defect log is being generated. A general status of zero indicates the log has been generated and that the PP can use the Dump CM Buffer (0070) function to input the defect log.

In the CM buffer, the first four words define the reallocation status of the four spare cylinders. Bits 0 through 15 are all ones if the spare cylinder is unused. Each of the first four words is as follows:



The fifth word is a number count of flagged sectors. Each flagged sector is reported using three words as indicated below.



READ COS (0050)

The Read COS function allows the PP to read the COS program from a drive. This function must be preceded by a Connect (0000) function to reserve the CM and provide a drive number.

WRITE COS (0051)

The Write COS function allows the PP to write the COS program on a reserved cylinder of a drive. This function must be preceded by a Connect (0000) function to reserve the CM and provide a drive number. General status is returned indicating busy (0002), while the CM is verifying the cyclic redundancy code (CRC) and writing COS to disk.

READ DIAGNOSTICS (0052)

The Read Diagnostics function allows the PP to read the Level II Diagnostic program from a drive. This function must be preceded by a Connect function to reserve the CM and provide a drive number.

WRITE DIAGNOSTICS (0053)

The Write Diagnostics function allows the PP to write the Level II Diagnostic program on a reserved cylinder of a drive. This function must be preceded by a Connect (0000) function to reserve the CM and provide a drive number. General status is returned indicating busy (0002) while the CM is verifying the CRC and writing diagnostics to disk.

READ ERROR LOG (0054)

The Read Error Log function allows the PP to read the drive and CM history error logs. The Read Error Log function must be preceded by a Connect (0000) function to reserve the CM and provide a drive number. If the drive number is zero, the drive error log followed by the CM error log is returned. If the drive number is not zero, only the drive error log is returned. The remaining words of the fixed length transferred to the PP are zero-filled.

The drive error log in the CM is thirty-six 16-bit words and the CM error log is sixteen 16-bit words. The adapter transfers one 8-bit byte right-justified in each word sent to the PP. The upper (bits 8 through 15) byte of each 16-bit CM word is transferred first.

If an error log overflow occurs during a Read (0004) or Write (0005 or 0035) function, the adapter erases the error log. The adapter does not support the CM's Update Error Log command; thus, the only way the error log on disk is updated, is by issuing the Power-Down Spindle (0056) function.

INPUT PROCESSOR STATUS (0060)

The Input Processor Status function allows the PP to input the following information from the adapter:

- Eight 32-bit data registers (D0-D7).
- Eight 32-bit address registers (A0-A7).
- Six 16-bit I/O ports.
- The rightmost 12 bits of the 16-bit status register.
- The 8-bit interrupt type.
- Program Counter (PC).

The adapter transfers one 8-bit byte right-justified in each word sent to the PP. The upper byte of the register, port, and program counter are transferred first.

82-Word Format:

D0	Word 1	Word 2	Word 3	Word 4
D1	Word 5	Word 6	Word 7	Word 8
.	.	.	.	.
.	.	.	.	.
D7	Word 29	Word 30	Word 31	Word 32
A0	Word 33	Word 34	Word 35	Word 36
.	.	.	.	.
.	.	.	.	.
A7	Word 61	Word 62	Word 63	Word 64
P0	Word 65	Word 66		
.	.	.		
.	.	.		
P5	Word 75	Word 76		
Status	Word 77			
Not used	Word 78			
Interrupt	Word 79			
PC	Word 80	Word 81	Word 82	Word 83

DUMP ADAPTER MEMORY (0061)

The Dump Adapter Memory function allows the PP to input the entire contents of adapter RAM memory. It is executed in ROM. A maximum of 8192 16-bit adapter memory words can be input by the PP. Bit 14 of processor output port 7002 is set during the data transfer to disable the processor from interrupting on a memory parity error. The microcode sets bit 11 if the 8-bit byte read from the adapter memory contains a parity error. The PP must disconnect the channel if it does a partial input.

16 384-Word Parameter Format:

Word 1 - Location 2000 hexadecimal (right-justified)
Word 2 - Location 2001 hexadecimal (right-justified)
Word 3 - Location 2002 hexadecimal (right-justified)
Word 4 - Location 2003 hexadecimal (right-justified)
.
.
.
Word 16 383 - Location 5FFE (right-justified)
Word 16 384 - Location 5FFF (right-justified)

MANIPULATE PROCESSOR (0062)

The Manipulate Processor function allows a PP to do the following:

- Execute at any adapter memory address.
- Change an adapter memory location.
- Set the starting address for the Input Adapter memory function (0063).
- Set the starting address for the Input CM Command/Status Buffer (0067) function.

Adapter instructions executed should terminate with a return from subroutine instruction (RTS).

Parameter Format:

Word 1

Bits 3-11 Not used.

Bit 2 Execute beginning at the address specified in words 2 and 3.

Bit 1 Set Starting Address to value in words 2 and 3.

Bit 0 Store value in words 4 and 5 at program address specified by words 2 and 3.

Word 2 Leftmost 8 of 16-bit P address (right-justified).

Word 3 Rightmost 8 of 16-bit P address (right-justified).

Word 4 Leftmost 8 of 16-bit value (right-justified).

Word 5 Rightmost 8 of 16-bit value (right-justified).

INPUT ADAPTER MEMORY (0063)

The Input Adapter Memory function allows the PP to input 32 adapter memory words. The beginning address is selected with the Manipulate Processor function (0062).

Parameter Format (all words are right-justified):

Word 1 Leftmost 8 bits of adapter word 1 to be input.

Word 2 Rightmost 8 bits of adapter word 1 to be input.

.
.
.

Word 63 Leftmost 8 bits of adapter word 32 to be input.

Word 64 Rightmost 8 bits of adapter word 32 to be input.

EXECUTE ADAPTER DIAGNOSTICS (0064)

The Execute Adapter Diagnostics function causes the adapter to run its internal diagnostics. A one-word parameter determines which section the adapter runs. General status reports the result of the diagnostic. For all phase 3 diagnostics, general status of zero indicates no failure and a general status of 5XXX indicates a failure, where XXX is an error code. Phase 4 diagnostics force errors and must be run one section at a time. Refer to appendix C for more information. To stop the diagnostic from looping, a Zero Word Autoload function can be issued.

One-Word Parameter:

Bit 11 Loop On Error (phase 3 diagnostic sections only).

Bit 10 Loop Test (phase 3 diagnostic sections only).

Bit 9 Execute all phase 3 diagnostics if set. Execute section in bits 0-4 if not set.

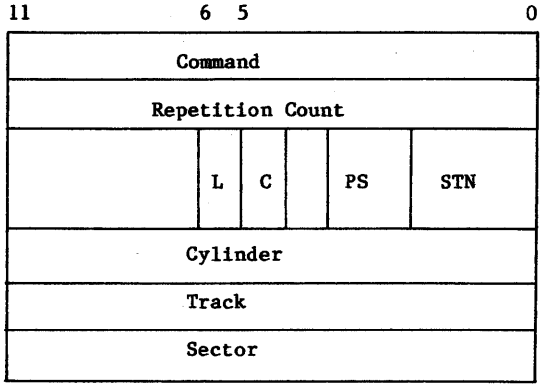
Bits 5-8 Not used.

Bits 0-4 Section number.

EXECUTE CM DIAGNOSTICS (0065)

The Execute CM Diagnostics function allows the PP to execute the Level II CM diagnostic commands and an ISI test. It must be preceded by a Connect (0000) function to reserve the CM and provide a drive number. A general status of 0000 indicates the diagnostic completed without error. A general status of 0002 indicates the CM is busy executing the diagnostic. A general status of 5000 indicates an error occurred. Detailed Status words 8 through 10 have the Level I or Level II diagnostic code, and detailed status word 17 has the ISI test error code.

Six-word Parameter Format:



Word 1

Bits 9-11 Not used.

Bit 8 Run ISI test if set.

Bits 0-7 One of the 7X hexadecimal commands to be run if bit 8 is zero. Refer to volume 2 of the CM Hardware Maintenance Manual listed in the preface for CM Level 2 Diagnostics.

Word 2 Test repetition count

Word 3

Bits 8-11 Not used.

Bit 7 Loop on error.

Bit 6 Continue after error.

Bit 5 Not used.

Bit 4 Program Source (0=disk, 1=host).

Bits 0-3 Subtest number.

DUMP CM COMMAND/STATUS BUFFER (0066)

The Dump CM Command/Status Buffer function allows the PP to input the 256 16-bit word command/status buffer residing in CM memory. It must be preceded by a Connect (0000) function to reserve the CM. The adapter transfers one 8-bit byte right-justified in each word sent to the PP. The upper (bits 8 through 15) byte of each 16-bit CM word is transferred first. The CM command/status buffer is shown in table 3-2.

RELOAD ADAPTER (0067)

This function allows the PP to load microcode into adapter memory. It is identical to the Autoload Adapter from PP (0414) function except for the following: it does not execute ROM diagnostics, it does not do a memory test, and it does not release CMs.

DUMP CM DATA BUFFER (0070)

The Dump CM Data Buffer function allows the PP to read the entire CM data buffer which consists of 16 384 bytes. It must be preceded by a Connect (0000) function to reserve the CM. The adapter transfers one 8-bit byte right-justified in each word sent to the PP. This function allows the PP to read the defect log when the Generate Defect Log (0047) function completes.

INPUT COMMAND/STATUS BUFFER (0072)

The Input CM Command/Status Buffer function allows the PP to input 32 consecutive 16-bit words of the command/status buffer residing in CM memory. It must be preceded by a Connect (0000) function to reserve the CM. The Manipulate Processor (0062) function must be used to set the starting 16-bit address. The adapter transfers one 8-bit byte right-justified in each word sent to the PP. The upper (bits 8 through 15) byte of each 16-bit CM word is transferred first. The CM command/status buffer is shown in table 3-2.

Table 3-2. CM Command/Status Buffer

16-bit CM Address	Description	16-bit CM Address	Description
00-07	Command block 0	87	Attention delay parameters
08-0F	Command block 1	88-8F	Operating mode parameters
10-17	Command block 2	90-97	Device 0 status
18-1F	Command block 3	98-9F	Device 1 status
20-27	Command block 4	A0-A7	Device 2 status
28-2F	Command block 5	A8-AF	Device 3 status
30-37	Command block 6	B0-EF	Reserved
38-3F	Command block 7	F0-F3	Device revision levels
40-7F	User storage area	F4-FD	Reserved
80-86	CM status	FE-FF	CM revision level

Command Operating System (COS)

The software program that is executed by the microprocessor in the CM. A portion of the COS program is located in ROM. A larger portion of the COS program resides in RAM and must be loaded whenever a dc power up occurs.

Control Module (CM)

The intelligent control logic that interfaces the ISD adapter through an ISI interface and communicates with Fixed Small Disks.

Firmware

The processor program that resides in ROM.

Fixed Small Disk (FSD)

A mass storage device.

Integrated Controller Interface (ICI)

A special interface connecting a PP and ISD adapter. It has no receiver/transmitter circuits, so it is usable only for short distance communication.

Intelligent Small Disk (ISD) Adapter

An adapter which provides the hardware connection between the ICI and ICI interfaces.

Intelligent Standard Interface (ISI)

The electrical and functional interface between the ISD adapter and CM.

Level II Diagnostic

Allows on-line detection and isolation of failing field replaceable units (FRUs) in the CM and disk drive.

Microcode

A processor program that executes in a device control module and performs interface and control functions previously performed by hardware logic. It is delivered to the user on prerecorded media in machine executable code form only.

The following table B-1 lists all general status values that are returned for each of the adapter functions. Some of the reasons for the status are provided.

Table B-1. General Status Values (Sheet 1 of 3)

Function	General Status	Reason
Connect (0000)	0000	No error and CM is reserved.
	0010	CM reserved to another adapter.
	5000	ICI channel parity error.
	5XXX	Adapter processor interrupt.
Seek (0001)	0000	No error and drive is on cylinder.
	0002	Either CM is busy or drive is positioning.
	0010	CM reserved to another adapter.
	5000	ICI channel parity error.
	5XXX	Adapter processor interrupt.
	5020	Drive not ready.
Read (0004) Read Protected Sector (0034) Read Data and ECC (0040)	0000	Read complete without error.
	4400	Recoverable read error.
	5000	Unrecovered read error.
	5XXX	Adapter processor interrupt.
Write (0005)	0000	Sector has been written to CM buffer without error.
	4400	Recoverable write error.
	5000	Channel parity error when transferring data (PP to adapter); buffer to disk error for previous sector written.
	5XXX	Adapter processor interrupt.
Continue (0014) after Read or Write	0000	Function complete without error.
	4400	Recoverable error.
	5000	Unrecoverable error.
	5XXX	Adapter processor interrupt.

Table B-1. General Status Values (Sheet 2 of 3)

Function	General Status	Reason
Format Pack (0016)	0000	The format operation completed without error.
	0002	CM is busy.
	5000	An error occurred during the formatting operation.
	5XXX	Adapter processor interrupt.
Write Microcode on Disk (0021)	0000	Function complete without error.
	0002	CM is busy.
	5000	An error occurred.
	5XXX	Adapter processor interrupt.
Block Transfer Buffer Write (0033)	0000	Function complete without error.
	5000	Channel parity error.
	5XXX	Adapter processor interrupt.
Write Last Sector (0035) Write Protected Sector (0037) Write Data, and ECC (0041)	0000	Write complete without error.
	4400	Recoverable write error.
	5000	Unrecoverable error; buffer to disk error for previous sector written.
	5XXX	Adapter processor interrupt.
Buffer Read (0043) Buffer Write (0044) Read CM Buffer (0045) Write CM Buffer (0046)	0000	Function complete without error.
	5000	An error occurred.
	5XXX	Adapter processor interrupt.
Generate Defect Log (0047)	0000	Function complete without error. The dump CM data buffer function can be used to read the log.
	0002	CM is busy.
	5000	Unrecoverable error.
	5XXX	Adapter processor interrupt.
Read COS (0050)	0000	Function complete without error.
Write COS (0051)	0000	CM is busy.
Read Diagnostics (0052) Write Diagnostics (0053) Read Error Log (0054)	5000	An error occurred.
	5XXX	Adapter processor interrupt.
Power-Up Spindle (0055) Power-Down Spindle (0056)	0000	Function complete without error.
	0002	The power up or power down is not complete.
	5000	An error occurred.
	5XXX	Adapter processor interrupt.
Execute Adapter Diagnostics (0064)	0000	Function complete without error.
	5XXX	An error occurred and XXX is the error code.

Table B-1. General Status Values (Sheet 3 of 3)

Function	General Status	Reason
Execute CM Diagnostics (0065)	0000	Function complete without error.
	0002	CM is busy.
	5000	An error occurred.
	5XXX	Adapter processor interrupt.
Dump CM Command/Status Buffer (0066) Input CM Command Status Buffer (0072) Dump CM Data Buffer (0070)	0000	Function complete without error.
	5000	An error occurred.
	5XXX	Adapter processor interrupt.
Autoload CM from PP (0071)	0000	Function complete, no error.
	0002	CM is busy.
	5000	An error occurred due to issuing the selective reset.
	5XXX	Adapter processor interrupt.
Autoload from PP (0414) Reload Adapter (0067)	0000	Autoload complete without error.
	5XXX	An error occurred and XXX is the error code.

Execution of the adapter diagnostics proceeds in four phases. Phase 1 is initiated by a channel master clear, a 0414 Autoload, or a 01UD Autoload. Phase 2 immediately follows phase 1 if Autoload from Disk (01UD). If Autoload from PP (0414), phase 2 is run when the channel goes full after two 16-bit words have been stored in adapter memory. Phase 3 starts when the last word of the microcode is read. Any portion of phase 3 or 4 can be initiated by the PP anytime after microcode is loaded using the Execute Adapter Diagnostics function (0064). Phase 2 can be initiated only during an Autoload from PP (0414) or an Autoload Microcode/COS from Disk (01UD). Phase 4 can be initiated only by the PP anytime after microcode is loaded.

For a phase 1 error the processor halts. If initiated by an Autoload function, the function is not replied to. Any phase 2, 3, or 4 error is reported in general status. General status is 5XXX, where XXX is the error code.

Section	Phase	Test
1	1	Processor Instruction Test.
2	1	ROM Checksum.
3	2	RAM Test.
4	2	Correct Microcode Test.
5	3	RAM Checksum.
7	3	Buffer Memory Test.
8	3	I/O Port Test.
9	3	RAM Parity Test.
A	3	Buffer Parity Test.
B	3	Maintenance Loop Test (12/16-bit converter).
C	3	ISI Test.
D	3	Processor to Buffer (via ISI and 12/16-converter).
E	3	Buffer to Processor (via ISI and 12/16-converter).
F	3	Extended Buffer Test.
10	3	ISI Parity Test.
11	4	Force Bus Error, Illegal I/O on ICI.
12	4	Force Bus Error, the processor detected a memory parity error.
13	4	Force Address Error.
14	4	ISI Deadman Timer Test.
15	4	Force Execution of an illegal instruction.
16	4	Force correctable adapter memory parity error in read routine.
17	4	Force correctable adapter memory parity error in write routine before the general status word is sent.
18	4	Force correctable adapter memory parity error in write routine after the general status word is sent.
19	4	Force uncorrectable adapter memory parity error in read routine.
1A	4	Simulate a memory parity error in the CM.
1B	4	Force an ISI parity error on a write to disk.
1C	4	Force an ICI parity error on a read from disk.

The following are section descriptions.

Section 1 Processor Instruction Test

This section tests the registers and instructions of the 68000 microprocessor.

Section 2 ROM Checksum

This section checksums the words in ROM and compares the result to the last long word in ROM.

Section 3 RAM Test

This section writes patterns into the entire RAM program memory. It then reads the memory and compares the patterns to the expected result. The patterns used are FFFFFFFF. FEFDFBF7, 00000000, and pattern-address in word mode. Hexadecimal error codes returned are 27, 28.

Section 4 Correct Microcode Test

This section tests the third word of the loaded microcode for a value of 3101 hexadecimal. If incorrect, an error code of 30 hexadecimal is returned.

Section 5 Checksum RAM

This section checksums the words in RAM memory and compares the memory to an expected value. An error code of 31 hexadecimal is returned if a checksum error occurs.

Section 6 Not used

Section 7 Buffer Memory Text

This section writes patterns with the processor into buffer memory. It then reads buffer memory with the processor and compares the memory to the expected result. The patterns written into the buffer are FFFF, AAAA, 5555, pattern-address, and 0000. Hexadecimal error codes returned are 60, 61.

Section 8 I/O Port Test

This section tests I/O ports 7000 through 700B. The bit patterns used are odds, evens, ones, and zeros for both byte and word operations. Hexadecimal error codes returned are 62, 63.

Section 9 RAM Parity Test

This section forces both upper and lower byte parity errors in RAM using various data patterns. Parity error stop disable is set during this test so the processor does not interrupt. Hexadecimal error codes returned are 64 through 6F.

Section A Buffer Parity Test

This section forces parity errors in buffer memory using various patterns. Parity error stop disable is set during this test so the processor does not interrupt. Hexadecimal error codes returned are 70 through 7B.

Section B Maintenance Loop Test

This section loops eight data words from buffer memory, through the 12/16 bit converter, back to buffer memory. The pattern used from the buffer is FFFF, AAAA, 5555, 0000, 0000, 5555, AAAA, and FFFF. This pattern is used for 16 to 16, 12 to 16, 16 to 12, and 12 to 12 bit conversions. Hexadecimal error codes returned are 82 through 85.

This section also forces a buffer parity error. Hexadecimal error code 8F is returned if the buffer parity error status bit does not set.

Section C ISI Test

This section loops data from the processor, through the ISI data bus, back to the processor. The patterns used are zeros, ones, odds, and evens. Hexadecimal error codes returned are 80, 81.

Section D Processor to Buffer Test

This test sends eight data words from the processor, through the ISI, through the 12/16 bit converter, into buffer memory. The same patterns are used in section B. Hexadecimal error codes returned are 86 through 8A.

Section E Buffer to Processor Test

This section sends eight data words from the buffer, through the 12/16 bit converter, through the ISI, to the processor. The same patterns are used in section B. Hexadecimal error codes returned are 8B through 90.

Section F Extended Buffer Test

This test sends data from the processor, through the ISI, through the 12/16 bit converter, into buffer memory. The entire buffer memory is written in 16-bit mode with pattern equal address. The processor then verifies that the data was written correctly. Using buffer control logic, data is then transferred from the buffer, through the 12/16 bit converter, through the ISI, to the processor for verification. Converter data is 16 bits in and 16 bits out. Hexadecimal error codes returned are 96, 97.

Section 10 ISI Parity

This section sends data with bad parity from the processor to the ISI data bus, and then verifies the parity errors status bit sets. This section also tests the capability to disable ISI parity error detection. Hexadecimal error codes returned are 91, 92.

Section 11 Illegal I/O on ICI

This section tests the ability of the hardware to interrupt when an input on an inactive ICI is attempted. General status of 5012 indicates the test was successful. To guarantee the ICI is inactive the PP must delay at least 50 ms before issuing the general status function.

Section 12 Memory Parity Error

This section tests the ability of the hardware to interrupt when a memory parity error occurs. General status of 5013 indicates the test was successful. A reload of microcode is not required after this memory parity error.

Section 13 Address Error

This section tests the ability of the hardware to interrupt when reading a word beginning at an odd byte address. General status is 5001 if the test is successful.

Section 14 ISI Deadman Timer

This section outputs one word to the ISI when command sequence is not set. The processor is hung in the output until the ISI timer expires. General status of zero indicates the timer works and the ISI timer status bit is set.

Section 15 Illegal Instruction

This section tests the ability of the hardware to interrupt when executing an illegal instruction. General status is 5003 if the test is successful.

Section 16 Force MPE in Read Routine

This section writes a correctable memory parity error into a location in the read routine. It allows the higher level processor to verify its recovery algorithm.

Section 17 Force MPE in Write Routine

This section writes a correctable memory parity error into a location in the write routine before the general status word is sent. It allows the higher level processor to verify its recovery algorithm.

Section 18 Force MPE in Write Routine

This section writes a correctable memory parity error into a location in the write routine after the general status word is sent. It allows the higher level processor to verify its recovery algorithm.

Section 19 Force MPE in Read

This section writes an uncorrectable memory parity error into a location in the read routine. It allows the higher level processor to verify its recovery algorithm.

Section 1A Force MPE in CM

This section simulates forcing a memory parity error in CM memory. After executing this section, the first time a sector is read from disk, general status is 5017, indicating that a memory parity error occurred in the CM. This error occurs only once.

Section 1B Force ISI Parity Error

After executing this section, a word in the data field of the second sector being written to disk at 1:1 interlace is transferred across the ISI interface with a parity error. This error occurs only once.

Section 1C Force ICI Parity Error

After executing this section, the first word of the first sector read from disk is transferred to the PP with incorrect parity.

Error Code (hexa-decimal)	Test Description and Processor Status
00	This is not an error code. See detailed status for a description of the error.
01	The processor interrupted due to an address error.
02	The processor interrupted due to an uncorrectable RAM parity error.
03	The processor interrupted due to executing an illegal instruction.
04	The processor interrupted due to zero divide.
05	The processor interrupted due to executing a TRAPV instruction when overflow is set.
06	The processor interrupted due to executing a TRAP instruction.
07	The processor interrupted due to instruction trace mode.
08	The processor interrupted due to executing a CHK instruction.
09	The processor interrupted due to a privilege violation.
0A	The processor interrupted because an ICI transfer was attempted on an inactive channel.
0B	The processor interrupted due to a correctable RAM parity error.
0C	The processor interrupted due to a ROM parity error.
0E	A function sent across the ICI has a parity error or is not defined in this appendix.
0F	Status received from the CM indicates COS must be loaded.
10	The drive is present, not ready, and no fault condition exists. This is returned only after a seek command.

Error Code (hexa-decimal)	Test Description and Processor Status
27	Write pattern-address into RAM in word mode. The value read from RAM did not compare. A2 - Failing address D3 - Expected value D6 - Error code
28	Write data pattern into RAM. The value read from RAM did not compare. A2 - Failing address D1 - Actual value D3 - Expected value D6 - Error code
29	Could not select the CM during autoload from disk.
2A	An ISI parity error occurred during autoload from disk.
2B	An ISI timeout occurred during autoload from disk.
2D	Select active from the CM dropped during autoload from disk.
30	The third word of microcode did not compare with 3101 hexadecimal.
31	RAM checksum error. D0 - Expected checksum D1 - Actual checksum D6 - Error code
60	Write pattern-address into buffer memory. The value read from the buffer does not compare with the pattern. A2 - Failing buffer address D0 - Expected memory value D1 - Actual memory value D6 - Error code
61	Write pattern into buffer memory. The value read from the buffer does not compare with the pattern. The patterns used are: FFFF, 0000, 5555, and AAAA. A2 - Failing buffer address D0 - Expected memory value D1 - Actual memory value D6 - Error code
62	Port not clear after reset. A0 - Failing port address D0 - Expected value D1 - Actual value D6 - Error code
63	Output word on port. The word input from the same port did not compare with the expected value. A0 - Failing port address D0 - Expected value D1 - Actual value D2 - Pattern output D6 - Error code
64-6F	Output word in RAM forcing even parity. The word or byte input did not give correct parity status.

Output Parity

Input Mode		UB=Even LB=Even	UB=Even LB=Odd	UB=Odd LB=Even	UB=Odd LB=Odd
	Word	64	67	6A	6D
	Lower Byte	65	68	6B	6E
	Upper Byte	66	69	6C	6F

A3 - Memory location at parity error
D0 - Pattern written into memory
D1 - Data read back from memory
D2 - Parity error occurred: FF=YES, 00=NO
D3 - Parity error expected: FF=YES, 00=NO
D6 - Error code

Error Code (hexa-decimal)	Test Description and Processor Status
70-7B	Output word in buffer forcing even parity. The word or byte input did not give correct parity status.

Output Parity

Input Mode		UB=Even LB=Even	UB=Even LB=Odd	UB=Odd LB=Even	UB=Odd LB=Odd
	Word	70	73	76	79
	Lower Byte	71	74	77	7A
	Upper Byte	72	75	78	7B

A3 - Memory location at parity error
D0 - Pattern written into memory
D1 - Data read back from memory
D2 - Parity error occurred: FF=YES, 00=NO
D3 - Parity error expected: FF=YES, 00=NO
D6 - Error code

Error Code (hexa-decimal)	Test Description and Processor Status
80	Processor loops data on ISI and data does not compare. A0 - Pattern address A1 - ISI port address D0 - Word output D1 - Word input D6 - Error code
81	Processor loops data on ISI. The data compares but a parity error occurred. See error code 80 for register definitions.

Error Code (hexa-decimal)	Test Description and Processor Status
82-85	Transfer eight words from the buffer, to the 12/16 converter, and back to the buffer.
82	Transfer in progress not clear. D0 - Transfer address D2 - Converter mode: 0=12/12, 1=12/16, 2=16/12, 3=16/16 D6 - Error code
83	Buffer parity error occurred during the data transfer. D2 - Converter mode: 0=12/12, 1=12/16, 2=16/12, 3=16/16 D6 - Error code
84	Data miscompare when comparing the buffer data from the transfer to the expected data. A0 - Failing address A1 - Expected address D0 - Expected word D1 - Actual word D2 - Transfer mode: 0=12/12, 1=12/16, 2=16/12, 3=16/16 D6 - Error code
85	Even parity written into buffer during transfer. See error code 84 for register definitions.
86	Data was looped from the processor, through the ISI, through the converter, into buffer memory. The transfer did not complete. See error code 82 for register values.
87	Data was looped from the processor, through the ISI and converter, into buffer memory. Bit 13 of port 1 is set indicating a buffer parity error occurred. See error code 83 for register values.
88	Data was looped from the processor, through the ISI and converter, into buffer memory. The data that was looped miscompared. See error code 84 for register values.
89	Data was looped from the processor, through the ISI and converter, into buffer memory. Bit 12 of port 1 is set indicating a memory parity error occurred. See error code 84 for register values.
8A	Data was looped from the processor, through the ISI and converter, into buffer memory. Bit 3 of port 1 is set indicating an ISI parity error occurred. See error code 83 for register values.
8B	Data was looped from the buffer, through the converter and the ISI, to the processor. The transfer did not complete. See error code 82 for register values.
8C	Data was looped from the buffer, through the converter and the ISI, to the processor. Bit 13 of port 1 is set, indicating a buffer parity error occurred. See error code 83 for register values.
8D	Data was looped from the buffer, through the converter and the ISI, to the processor. The data that was looped miscompared. See error code 84 for register values.
8E	Data was looped from the buffer, through the converter and the ISI, to the processor. Bit 12 of port 1 is set, indicating a memory parity error occurred. See error code 84 for register values.
8F	A buffer memory parity error was forced, but bit 13 of port 1, indicating buffer parity error, did not set when the word was read. D3 - Force upper parity error if 0, if 1, force lower parity error D6 - Error code
90	Data was looped from the buffer, through the converter and the ISI, to the processor. Bit 3 of port 1 is set, indicating an ISI parity error occurred. See error code 83 for register values.
91	An ISI parity error was forced, but bit 3 of port 1, indicating ISI parity error, did not set. D0 - Pattern output D5 - Upper byte of port 1 D6 - Error code
92	An ISI parity error was forced with disable ISI parity set, but bit 3 of port 1, indicating ISI parity, still set. D6 - Error code
93	The processor did not interrupt when a memory parity error occurred.
94	The processor did not interrupt when it did an input on the ICI when it was inactive.
95	The processor did not interrupt when an odd address was read in word mode.

Error Code (hexa-decimal)	Test Description and Processor Status
96	Data was looped from the processor, through the ISI and converter, into buffer memory. The data looped did not compare. D0 - Expected value D1 - Actual value D6 - Error code
97	Data was looped from the buffer, through the converter and ISI, to the processor. The data looped did not compare. D0 - Expected value D1 - Actual value D6 - Error code
98	An ISI time out was forced but bit 0 of port 1, indicating ISI time out, did not set.
99	The processor did not interrupt when it executed an illegal instruction.

To obtain more information than is provided by detailed status for subsystem problems, the adapter microcode and CM command/status buffer can be checked using the 0061 and 0066 instructions. The 0061 function can be used to dump the adapter and the 0066 function can be used to dump the CM command/status buffer. The first word of the dumped adapter corresponds to memory address 2000 hexadecimal. The following is a list of some of the key locations.

Byte Address (hexadecimal)	Description
2004	Has a value of 3101 hexadecimal, which is checked during autoload to verify adapter microcode is being loaded.
2006-2009	Expected memory checkusm.
200A-200D	Actual memory checksum.
201A	Has a value in the range of 0 to 1E hexadecimal that can be added to 201C hexadecimal to give the location of the next function to be stored in the 16-word table.
201C-203B	16-word function history table.
203E-2041	Address of last memory parity error.
5D36	Address of last four seek parameter words received.

The first word of the dumped CM command/status buffer corresponds to address zero. The following is a list of some of the key locations.

Word Address (hexadecimal)	Description
7	Last command issued to drive 0.
F	Last command issued to drive 1.
17	Last command issued to drive 2.
1F	Last command issued to drive 3.
80	CM status for the last completed command.

Table E-1 lists function reply times, data/parameter window times, and total execution times for each function. The function reply time is the typical time between function issue by the PP and function reply by the adapter. Function reply times assume that the preceding function has completed, and that the adapter is waiting for another function.

The minimum data/parameter window time is the shortest amount of time between function reply and data/parameter transfer. When the PP has not started data/parameter transfer by the maximum window time, the adapter prepares error status and waits for the next function.

Total execution time begins when the adapter detects the function and ends when the adapter starts waiting for the next function. The maximum execution time is usually a result of an error condition. For example,the maximum execution time for a Seek function corresponds to the maximum time of the ICI deadman time out.

Refer to the ISD Hardware Maintenance Manual listed in the preface for timing diagrams of the read and write sequences.

Table E-1. Function Code Timing Data

Octal Function Code	Function Reply Time	Data/Parameter Window Time	Total Execution	Notes
0000	60 µs	15 µs/5-16 s	170 µs/5-16 s	1
0001	50 µs	25 µs/5-16 s	225 µs/5-16 s	
0004	40 µs	25 µs/100 ms	3 ms/400 ms	
0005	40 µs	25 µs/100 ms	6 ms/400 ms	
0010	140 µs	Not applicable	140 µs/400 ms	
0012	40 µs	20 µs/5-16 s	80 µs/5-16 s	
0014	45 µs	25 µs/100 ms	3 ms/400 ms	
0016	40 µs	25 /5-16 s	6 ms/5-16 s	
0020	50 µs	Not applicable	75 µs/400 ms	
0021	40 µs	6 ms/5-16 s	25 ms/5-16 s	
0023	40 µs	40 µs/5-16 s	490 µs/5-16 s	
0032	50 µs	25 µs/5-16 s	1000 µs/5-16 s	
0033	50 µs	25 µs/5-16 s	1200 µs/5-16 s	
0034	40 µs	25 µs/100 ms	3 ms/400 ms	
0035	40 µs	25 µs/100 ms	6 ms/400 ms	
0037	40 µs	25 µs/100 ms	6 ms/400 ms	
0040	40 µs	6 ms/7 ms	8 ms/400 ms	
0041	40 µs	6 ms/7 ms	8 ms/400 ms	
0043	50 µs	10 µs/30 ms	280 µs/400 ms	
0044	50 µs	10 µs/30 ms	280 µs/400 ms	
0045	40 µs	2 ms/100 ms	4 ms/400 ms	
0046	40 µs	2 ms/100 ms	4 ms/400 ms	
0047	40 µs	Not applicable	100 µs/400 ms	
0050	40 µs	3 s/5-16 s	3500 ms/5-16 s	
0051	40 µs	6 ms/5-16 s	1500 ms/5-16 s	
0052	40 µs	3 s/5-16 s	3500 ms/5-16 s	
0053	40 µs	6 ms/5-16 s	1500 ms/5-16 s	
0054	40 µs	6 ms/5-16 s	8 ms/5-16 s	
0055	65 µs	15 µs/5-16 s	225 µs/5-16 s	1
0056	65 µs	15 µs/5-16 s	225 µs/5-16 s	1
0060	40 µs	20 µs/5-16 s	420 µs/5-16 s	
0061	50 µs	30 µs/5-16 s	150 ms/5-16 s	
0062	40 µs	20 µs/5-16 s	110 µs/5-16 s	
0063	40 µs	20 µs/5-16 s	360 µs/5-16 s	
0064	60 µs	20 µs/5-16 s	110 ms/5-16 s	2
0065	40 µs	20 µs/5-16 s	3 ms/5-16 s	
0066	40 µs	135 µs/3-6 s	12 ms/3-6 s	
0067	50 µs	6 ms/5-16 s	250 ms/5-16 s	
0070	40 µs	2 ms/5-16 s	225 ms/5-16 s	
0071	40 µs	3.5 s /5-16 s	36 s/60 s	3
0072	50 µs	125 µs/5-16 s	550 µs/5-16 s	
0414	550 µs	15 µs/5-16 s	830 ms/5-16 s	
01UD	50 s	Not applicable	50 s /80 s	4
03UD	15 s	20 µs/5-16 s	15 s /45 s	5
05UD	75 ms	20 µs/5-16 s	75 ms/45 s	5

Notes:

1. This time occurs when the CM is busy. Add 125 ms the first time when the command is put into execution.
2. This time occurs when executing all phase 3 sections.
3. This time occurs when four drives cabled to the CM are ready.
4. This time occurs when the drive must be spun up and no drives cabled to the CM are ready.
5. The longer time occurs when the drive is not ready (spun up). If an error occurs, the microcode retries until the channel is disconnected.

COMMENT SHEET

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