Elite Disc Drive

ST41201K

Reference Manual

(IPI Interface)

Seagate

Elite Disc Drive

ST41201K (97509-12G)

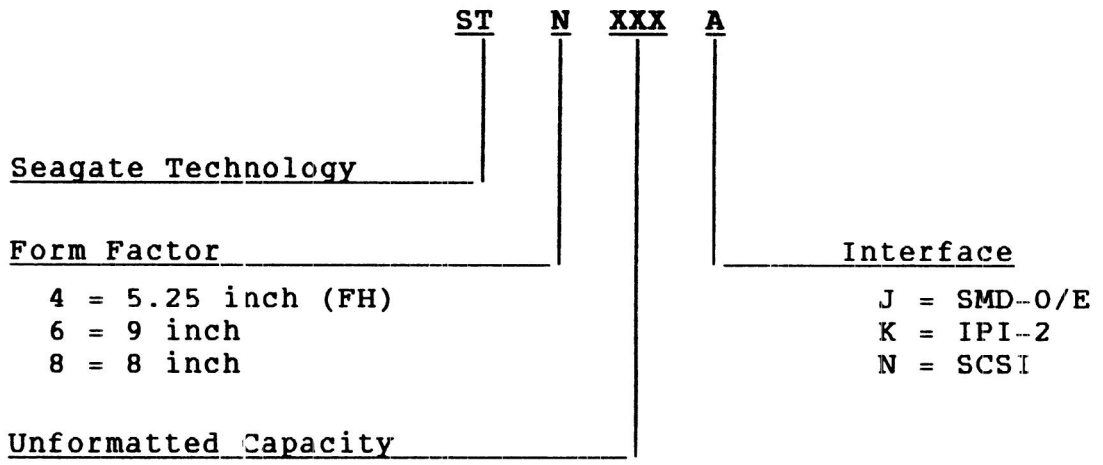
Reference Manual
(IPI Interface)

General Maintenance Information
Planning the System
Interface Functions

Publication Number: 83327330-A

Seagate

Seagate Disc Drive Product Numbers



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We value your comments. A Comment Sheet is provided at the back of this manual.

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PREFACE

This manual is a reference book for users of the Seagate ST41201K Elite disc drives (employing the IPI interface). It supplements the information presented in the user's manual. It is intended to aid engineers who are designing subsystems using the drive and customer engineers who install and check out the drive. This manual should be used in conjunction with the user's manual.

The information in this manual is presented as follows:

Section 1 - General Maintenance Information. Contains information on warnings and precautions, maintenance tools and materials, testing the drive, and maintenance procedures.

Section 2 - Planning the System. Provides guidelines for enclosure design and for proper airflow, and discusses the various sweep cycle options.

Section 3 - Interface Functions. Describes the IPI interface: the signal lines, interface signal processing, unit selection, and spindle synchronization.

New features, technical changes, additions, and deletions in this manual are indicated as follows:

- A vertical bar in the outer margin of a page marks the changed area.
- A dot by the page number indicates the entire page contains new or changed information.
- A vertical bar by the page number indicates the information was moved from another page, but there were no technical or editorial changes.

The following manuals apply to the Elite disc drive. They are available from:

Seagate Technology, Inc.
Customer Services
12701 Whitewater Drive
Minnetonka, MN 55343

Phone: (612) 931-8612
Fax: (612) 931-8817

Publication No.	Title
83327320	ST41201K User's Manual (contains general description, installation procedures, operating instructions, parts data, and maintenance information)
83327330	ST41201K Reference Manual

For more information about the drive and interface described in this manual, you can request copies of the following specifications from your Seagate sales representative:

Specification No.	Title
64403300	Specification for Synchronized Spindle Systems
64403102	Product Specification for the ST41201K Elite Disc Drive
64731600	Seagate Specification for the IPI-2 Intelligent Peripheral Interface
ISO 9318-2	Device Specific Command Set for Magnetic Disc Drives (IPI-2)
ISO 9318-6	Enhanced Physical Level (IPI)

IMPORTANT SAFETY INFORMATION AND PRECAUTIONS

Use of proper safety and repair techniques is important for safe, reliable operation of this unit. Service should be done only by qualified persons. We recommend the procedures in this manual as effective ways of servicing the unit. Some procedures require the use of special tools. For proper maintenance and safety, you must use these tools as recommended.

The procedures in this manual and labels on the unit contain warnings and cautions that must be carefully read and followed to minimize or eliminate the risk of personal injury. The warnings point out conditions or practices that may endanger you or others. The cautions point out conditions or practices that may damage the unit, possibly making it unsafe for use.

You must also understand that these warnings and cautions are not exhaustive. We cannot possibly know, evaluate, and advise you of all the ways in which maintenance might be performed or the possible risk of each technique. Consequently, we have not completed any such broad evaluation. If you use a non-approved procedure or tool, first ensure that the method you choose will not risk either your safety or unit performance.

For the safety of yourself and others, observe the following warnings and precautions.

- Perform all maintenance by following the procedures in this manual.
- Follow all cautions and warnings in the procedures and on unit labels.
- Use sound safety practices when operating or repairing the unit.
- Use caution when troubleshooting a unit that has voltages present. Remove power from unit before servicing it.
- Wear safety shoes when removing or replacing heavy parts.
- In case of fire or other emergency, a means must be provided to isolate the drive from main power.
- When the drive is mounted in an equipment rack or cabinet, ensure that the internal temperature of the rack or cabinet will not exceed the limits defined for the drive. Where units are stacked vertically, pay special attention to the top where temperatures are usually highest.

- Follow the precautions listed under Electrostatic Discharge Protection in section 1 of this manual.

- Do not remove any circuit boards from the drive chassis. Return the entire drive for depot repair if any circuit board is defective. Removal of circuit boards by personnel not performing depot repair will damage components and may void the warranty.

- Do not remove the module from the drive chassis. Return the entire drive for depot repair if the module is defective.

- Do not attempt to disassemble the module. It is not field repairable. If the sealed module is opened by personnel not performing depot repair, this will damage components and void the warranty.

- As a component, this drive is designed to be installed and operated in accordance with UL1950, IEC380, IEC950, EN60950, CSA C22.2 154, CSA C22.2 220, and VDE0806. Refer to the user's manual for further information about installation.

- Always deenergize drive before removing or installing cables.

- If you do not use a recommended Seagate power supply, ensure the supply meets the specifications in this manual and is designed to be used in accordance with UL1950, IEC380, IEC950, EN60950, CSA C22.2 154, CSA C22.2 220, and VDE0806.

Use forced-air ventilation when bench-testing the drive to ensure proper cooling of drive components.

Section 1
General Maintenance Information

GENERAL MAINTENANCE INFORMATION 1

INTRODUCTION

This section contains general information relating to maintenance of the drive. You should be familiar with the information in this section and with drive operation before attempting any maintenance procedures. Information is divided into the following areas:

- Electrostatic Discharge Protection -- Provides instructions for the proper handling of electrostatically sensitive devices.
- Maintenance Tools and Materials -- Lists the tools and materials required to perform maintenance on the drive.
- Testing the Drive -- Provides information concerning the electrical testing of the drive, including a procedure for checking dc voltages supplied to the drive.
- Identifying Assemblies in the Drive -- Identifies the various parts of the drive.
- Maintenance Procedures -- Describes how to maintain the drive.

ELECTROSTATIC DISCHARGE PROTECTION

All drive electronic assemblies are sensitive to static electricity, due to the electrostatically sensitive devices used within the drive circuitry. Although some of these devices such as metal-oxide semiconductors are extremely sensitive, all semiconductors as well as some resistors and capacitors may be damaged or degraded by exposure to static electricity.

Electrostatic damage to electronic devices may be caused by a direct discharge of a charged conductor, or by exposure to the static fields surrounding charged objects. To avoid damage to drive electronic assemblies, service personnel must observe the following precautions when servicing the drive:

- Ground yourself to the drive whenever the drive electronics are or will be exposed. Connect yourself to ground with a wrist strap (refer to table 1-1 for part

numbers). Connection may be made to any grounded metal assembly. As a general rule, remember that you and the drive electronics must all be at ground potential to avoid potentially damaging static discharges.

- Turn off power before removing or installing the dc power cable.
- Do not remove any circuit boards from the drive.
- Never use an ohmmeter on any circuit boards.

> Removal of circuit boards by personnel not performing depot repair will damage components and may void the warranty.

MAINTENANCE TOOLS AND MATERIALS

The maintenance procedures described in this manual require the use of certain special tools, test equipment, and materials. These are listed in table 1-1 along with the appropriate Seagate part number. Note that the list includes only special tools. We assume that you have normal maintenance tools.

TABLE 1-1. MAINTENANCE TOOLS AND MATERIALS

Description	Seagate Part Number
Static Ground Wrist Straps 6 1/2 to 8 inch wrist up to 6 1/2 inch wrist	 12263496 12263623
Volt/ohmmeter	Ballantine 345 or equivalent digital voltmeter

TESTING THE DRIVE

During testing and troubleshooting, the drive is normally required to perform various operations such as reading and writing test data. System software can be used to control the drive during these operations.

Following the discussion of testing methods, there is a procedure for checking dc voltages supplied to the drive.

DRIVE DIAGNOSTICS

The drive has built-in diagnostic tests. These diagnostic tests may be performed via the interface as described in section 3 of this manual.

SYSTEM SOFTWARE

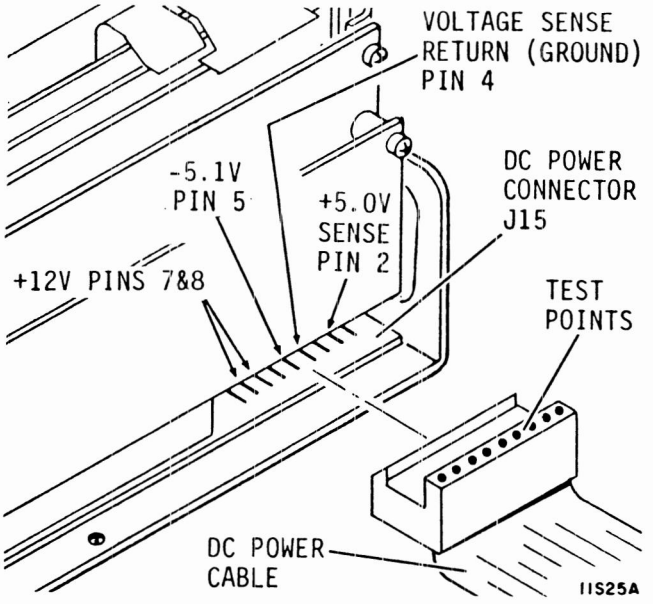
The drive may also be tested by use of system diagnostic test programs. This requires use of the controller and the appropriate software. In this type of testing, the drive communicates with the controller as in normal online operations, and special I/O connections are unnecessary.

Refer to manuals or other documentation applicable to the specific system or subsystem for information concerning the system software routines.

VOLTAGE CHECKS

The following procedure provides an overall check of the dc voltages used by the drive. Prior to performing this procedure, you should be familiar with the other information in this section and the safety information in the front of this manual.

The illustration to the right shows where the individual voltages appear on the drive's dc power connector (J15). Attach your test probe to test points located on the top surface of the dc cable connector.



1. Using system software, command continuous read/write operations with the drive on cylinder.

2. Connect the voltmeter ground lead to J15 - Pin 4 (Voltage Sense Return [Ground]).

3. Measure at the appropriate connection point to check the following voltages:

Voltage	Connection	Specification
+5.0 volt sense	J15 - Pin 1	+4.85 to +5.25 volts
-5.1 volts*	J15 - Pin 5	Not Applicable
+12 volts	J15 - Pins 7 & 8	+11.4 to +12.6 volts

*The IPI Elite has no requirement for -5.1 volts.

IDENTIFYING ASSEMBLIES IN THE DRIVE

The major drive assemblies and components are shown on figure 1-1. Figure 1-2 shows the power supply that is available if desired by the customer for installation.

As shown on figure 1-1, the drive components are supported by a chassis. The module is shock-mounted on one end of the chassis and the circuit boards plug into a mother board attached to the other end of the chassis.

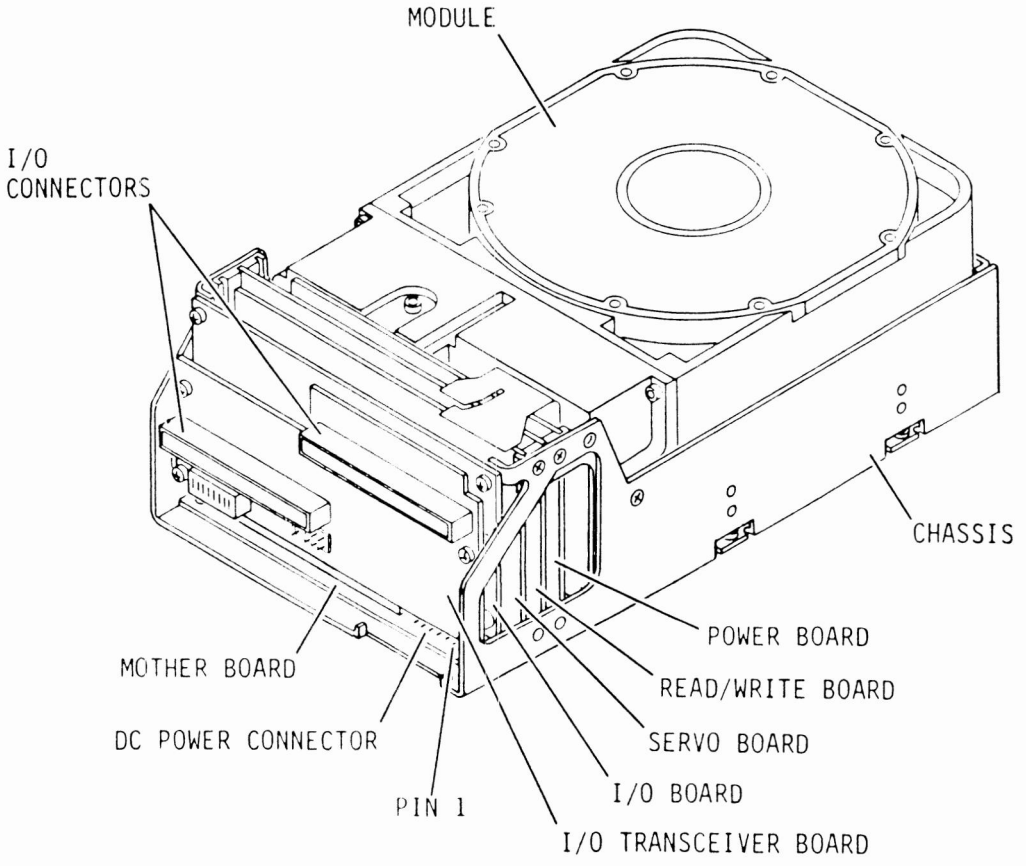


Figure 1-1. Drive Components

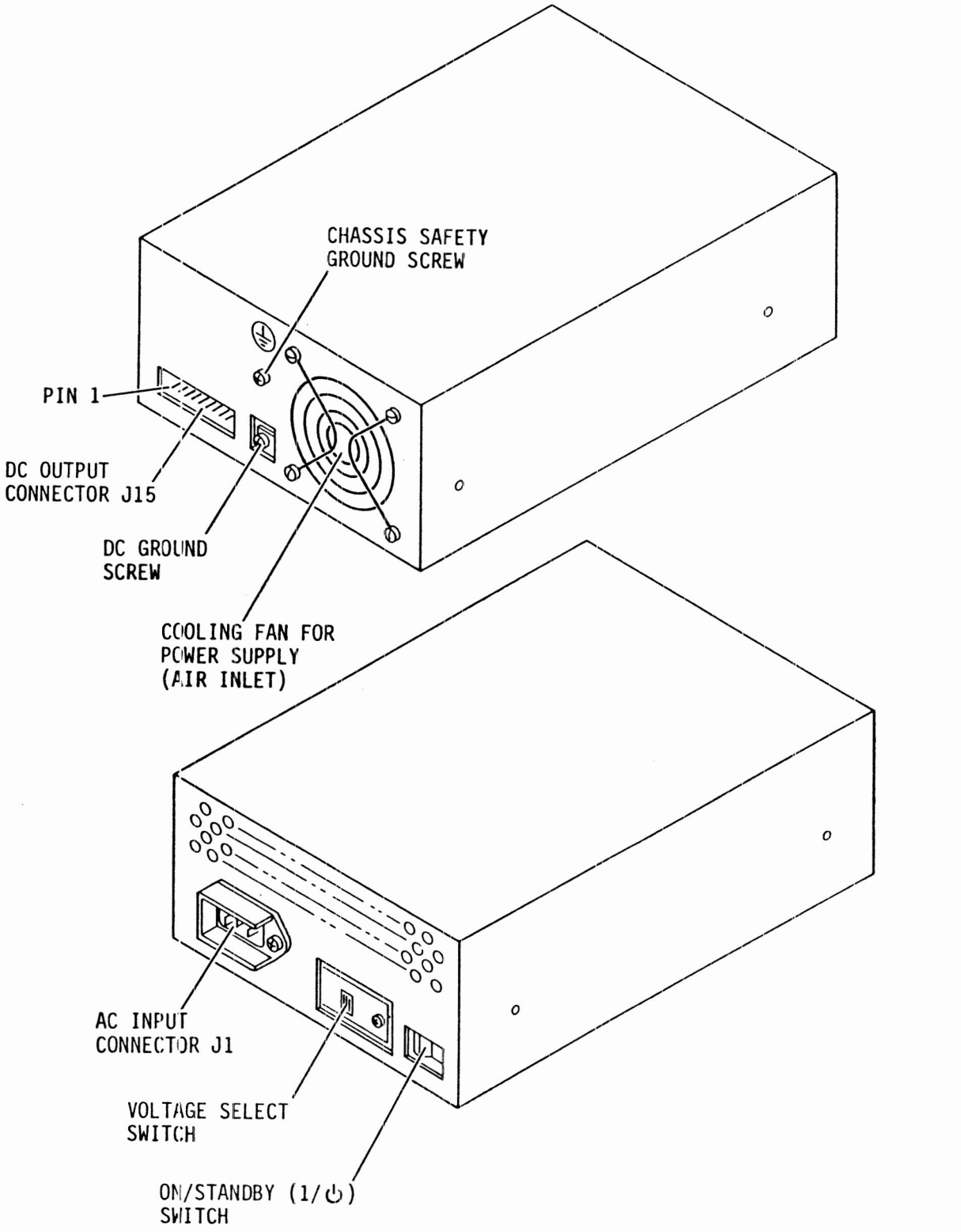


Figure 1-2. The Power Supply

MAINTENANCE PROCEDURES

This section contains the following maintenance information:

- Observing Maintenance Precautions
- Arranging for Depot Repair
- Removing and Replacing a Drive
- Removing and Replacing a Power Supply
- Packing a Drive for Shipment

OBSERVING MAINTENANCE PRECAUTIONS

Because the drive is depot-repairable, there are no field-replaceable parts. Before beginning any maintenance activities, observe the following precautions:

- Follow the precautions listed under Electrostatic Discharge Protection in the beginning of this section.
- Do not remove any circuit boards from the drive chassis. Return the entire drive for depot repair if any circuit board is defective. Removal of circuit boards by personnel not performing depot repair will damage components and may void the warranty.
- Do not remove the module from the drive chassis. Return the entire drive for depot repair if the module is defective.
- Do not attempt to disassemble the module. It is not field repairable. If the sealed module is opened by personnel not performing depot repair, this will damage components and void the warranty.
- Use forced-air ventilation when bench-testing the drive to ensure proper cooling of drive components.
- Do not connect or disconnect I/O cables while power is applied to the drive or controller.
- Do not connect or disconnect the dc power cable while the power supply is energized.

ARRANGING FOR DEPOT REPAIR

Before returning any units to Seagate, it is necessary to obtain a Returned Material Authorization (RMA) number. To get the number, you will need to know the part number and serial number of the unit. These numbers appear on a label located on the front surface of the module. Then contact:

Seagate Technology, Inc.
Customer Services
12701 Whitewater Drive
Minnetonka, MN 55343

Phone: 1-800-382-6060
Fax: (612) 931-8817

REMOVING AND REPLACING A DRIVE

CAUTION

When servicing the drive, observe all precautions listed under Electrostatic Discharge Protection in the beginning of this section. Failure to observe these precautions can result in serious damage to electronic assemblies.

To remove a drive for maintenance, perform the following steps:

1. Remove power from drive by setting On/Standby switch on power supply to Standby position.
2. Disconnect ac power cable from site power.
3. Rotate ejectors on I/O cable connectors to the unlatched position to loosen cable connections. Disconnect I/O cables from drive.
4. Disconnect spindle sync cables (if used) from drive.
5. Disconnect dc power cable from dc power connector on drive.
6. Remove mounting screws that secure drive chassis to cabinet.
7. Carefully lift drive from its mounting, and move it to desired location.

To install a replacement drive, follow the procedures in section 2 of the user's manual.

REMOVING AND REPLACING A POWER SUPPLY

To remove a power supply for maintenance, perform the following steps:

1. Remove power from drive by setting On/Standby switch on power supply to Standby position.

2. Disconnect ac power cable from site power.

3. Disconnect dc power cable from dc power connector on power supply.

4. Remove chassis safety ground screw from power supply to disconnect ground strap.

5. Remove mounting screws that secure power supply to cabinet.

6. Carefully lift power supply from its mounting, and move it to desired location.

To install a replacement power supply, follow the procedures in section 2 of the user's manual.

PACKING A DRIVE FOR SHIPMENT

If it is necessary to ship the drive, repackage the drive with the original packaging materials (saved during installation). Comply with the manufacturer's packaging instructions to ensure that the drive will be undamaged in shipment. To obtain packaging instructions or a new shipping container, contact:

Seagate Technology, Inc.
Customer Services
12701 Whitewater Drive
Minnetonka, MN 55343

Phone: 1-800-382-6060
Fax: (612) 931-8817

When ordering packaging instructions or a new shipping container, specify the exact equipment number and series code of the drive as shown on the equipment identification label.

Section 2
Planning the System

PLANNING THE SYSTEM 2

INTRODUCTION

This section is provided to supplement the installation instructions presented in the user's manual. To aid in configuring the drive for specific system requirements, the following subjects are discussed:

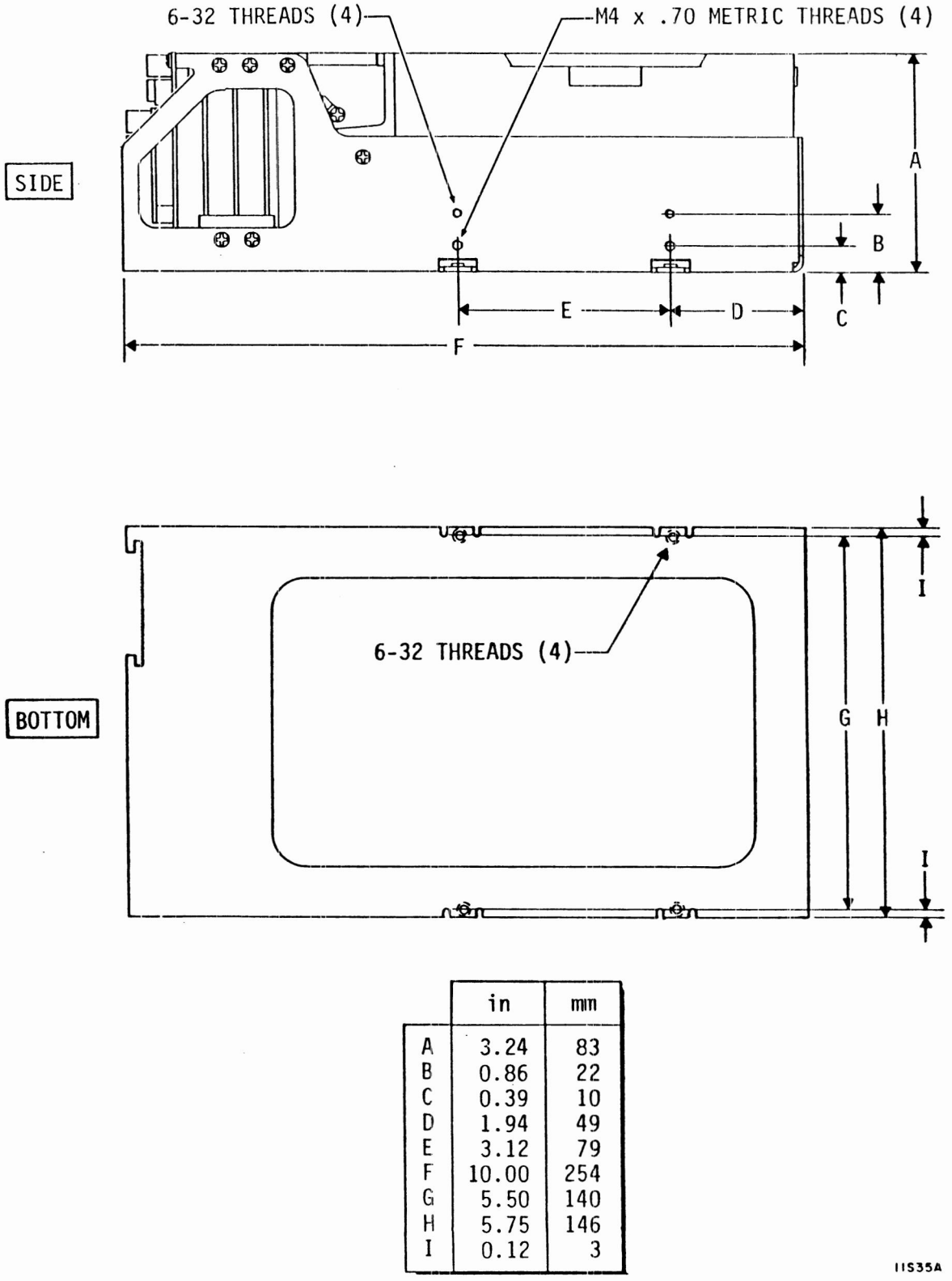
- Guidelines for Enclosure Design
- Guidelines for Proper Airflow
- Guidelines for I/O Cabling
- Programming the Sweep Cycle Function

GUIDELINES FOR ENCLOSURE DESIGN

The drive is offered as a component to be installed in an enclosure designed by the customer. The enclosure design must provide for mounting of the drive and power supply, cable routing, and cooling. See the next topic for guidelines on providing proper cooling.

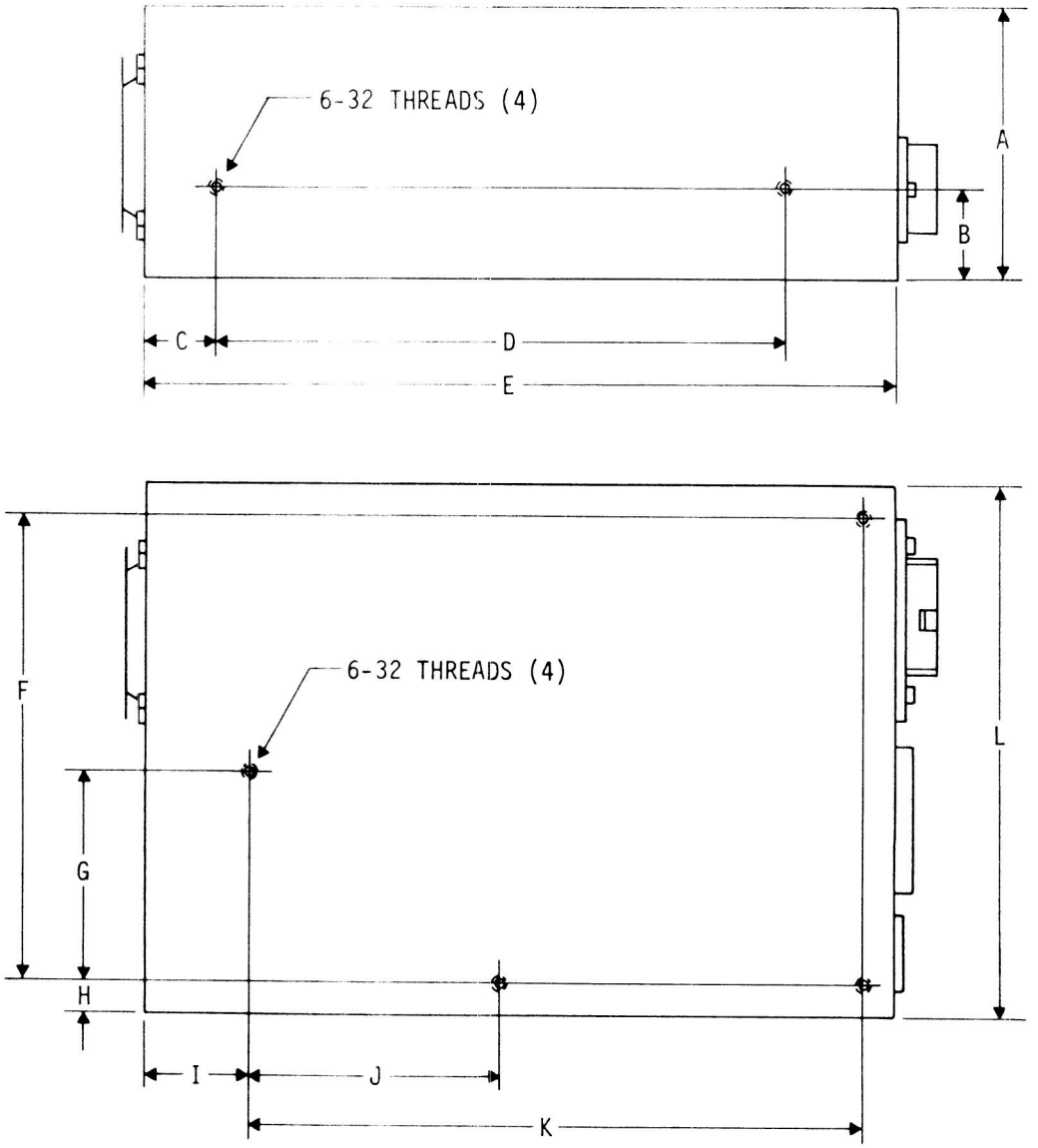
The system designer is responsible for obtaining any needed agency approvals such as FCC, UL, CSA, and VDE.

Figure 2-1 provides mounting dimensions for the drive. As described in the user's manual, the drive can be mounted using either side-mounting screws or bottom-mounting screws. Figure 2-2 provides similar information for the power supply. Like the drive, the power supply chassis has tapped holes in both the bottom surface and the two sides.



	in	mm
A	3.24	83
B	0.86	22
C	0.39	10
D	1.94	49
E	3.12	79
F	10.00	254
G	5.50	140
H	5.75	146
I	0.12	3

Figure 2-1. Drive Mounting Dimensions



	in	mm
A	2.75	70
B	0.95	24
C	0.80	20
D	6.00	152
E	8.00	202
F	4.90	124
G	2.20	56
H	0.335	9
I	1.11	28
J	2.675	68
K	6.55	166
L	5.57	141

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Figure 2-2. Power Supply Mounting Dimensions

GUIDELINES FOR PROPER AIRFLOW

The customer's enclosure design must ensure adequate cooling for the drive. Note that the fan in the power supply is intended for cooling only the power supply's internal parts.

The drive's product specification describes how to evaluate the airflow design. The evaluation consists of ensuring that the case temperatures of certain critical components remain acceptable during drive operation.

We recommend orienting the drive or directing the airflow in a way that creates the least amount of airflow resistance while providing airflow between the circuit boards and around the module. Also, choose the shortest possible path between the air inlet and exit. This minimizes the distance traveled by air that is heated by the drive and by other nearby heat sources.

Figure 2-3 shows the design approach with one or more fans placed alongside the drive adjacent to the circuit boards. The airflow patterns can be created by the fans either pushing or drawing air.

As shown in Figure 2-3, it is possible to install a pair of drives side-by-side so that the air circulation ventilates both drives. This circulation can be created by one or more fans.

Figure 2-4 suggests how to proceed when the overall flow pattern is from front to back or from back to front. By using baffles, a portion of the overall airflow can be redirected through the space between the circuit boards.

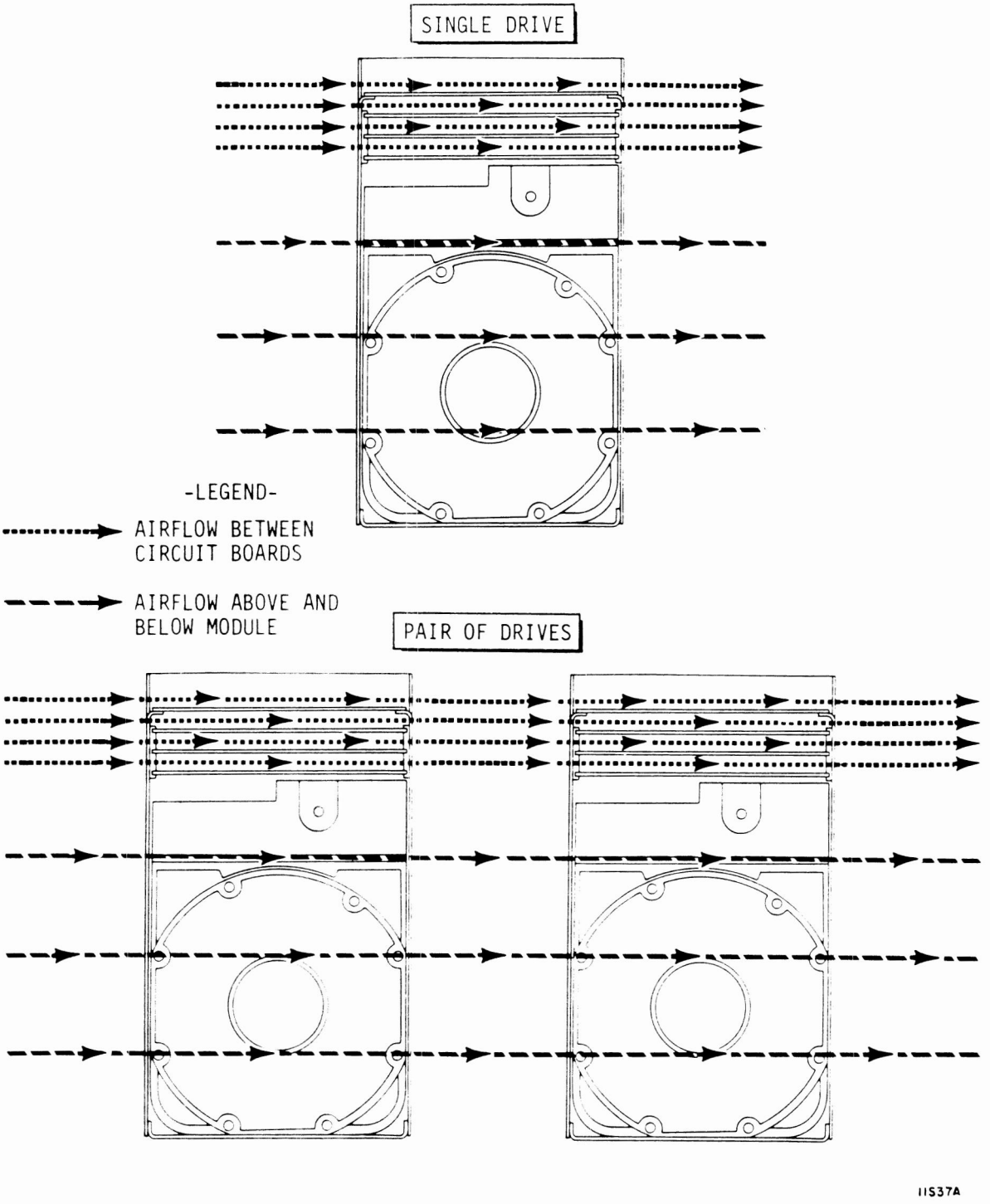


Figure 2-3. Perpendicular Airflow

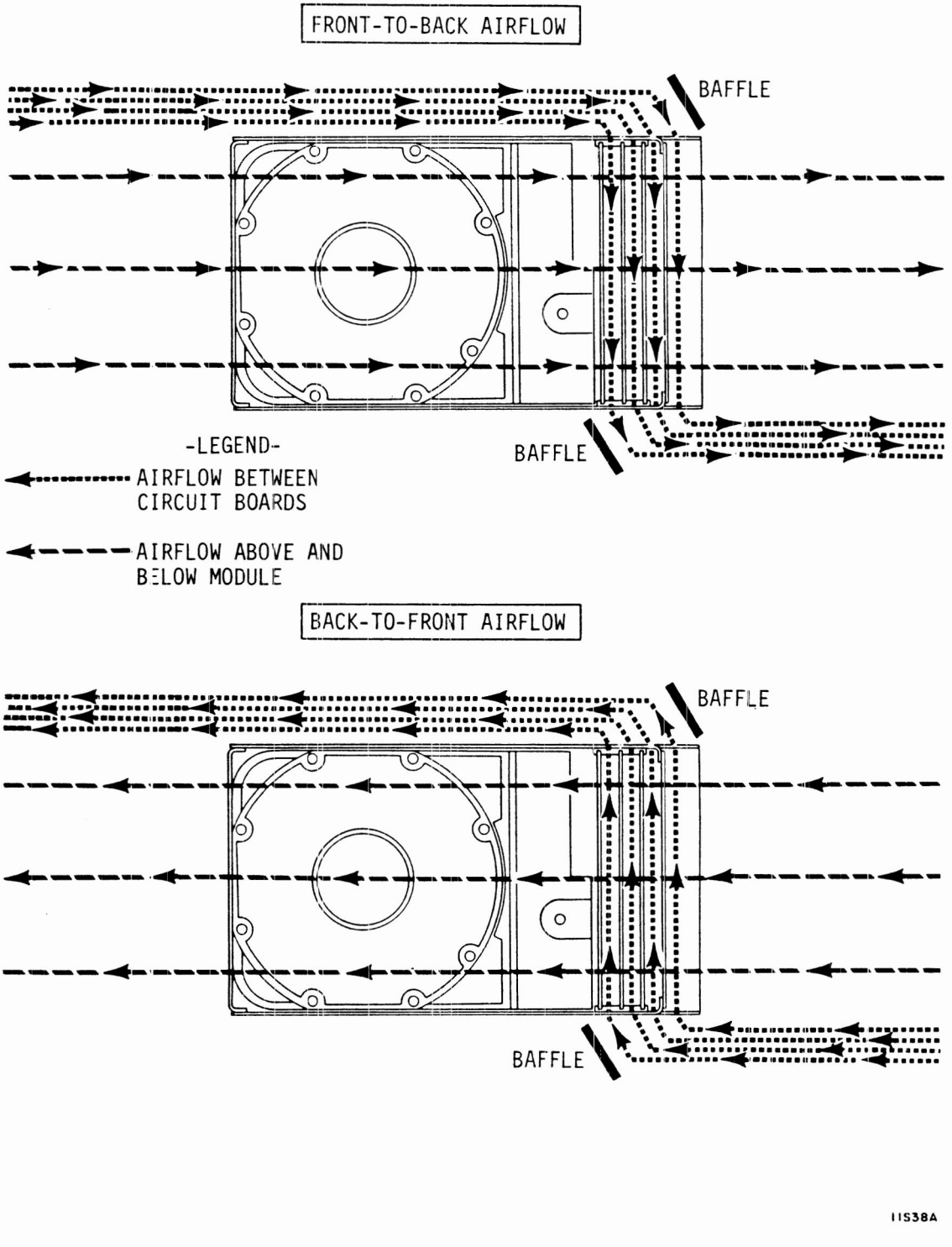


Figure 2-4. Lengthwise Airflow

GUIDELINES FOR I/O CABLING

This topic provides recommendations for I/O cabling and offers a list of parts that can be used in various cables. There are three general cabling schemes, as described in the following illustrations:

- Figure 2-5 describes how to design cables when the controller and all the drives are located in one cabinet.
- Figure 2-6 describes how to design cables when the controller is located in one cabinet and all the drives are located in another cabinet.
- Figure 2-7 describes how to design cables when the controller is located in one cabinet and the drives are located in two cabinets.

All three illustrations show how drives inside a cabinet are connected by continuous unshielded I/O cables that have a connector for each drive. In some cases, these internal cables connect to a bulkhead that allows external shielded cables to be connected. The use of shielded cables is necessary if the cables run between cabinets.

Table 2-1 lists parts needed to construct the unshielded I/O cables and bulkheads. It also provides terminator part numbers. Table 2-2 lists part numbers for shielded I/O cables in various lengths (ready to use). Refer to the appropriate illustration (figures 2-5 through 2-7) to determine the types of components required for your installation.

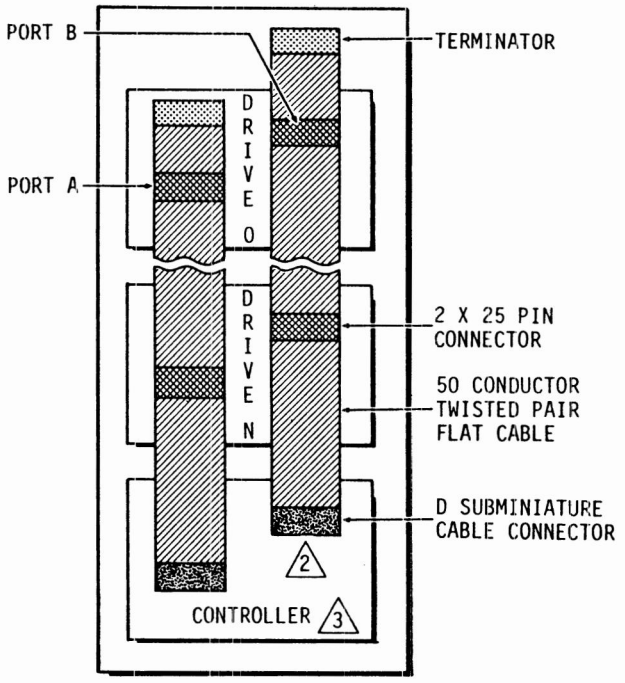
TABLE 2-1. CABLING COMPONENTS

Description	Vendor	Part Number
FLAT CABLE, 50-Conductor Twisted Pair	SEAGATE SPECTRA-STRIP	77611616 455-248-50
DRIVE END		
PLUG CONNECTOR, 50-Pin Mass Terminate	SEAGATE 3M	92010911 4650-6001
RECEPTACLE CONNECTOR, 50-Pin Mass Terminate	SEAGATE 3M	10130447 3425-6050
PULL TAB	SEAGATE DUPONT 3M	92004804 66147-008 3490-5
TERMINATOR, Standard IPI-2 Unshielded	SEAGATE ZERCOM	89500014 890913
CONTROLLER END		
PLUG CONNECTOR, 50-Pin 'D' Subminiature Mass Terminate	SEAGATE AMP	15386933 746790-1
RECEPTACLE CONNECTOR, 50-Pin 'D' Subminiature Mass Terminate	SEAGATE AMP	15386932 746789-1
TERMINATOR, Standard IPI-2 Shielded	SEAGATE AMP	15458851 748160-1
ADAPTER ASSEMBLY, 'D' Subminiature to Micro 'D' Connector	SEAGATE	70527050

TABLE 2-2. SHIELDED I/O CABLES

Length	Seagate Part Number
10 foot (3.05 metre)	47191101
15 foot (4.57 metre)	47191108
25 foot (7.62 metre)	47191102
50 foot (15.25 metre)	47191103
60 foot (18.3 metre)	47191110
75 foot (22.9 metre)	47191104
100 foot (30.5 metre)	47191105
150 foot (45.7 metre)	47191106

DRIVES AND CONTROLLER IN ONE CABINET



NOTES:

1. CABLES AND TERMINATORS SHOWN ARE UNSHIELDED.
2. D SUBMINIATURE AND MICRO D CONNECTORS ARE SHIELDED.
3. IPI CONTROLLER CAN HAVE D SUBMINIATURE OR MICRO D CONNECTOR. IF CONTROLLER HAS MICRO D CONNECTOR, ADAPTER WILL BE REQUIRED FOR CONVERSION.

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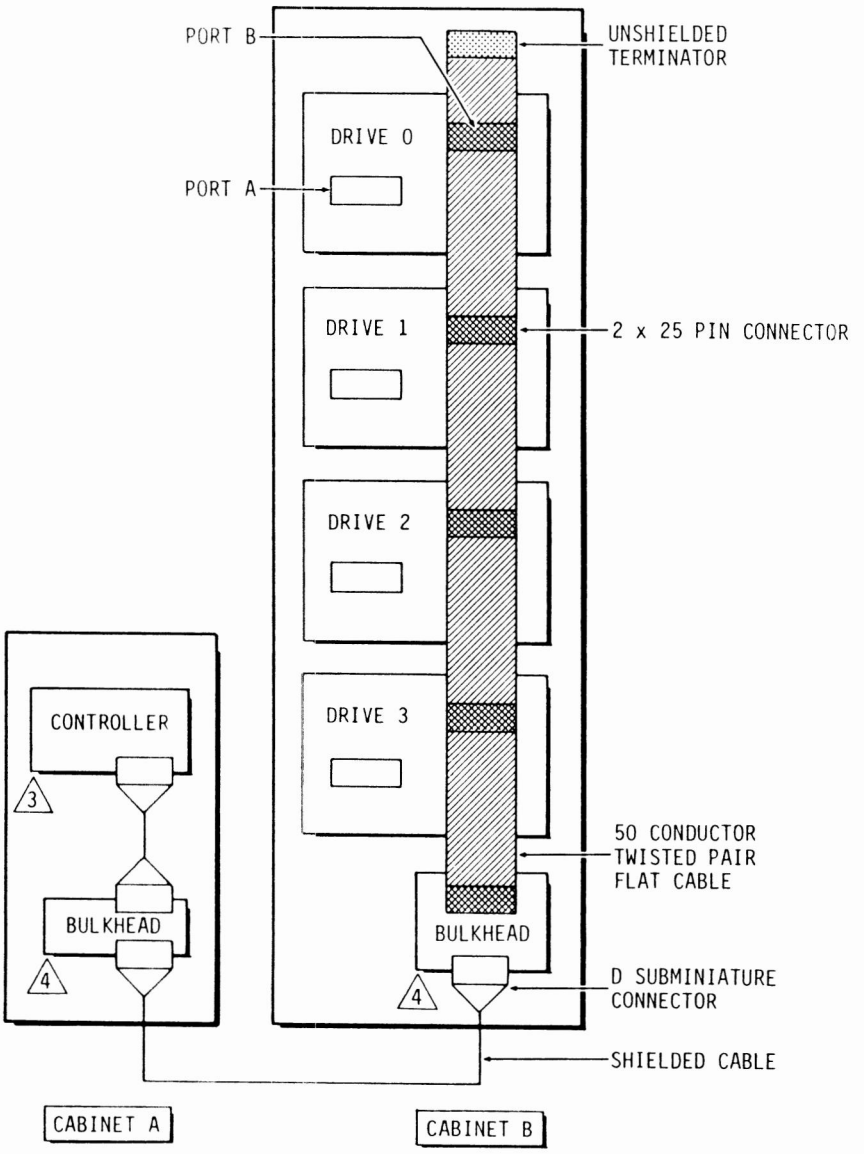
Figure 2-5. Cabling With One Cabinet

DRIVES AND CONTROLLER IN SEPARATE CABINETS



NOTES:

1. CONTROLLER IN ONE CABINET (A).
2. ALL DRIVES IN ANOTHER CABINET (B).
3. IPI CONTROLLER CAN HAVE D SUBMINIATURE OR MICRO D CONNECTOR. IF CONTROLLER HAS MICRO D CONNECTOR, ADAPTER WILL BE REQUIRED FOR CONVERSION.
4. BOTH BULKHEADS HAVE D SUBMINIATURE CONNECTORS.
5. PORT A OF ALL DRIVES SHOULD BE CONNECTED TO CONTROLLER IN SIMILER FASHION.

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Figure 2-6. Cabling With Two Cabinets

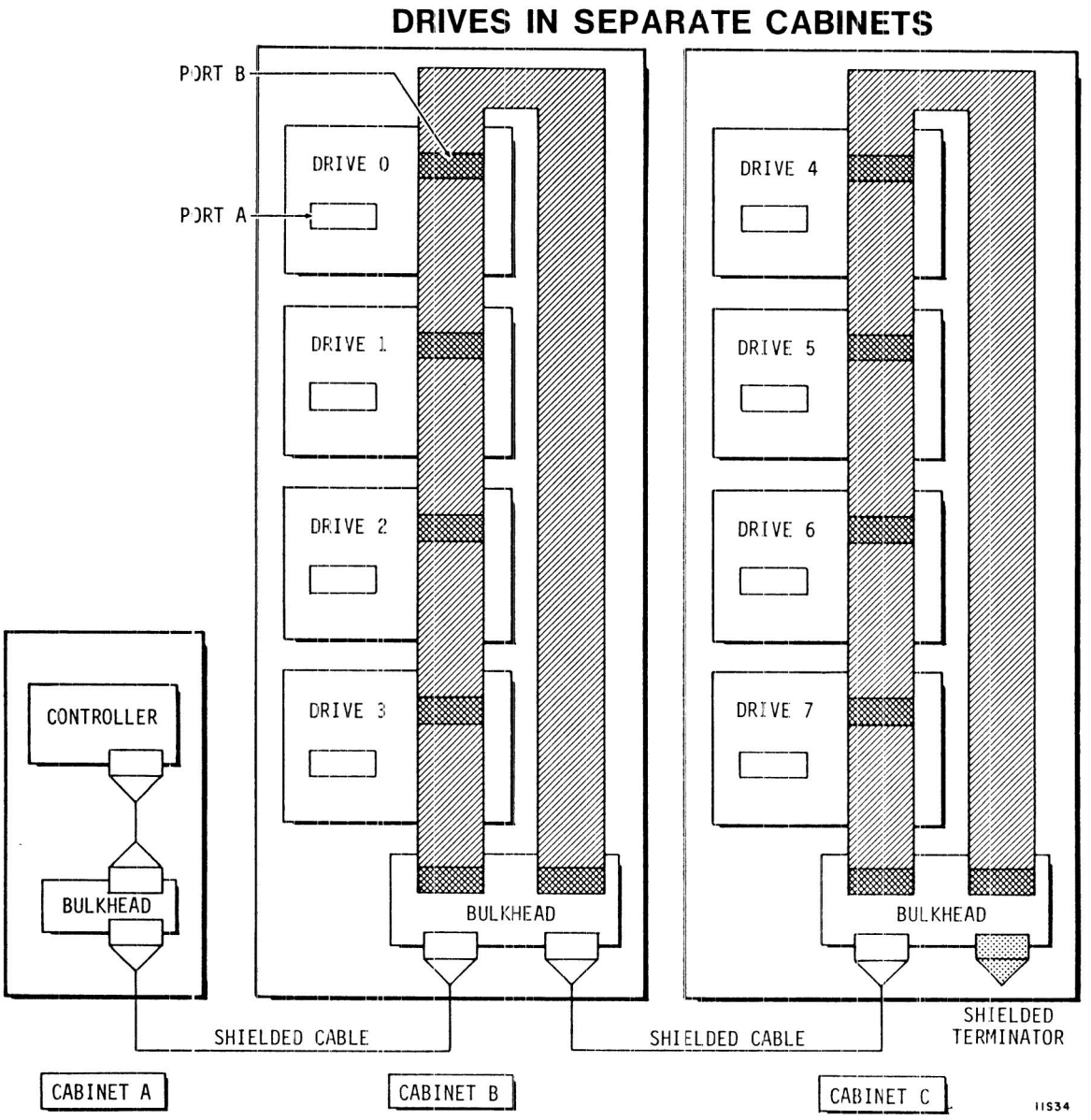


Figure 2-7. Cabling With Three Cabinets

PROGRAMMING THE SWEEP CYCLE FUNCTION

The sweep cycle is a feature that periodically moves the heads to different locations on the discs during intervals when the drive is idle. The following are highlights of the sweep cycle function:

- Using the sweep cycle enhances drive reliability. We encourage you either to enable the drive sweep cycle or to use a sweep cycle driven at the system or subsystem level. Consult with an analyst in making this choice.

- There are several sweep cycle options available at the drive level. To make sure that the selected option is compatible with system operation, check the controller user's manual.

- The sweep routine consumes approximately 11 seconds of a 13-hour period. Thus, the drive is available to the system more than 99.98% of the time.

- You may disable the sweep cycle (described below) without affecting the specified Mean Time Between Failures (MTBF) or warranty agreements.

Status codes associated with the sweep cycle are discussed in section 3 of this manual.

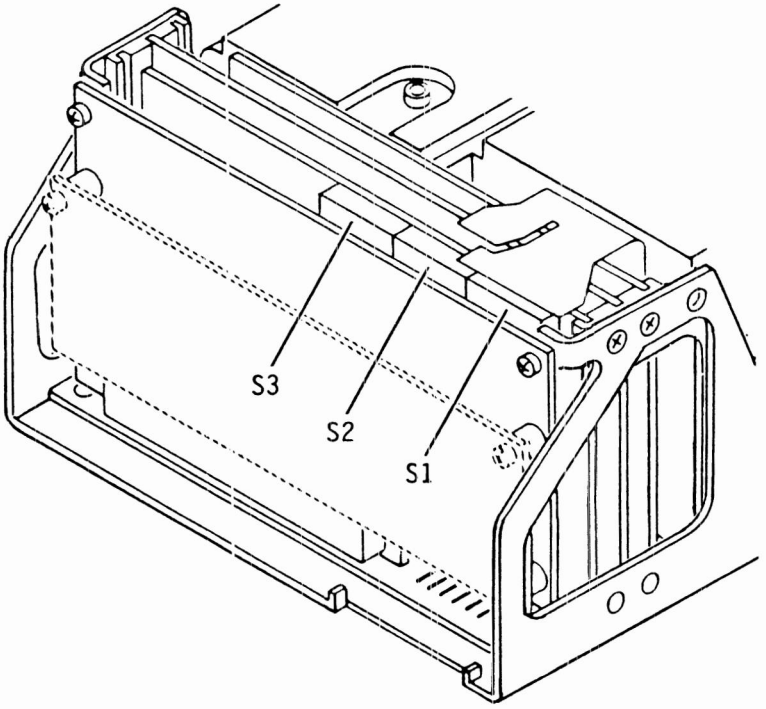
The drive is preset during manufacturing with a set of sweep cycle options selected. Two DIP switches on the servo board control the selection, as shown in figure 2-8.

The two sweep cycle switches are identified as Sweep Cycle Enable and Enable Sweep Only on Seeks. The following paragraphs discuss the functions controlled by each switch and tell different ways to position the switches:

Sweep Cycle Enable -- enables or disables the sweep cycle function. The switch can be positioned as follows:

- Open (Off) position -- disables the sweep cycle function. The other switch then has no effect.

- Closed (On) position -- enables the sweep cycle function.

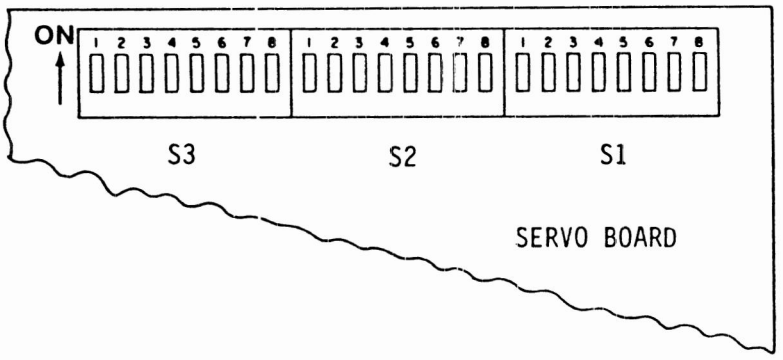


DIP SWITCH S3

1-SECTOR SWITCH 2^0 (1)
2-SECTOR SWITCH 2^1 (2)
3-SECTOR SWITCH 2^2 (4)
4-SECTOR SWITCH 2^3 (8)
5-SECTOR SWITCH 2^4 (16)
6-SECTOR SWITCH 2^5 (32)
7-SECTOR SWITCH 2^6 (64)
8-SECTOR SWITCH 2^7 (128)

DIP SWITCH S2

1-SECTOR SWITCH 2^8 (256)
2-SECTOR SWITCH 2^9 (512)
3-SECTOR SWITCH 2^{10} (1024)
4-SECTOR SWITCH 2^{11} (2048)
5-SECTOR SWITCH 2^{12} (4096)
6-SECTOR SWITCH 2^{13} (8192)
7-SECTOR SWITCH 2^{14} (16384)
8-RUNT SECTOR



DIP SWITCH S1

1-SWEEP CYCLE ENABLE
2-ENABLE SWEEP ONLY ON SEEKS
3-MANUFACTURING TEST
4-WRITE ENABLE
5-UNIT SELECT 2^0
6-UNIT SELECT 2^1
7-UNIT SELECT 2^2
8-UNIT SELECT 2^3

11S31A

Figure 2-8. Servo Board Switches

Enable Sweep Only on Seeks -- enables or disables the option to sweep only on seeks. When this option is enabled (required for IPI drives), sweep movements can occur only in conjunction with seeks required by the controller. Each time the drive performs a sweep cycle, it starts a 12-minute timeout. When the timeout has elapsed, the drive performs another sweep cycle only when it receives a Seek command. When combining a sweep cycle with a seek, the drive performs the sweep cycle first and then executes the Seek command. The switch can be positioned as follows:

- Open (Off) position -- disables the option to sweep only on seeks (sweep cycles can be initiated within the drive).
- Closed (On) position -- enables the option to sweep only on seeks (each sweep segment is part of a controller-driven seek).

If a sweep segment was initiated by a Seek command, the drive performs the sweep function and then moves the heads to the cylinder requested by the controller.

If a sweep segment is initiated within the drive, the drive performs the seek and returns to the original cylinder (where it was before the seek occurred. When it returns depends on drive activity. If the drive had not been selected during the 12 minutes prior to a sweep, the heads stay on a cylinder accessed during the sweep segment. Later, when the drive is reselected, the heads return to the original cylinder.

Section 3
Interface Functions

INTERFACE FUNCTIONS 3

INTRODUCTION

This section provides an overview of the Intelligent Peripheral Interface (IPI) as it is used in the Elite drive. This drive-to-controller interface uses commands defined in the Level 2 (IPI-2) specification developed by the American National Standards Institute (ANSI). Level 2 refers to the commands that are used to control drive-dependent operations.

It is beyond the scope of this manual to provided a detailed description of all the features, capabilities, variations, and protocol of the IPI interface. This information is provided in the IPI-2 interface specifications listed in the preface (in the front of this manual).

The interface is the communications channel between the controller and the drive. All communications between drive and controller must pass through the interface. It provides high-speed transfer of commands, responses, and data between controller and drive. Many of these communications are enabled only when the controller has the drive selected.

The interface consists of the I/O cables and the logic required to process the signals sent between drive and controller.

This section is divided into the following areas:

- I/O Cables -- Describes the signal lines on the interface.
- Interface Signal Processing -- Shows how the interface transfers commands, status, and data.
- Unit Selection -- Describes drive selection by either of two controllers.
- Spindle Synchronization -- Describes the interface commands that relate to spindle synchronization.

I/O CABLES

The drive has one I/O cable per port. This cable is a 50-conductor, twisted-pair cable. It contains all the interface lines going between the drive and controller. Figure 3-1 shows the interface lines in the cable. The function of each of the lines is summarized in table 3-1.

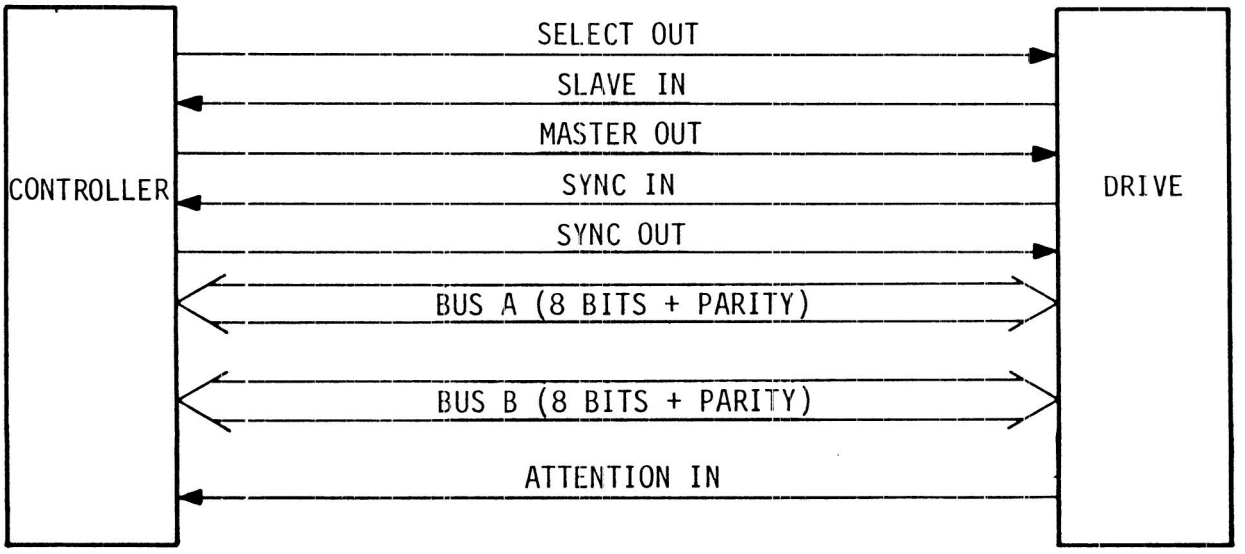


Figure 3-1. Interface Lines

TABLE 3-1. INTERFACE LINES

Signal	Source	Function
Bus A	C - D	Nine bidirectional lines: Bits 0 - 7 plus an odd parity bit. During command and control sequences, Bit 7 is the most significant bit. The controller uses Bus A for all control sequences. Data is transferred in parallel over Bus A and Bus B.
Bus B	C - D	Like Bus A except that the drive uses Bus B for all control sequences.
Select Out	C	Selects the drive and maintains the selection.
Slave In	D	Acknowledges controller-started control sequences and request sequences. Ends information transfers.
Master Out	C	Starts or stops information transfers and certain control sequences.
Sync In	D	During information transfers to the drive, indicates that the drive is ready to receive information. During information transfers to the controller, indicates that the drive has placed valid information on the buses.
Sync Out	C	During information transfers to the drive, indicates that the controller has placed valid information on the buses. During information transfers to the controller, indicates that the controller has accepted the information. Goes active to start each bus control sequence.
Attention In	D	Informs the controller that one or more drives that require service. When certain interrupts go active, the drive activates Attention In, provided that no drive is selected.
C = Controller		D = Drive

INTERFACE SIGNAL PROCESSING

Signal processing on the IPI interface follows a state-driven protocol. The IPI-2 interface specifications listed in the preface provide the details of this protocol. This topic provides an overview of the following aspects of signal processing:

- States
- Sequences
- Bus Controls
- Status
- Drive Specific Information

STATES

States are interface conditions defined by the logic levels of the following control lines:

- Select Out
- Slave In
- Master Out
- Sync In
- Sync Out

For each state transition on the interface, only one control line changes. Figure 3-2 is a state diagram showing possible state transitions. Table 3-2 lists the states and provides a brief explanation of their functions.

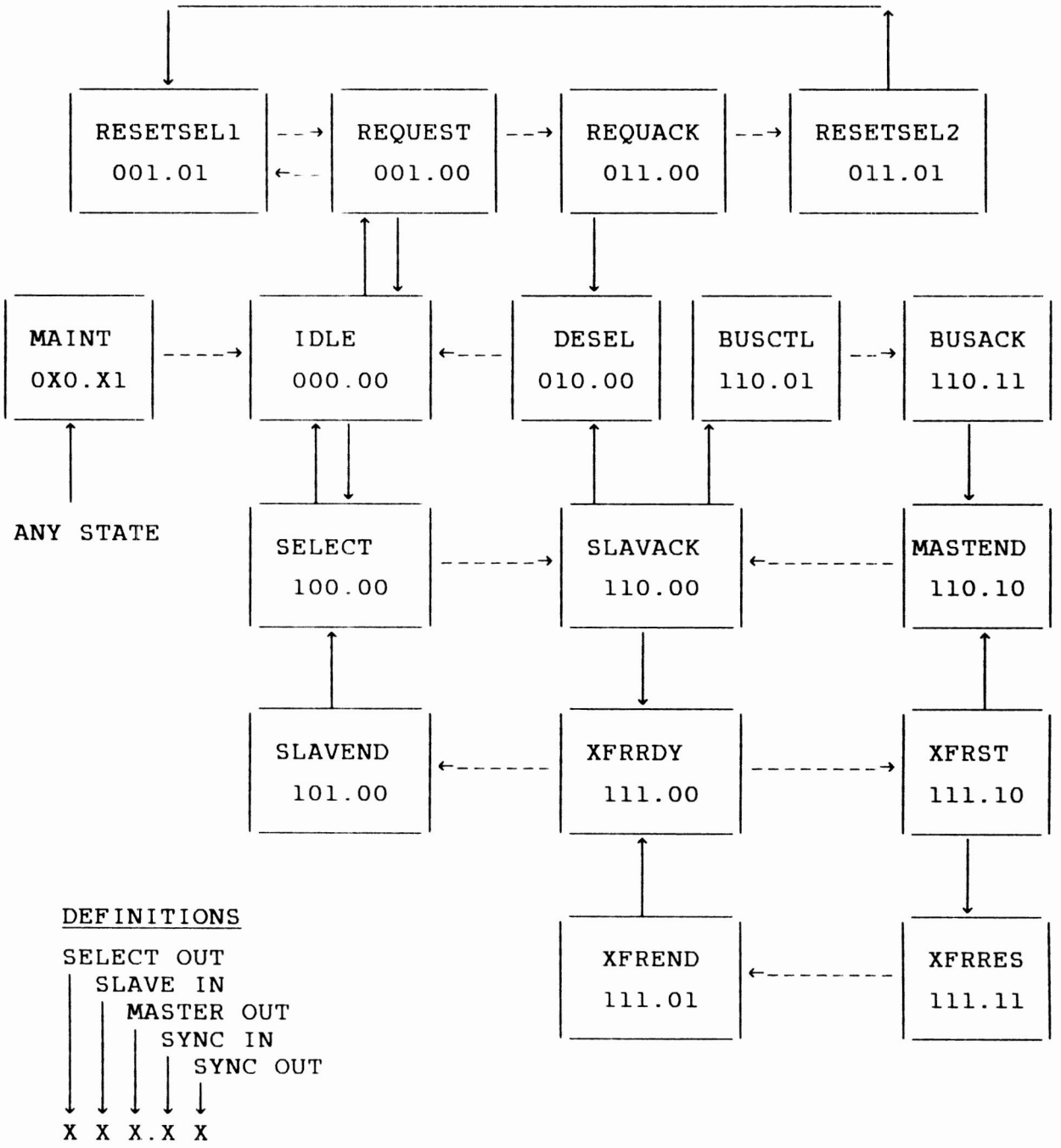


Figure 3-2. Bus State Diagram

TABLE 3-2. INTERFACE STATE FUNCTIONS

State Abbreviation	State Name	C/D*	Comments
BUSACK	Bus Acknowledge	D	Acknowledges that the bus control octet has been accepted by the drive.
BUSCTL	Bus Control	C	Conditions the transceivers for the following information transfer.
DESEL	Deselection	C	Starts the deselection of the drive by the controller.
IDLE	Idle	-	The interface is in the IDLE state when all the control signals are inactive. Abnormal entries to this state occur whenever the controller and drive(s) recognize an undefined state or state transition. The buses are released prior to entering the IDLE state, except during the request interrupts and master reset sequences.
MAINT	Maintenance	C	Starts maintenance mode on all drives. The controller starts the maintenance mode by executing a master reset sequence.

* = Indicates whether entry into this state is controlled by the Controller or Drive.

Continued

TABLE 3-2. INTERFACE STATE FUNCTIONS (Contd)

State Abbreviation	State Name	C/D	Comments
MASTEND	Master End	C	Either acknowledges that the bus acknowledge octet has been accepted, or it starts termination of an information transfer by the controller.
REQUACK	Request Acknowledge	D	The drive sets the requested response on Bus B and raises Slave In to enter this state.
REQUEST	Request	C	Causes the drive to respond with the address octet, the drive interrupts octet, the transfer settings octet, or to start selective reset.
RESETSEL1	Selective Reset 1	C	Starts a reset of the drive identified by the selective reset control octet on Bus A. Also ends maintenance mode.
RESETSEL2	Selective Reset 2	C	The drive releases or drops all interface lines upon recognition of this state, and causes an entry to RESETSEL1.
SELECT	Selection	C	This state starts the selection sequence. In the SELECT state it is necessary to know the previous state in order to respond correctly.

Continued

TABLE 3-2. INTERFACE STATE FUNCTIONS (Contd)

State Abbreviation	State Name	C/D	Comments
SELECT (Contd)			• When entered from IDLE, it is a true selection and the drive responds with select status on Bus B. • When entered from SLAVEND, SELECT is an intermediate state following an information transfer between the controller and the selected drive.
SLAVACK	Slave Acknowledge	D	Acknowledges selection, the end of a bus control sequence, or the end of an information transfer. In the SLAVACK state, it is necessary to know the previous state because Bus B contents are different depending on the state that SLAVACK was entered from.
SLAVEND	Slave End	D	Used by the drive to end an information transfer.
XFREND	Transfer End	D	Used by the drive to acknowledge the acceptance of information on transfers "out" and to complete the transferring of each double octet of an information transfer.

Continued

TABLE 3-2. INTERFACE STATE FUNCTIONS (Contd)

State Abbreviation	State Name	C/D	Comments
XFRRDY	Transfer Ready	C	Used by the controller to transfer each double octet of an information transfer.
XFRRES	Transfer Response	C	Used by the controller to acknowledge the acceptance of information on the buses for transfers "In," or to validate that the buses have stable information on transfers "out."
XFRST	Transfer Start	D	Acknowledges the start of an information transfer: • Indicates that the drive is ready to accept information for transfers "out." • For transfers "In," it validates that the buses have stable information.

SEQUENCES

Sequences are a series of states that follow each other in a definite order to accomplish a function. Table 3-3 lists the available sequences.

TABLE 3-3. SEQUENCES

Name	Description
Master Reset	Allows the controller to start maintenance mode for all drives in a daisy chain.
Selective Reset	Allows the controller to reset a single drive and to end maintenance mode.
Selection	Occurs when the controller addresses a drive.
Deselection	Allows the controller to deselect the drive by dropping Select Out.
Request Interrupts	Allows the controller to interrogate all drives to determine the service (or class of service) desired.
Request Drive Interrupts	Allows the controller to interrogate a specific drive to determine the service (or class of service) desired.
Request Transfer Settings	Allows the controller to interrogate the specified drive as to its information transfer characteristics. The transfer characteristics apply to command/response transfers only.
Information Transfer	Information transfers are interchanges on the physical interface of commands, responses, and data that are part of a single bus exchange. All information transfers are preceded by a bus control sequence and end with an ending status sequence. The bus control sequence defines what type of information transfer is to follow.
Bus Control	Allows the controller to establish the bus configuration for the next information transfer. The ending status sequence starts when the transfer ends.
Ending Status	Allows the controller and drive to present the status of the previous information transfer.

	Bus A Parameters (To Drive)	Bus B Parameters (From Drive)
	Master Reset Octet (specific bits active)	Undefined
	Selective Reset Control (reset type, drive address)	Undefined
→	Selection Octet (priority, drive address)	Selection Status Octet (drive address response)
	Undefined	Undefined
→	Request Interrupts Octet (type of interrupt requested)	Bit-Significant Address Octet (drive address response)
	Request Drive Int. Octet (specific bits active, drive address)	Drive Interrupts Octet (various interrupt bits defined)
→	Request Transfer Settings Octet (specific bits active, drive address)	Transfer Settings Octet (various bits define different transfer modes)
→	Bus A and Bus B each transfer 8 bits of a 16-bit word	
→	Bus Control Octet (describes next command, response, or data transfer; see Bus Controls topic)	Undefined
	Controller Status Octet (controller describes previous information transfer)	Drive Status Octet (drive describes previous information transfer)

BUS CONTROLS

The bus controls specify the condition of the bus and the information to be transferred. The three bus controls are: Command, Response, and Data.

Command Controls

The Command Controls are eight-bit codes supplied as part of a bus control sequence. They allow commands to be transmitted to the drive. The valid Command Controls and their hexadecimal codes are listed in table 3-4.

TABLE 3-4. COMMAND SUMMARY

Code	Name and Definition
01	Load Drive Function -- causes the drive to perform the function specified in the function code (for example: enable/disable ports, reserve, release, enable interrupts, power sequencing, recalibrate, error recovery, drive diagnostics, and enable/disable reporting for spindle sync).
02	Load Format Specification -- a time dependent function that transmits a Format Specification to the drive. A Format Specification is an ordered list of parameters that specify the format of the tracks and sectors on the disc.
03	Load Drive Specific Information -- transmits drive specific information to the drive (for example: sync byte value and device unique ID).
04	Load Cylinder Address -- a time dependent function that causes the drive to seek to the cylinder specified in the command.
05	Load Head Address -- causes the drive to select the head specified in the command.

Continued

TABLE 3-4. COMMAND SUMMARY (Contd)

Code	Name and Definition
06	Load RPS Target Sector Address -- causes the drive to select the physical sector specified for the target in the command.
07	Load Position -- causes the drive to seek to the specified cylinder, select the specified head, and select the specified RPS target sector.
30	Reserve -- reserves the drive to this port until released, or until a Priority Select or Reset is received. This command must be enabled by a function code within Bus Control 01, or it will be rejected.
31	Release -- releases the drive, upon deselection, from being reserved by this port. This command must be enabled by a function code within Bus Control 01, or it will be rejected.

Response Controls

The Response Controls are eight-bit codes supplied as part of a bus control sequence. They allow responses to be read from the drive. The valid Response Controls and their hexadecimal codes are listed in table 3-5.

TABLE 3-5. RESPONSE SUMMARY

Code	Name and Definition
41	Read Configuration -- causes the drive to transfer configuration information (for example: drive type, features, cylinder addressing, switch settings).
42	Read Format Specification -- causes the drive to transfer the current Format Specification (see code 02 in table 3-4).
43	Read Drive Specific Information -- causes the drive to transfer drive specific information (includes status codes, FRU codes, and fault codes). Refer to the topic Drive Specific Information later in this section.
44	Read Status -- causes the drive to transfer up to eight octets of status (defined later in figure 3-3).
46	Read Current Sector Address -- causes the drive to transfer the current sector address.
47	Read Current Position -- causes the drive to transfer the current position (cylinder address, head address, and RPS target sector address).
48	Read Extended Status -- causes the drive to transfer extended status (defined later in figure 3-4).

Data Controls

The Data Controls provide for reading and writing on the disc. They specify the direction of the transfer, the fields involved, the orientation of those fields, and step head control.

There are two Data Controls, field and sector. The field controls specify operations on a single field or a pair of fields. The sector controls are combined controls that specify operations on sectors having a header and 1 or 2 data fields. When using field controls, the previous field must have been operated on by a field or sector Data Control.

The Data Controls are eight-bit codes supplied as part of a bus control sequence. When Bit 4 is set in any Data Control, the head address counter advances at the end of a successful transfer. The head address counter is advanced unconditionally by the step head control.

The Data Control format results in eight groups and a special control as shown below:

- Skip/Write Data Field
- Verify Header, Write Data
- Write Header, Write Data
- Write Header, Write Data at Target
- Skip/Read Data Field
- Skip Header, Read Data
- Read Header, Read Data
- Read Header, Read Data at Target
- Step Head

Table 3-6 is a summary of these Data Controls. When two hexadecimal codes are listed in the table, the first includes no head step; the second includes head step.

TABLE 3-6. DATA CONTROL SUMMARY

Code	F/S*	Name
80	F	Skip Data Field
81,91	F	Write Data Field
82,92	F	Skip Data Field and Write Data Field
83,93	F	Write Two Data Fields
84,94	S	Verify Header

* = Indicates whether the data control operates on fields (F) or sectors (S).

Continued

TABLE 3-6. DATA CONTROL SUMMARY (Contd)

Code	F/S	Name
85,95	S	Verify Header and Write Data Field 1
86,96	S	Verify Header and Write Data Field 2
87,97	S	Verify Header and Write Data Fields 1 and 2
88,98	S	Write Header
89,99	S	Write Header and Data Field 1
8A,9A	S	Write Header and Data Field 2
8B,9B	S	Write Header and Data Fields 1 and 2
8C,9C	S	Write Header at Target
8D,9D	S	Write Header and Data Field 1 at Target
8E,9E	S	Write Header and Data Field 2 at Target
8F,9F	S	Write Header and Data Fields 1 and 2 at Target
90	-	Step Head
C0	F	Skip Two Data Fields
C1,D1	F	Read Data Field
C2,D2	F	Skip Data Field and Read Data Field
C3,D3	F	Read Two Data Fields
C4,D4	S	Skip Header
C5,D5	S	Skip Header and Read Data Field 1
C6,D6	S	Skip Header and Read Data Field 2
C7,D7	S	Skip Header and Read Data Fields 1 and 2

Continued

TABLE 3-6. DATA CONTROL SUMMARY (Contd)

Code	F/S	Name
C8,D8	S	Read Header
C9,D9	S	Read Header and Data Field 1
CA,DA	S	Read Header and Data Field 2
CB,DB	S	Read Header and Data Fields 1 and 2
CC,DC	S	Read Header at Target
CD,DD	S	Read Header and Data Field 1 at Target
CE,DE	S	Read Header and Data Field 2 at Target
CF,DF	S	Read Header and Data Fields 1 and 2 at Target
D0	-	Reserved

STATUS

Status Response

The status bits of the status response indicate exception conditions. They are set on the occurrence of an exception event. The setting of any exception status bit activates the status pending interrupt and the Attention In signal, if enabled. Refer to figure 3-3 for a description of all status response bits.

The drive transfers the status response to the controller upon receiving a read status bus control. Drive faults are cleared when the status response is read, if the fault no longer exists.

Extended Status Response

The drive transfers the Extended Status Response to the controller upon receiving a read extended status bus control. The extended status bits are static indications of the current flag states and drive conditions. Refer to figure 3-4 for a description of all the extended status response bits.

OCTET NAME	OCTET	MSB 7	6	5
EXCEPTION STATUS	0	STATUS RESPONSE	UNSOLICITED EXCEPTION	BUS CONTROL EXCEPTION
UNSOLICITED EXCEPTION	1	RESET COMPLETE	ALTERNATE PORT PRIORITY SELECT	ALTERNATE PORT FORMAT CHANGED
BUS CONTROL EXCEPTIONS	2	INVALID BUS CONTROL	INVALID PARAMETER	UNSUPPORTED BUS CONTROL
DRIVE EXCEPTIONS	3	SPEED FAULT	OFF CYLINDER FAULT	HEAD SELECT FAULT
DRIVE EXCEPTIONS	4	WRITE PROTECT FAULT	RESERVED	WRITE TRANSITION FAULT
DRIVE EXCEPTIONS	5	DIAGNOSTIC STATUS AVAILABLE	DIAGNOSTIC TESTS INCOMPLETE	W/R DIAGNOSTIC TESTS DISABLED
DRIVE EXCEPTIONS	6	RESERVED	RESERVED	RESERVED
DRIVE EXCEPTIONS	7	RESERVED	RESERVED	RESERVED

Figure 3-3. Status Response (Sheet 1 of 2)

OCTET	4	3	2	1	LSB 0
0	READ FAULT	WRITE FAULT	SEEK FAULT	SPINDLE FAULT See Note 1	EXECUTION FAULT
1	ALTERNATE PORT FORMAT COMPLETE	RESERVED	READY TO NOT READY TRANSITION	NOT READY TO READY TRANSITION	RESERVED
2	BUS CONTROL CONTEXT	DATA BUS CONTROL LATE	RESERVED	RESERVED	RESERVED
3	RESERVED	RESERVED	VOLTAGE FAULT	LOGIC TEMP FAULT	RESERVED
4	HEAD OFFSET FAULT	DATA STROBE FAULT	RESERVED	RESERVED	RESERVED
5	RESERVED	RESERVED	RESERVED	RESERVED	NO SYNC TRANSITION See Note 1
6	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED
7	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED

Note 1: For drives with synchronized spindles, these bits are set in response to a loss of spindle sync.

Figure 3-3. Status Response (Sheet 2)

OCTET NAME	OCTET	MSB 7	6	5
INTERFACE FLAGS	0	EXTENDED STATUS	PORT NUMBER	ALTERNATE PORT ENABLED
DATA RECOVERY FLAGS	1	OFFSET DIRECTION	OFFSET MSB	OFFSET LSB
DRIVE CONTROL FLAGS	2	WRITE PROTECTED	SPINDLE POWER ON	RESERVED
DRIVE STATUS	3	UP TO SPEED	ON CYLINDER	RESERVED
DRIVE ALARMS	4	RESERVED	RESERVED	ILLEGAL HEAD SELECT
VENDOR DEFINED	5	RESERVED	RESERVED	RESERVED
VENDOR DEFINED	6	RESERVED	RESERVED	RESERVED
VENDOR DEFINED	7	RESERVED	RESERVED	RESERVED

Figure 3-4. Extended Status Response (Sheet 1 of 2)

OCTET	4	3	2	1	LSB 0
0	RESERVE ACTIVE	COMMAND COMPLETE INTERRUPT ENABLED	RPS INTERRUPT ENABLED	STATUS PENDING INTERRUPT ENABLED	FORMAT SPECIFI-CATION PRESENT
1	EARLY DATA STROBE	LATE DATA STROBE	RESERVED	HEADER ECC ENABLED (Optional)	DATA ECC ENABLED (Optional)
2	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED
3	RESERVED	RESERVED	RESERVED	HDA READY	MEDIA PRESENT
4	RESERVED	RESERVED	VOLTAGE RANGE ERROR	LOGIC OVER TEMP	RESERVED
5	RESERVED	RESERVED	RESERVED	RESERVED	SYNC ACTIVE See Note 1
6	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED
7	RESERVED	RESERVED	RESERVED	RESERVED	RESERVED

Note 1: For drives with synchronized spindles, this bit is set whenever the spindle is synchronized to its reference.

Figure 3-4. Extended Status Response (Sheet 2)

DRIVE SPECIFIC INFORMATION

The Read Drive Specific Information bus control (Bus Control 43) transfers status information to the controller. This status information fits into two general categories:

- Native-controlled status -- generated by the Control MPU.
- Interface-controlled status -- generated by the I/O MPU.

The response to the bus control has the following parameters:

- Native-Controlled Diagnostic Status Codes -- presented in octets 02 - 11 and listed in table 3-7.
- Native-Controlled Diagnostic FRU Codes -- presented in octets 12 - 15. FRU codes are not available. The drive will return a status 80 when the controller issues a FRU request. No FRUs will be calculated.
- Native-Controlled Diagnostic Fault Codes -- presented in octets 16 - 1D and listed in table 3-8.
- Interface-Controlled Diagnostic Status Codes -- presented in octets 1E - 1F and listed in table 3-9.
- Interface-Controlled Diagnostic FRU Codes -- presented in octets 20 - 21 and listed in table 3-10.
- Interface-Controlled Diagnostic Fault Codes -- presented in octets 22 - 23 and listed in table 3-11.

TABLE 3-7. NATIVE-CONTROLLED DIAGNOSTIC STATUS CODES

Status Code	Status Description
NORMAL OPERATION CODES (Bit 6 is a zero)	
80	Ready
82	Stopping Motor
83	Motor Stopped
84	Load/Cal in Progress
85	Power Sequence in Progress
87	Starting Motor
88	Motor Up to Speed
89	I/O Self-Test Passed
8A	Sweep Segment in Progress
8B	Heads Left on Last Cylinder of Sweep
8C	Ready But Not On Cylinder
90	Ready & Spindle in Sync
91	Servo MPU Communication Test Passed
94	Load/Cal in Progress & Spindle in Sync
98	Motor Up to Speed & Spindle in Sync
9A	Sweep Segment in Progress & Spindle in Sync
9B	Heads Left on Last Cylinder of Sweep & Spindle in Sync
9C	Ready & Spindle in Sync But Not On Cylinder

Continued

TABLE 3-7. NATIVE-CONTROLLED DIAGNOSTIC STATUS CODES (Contd)

Status Code	Status Description
	DRIVE ERROR CODES (Bit 6 is a one)
C6	Seek Timeout
CA	Move Failed Due to Demodulator Check
CB	Off-Track Seek Error
CC	Seek Error Due to Actuator Locked or No Demodulator Active
CD	Illegal Cylinder Address
CE	Seek Error Due to Fault
CF	Seek Error on Settle In
D0	Low Vcc Glitch Recovery
D1	I/O MPU Hang Recovery
D2	Motor Stopped -- Braking Loop Failed
D3	First Seek Fault -- Motor Below Speed
D4	First Seek Fault -- Data Ready Pulse 1 Not Found
D5	First Seek Fault -- Data Ready Pulse 2 Not Found
D6	First Seek Fault -- Demodulator Active Not Found
D7	First Seek Fault -- Index Not Found
D8	Speed Loss
D9	Speed Loss Restart
DC	Locked Rotor
E0	Servo MPU Dead
E1	Servo MPU Communication Check Failed
E2	I/O Status Transfer Failed
E5	First Seek Failed for the Second Time
E6	Scan Failed -- Recovery in Progress
E7	Scan Failed for the Second Time -- Abort the Scan
E8	Seek Failure During Sweep
EE	I/O Self-Test Failed

TABLE 3-8. NATIVE-CONTROLLED DIAGNOSTIC FAULT CODES

Fault Code	Fault Description
80	Good Status
81	Read • Write Fault
82	(Read + Write) • Off Cylinder Fault
84	First Seek Fault
88	Write Fault
90	Write • Write Protected Fault
A0	Head Select Fault
C0	Voltage Fault

TABLE 3-9. INTERFACE-CONTROLLED DIAGNOSTIC STATUS CODES

Status Code	Status Description
Read/Write Tests	
00	Good Status
01	Failed during seek to diagnostic cylinder
02	Failed during RTZ seek from diagnostic cylinder
03	Not defined
04	Not defined
05	Failed during head select test
06	Failed during read header test
07	Failed during write data test
08	Failed during read data test
09	Sync byte error during read header test
0A	Data error during read header test
0B	Sync byte error during read data test
0C	Data error during read data test
Access Tests	
13	Failed during servo test
14	Failed during random seek test
15	Failed during access RTZ test
Read Drive Specific Tests	
20	Failed during read up of diagnostic status/error code log test
21	Failed during read up of FRU log test
22	Failed during read up of display fault log test

TABLE 3-10. INTERFACE-CONTROLLED DIAGNOSTIC FRU CODES

FRU Code	FRU Description
01	Servo Board or Read/Write Board
02	Module
03	Power Supply
04	I/O Board
05	Servo Board or Read/Write Board
06	Module

TABLE 3-11. INTERFACE-CONTROLLED DIAGNOSTIC FAULT CODES

Fault Code	Fault Description
00	Good Status
01	Read • Write Fault
02	(Read + Write) • Off Cylinder Fault
04	First Seek Fault
08	Write Fault
10	Write • Write Protected Fault
20	Head Select Fault
40	Voltage Fault

UNIT SELECTION

GENERAL

The drive must be selected before it will respond to any commands from the controller. This is the case because some drive transmitters are not enabled until the drive is selected.

The dual port selection logic consists of port enable/disable controls and the means for switching the drive between two ports. When both ports require the use of the drive at the same time, they must arbitrate. Only one controller is allowed to gain selection of the drive at any given time. A controller attempting to select, when the other controller has already selected or reserved the drive, will receive a busy indication at the time of selection.

The functions controlling port selection are as follows:

- Accessibility -- Reflects the current mode of the drive: neutral or switched.
- Select -- Logically connects the drive to the controller, thus enabling it to respond to commands from the selecting controller.
- Priority Select -- Allows a controller to force selection of a drive by releasing the interface to the controller currently having the drive selected or reserved.
- Reserve -- Reserves the drive so it can be reselected at any time by the reserving controller. This prevents it from being selected by the other controller, unless a priority select is issued.
- Priority Reserve -- Unconditionally reserves the drive to this controller. A priority select from the other controller overrides a priority reserve.
- Release -- Releases drive from a reserved condition.
- Enable/Disable -- Allows disabling either port during maintenance.

The following discussions describe each of these functions.

DRIVE ACCESSIBILITY

The drive can appear in one of two accessibility modes: neutral or switched. While in the neutral mode, the drive can be accessed through either enabled port. In the switched mode the drive can be accessed only through the switched port, unless a priority select is used.

The drive can become switched to a port under the following conditions:

- Selection of the port. If the Reserve or Priority Reserve function is issued after selection, the drive will remain switched to the port after deselection.
- A Priority Select is issued with a Selection sequence.

The drive remains switched to a port until one of the following conditions occur:

- The port is deselected and is not reserved.
- The port is deselected, and the reserved port has executed a Release function.
- An appropriate reset is executed on the port.
- The alternate port issues a Priority Select.
- The drive power is turned off and on.

SELECT

Unit selection starts when the controller initiates a selection sequence with a Selection byte on Bus A. Each drive in the string compares the drive address from the Selection byte to its own address stored in its Configuration register. If the address compares, there was no parity error on the Bus A, and the drive is not busy, the drive responds by putting its bit-significant address on Bus B and raising Slave In. The drive is now ready to accept further commands from the controller.

The drive's logical address is determined by switch settings on the servo board. This address can be any number from 0 to 7. The drive's logical address is loaded into the configuration register during the power on initialization.

The port that is selected will set the Force Selection Busy bit in the alternate port. This will cause a busy indication if selection is attempted on the alternate port.

When the drive is busy, Slave In is raised but no bit-significant address is put on Bus B. If a parity error was detected on Bus A, no drive response is made to the controller.

When two controllers attempt selection at the same time, the ports must arbitrate to determine which port will gain selection and which port will present a busy indication.

PRIORITY SELECT

If one controller has a drive selected and reserved, the other controller can force selection by issuing a Priority Select command. This command forces deselection from the controller presently using the drive and selects the drive for the controller issuing the Priority Select command.

RESERVE

When a controller gains selection and issues a Reserve command, the other controller will receive a busy indication when selection is attempted. This continues until the reserving controller issues a Release command, an appropriate reset is received from either controller, or a Priority Select is received from the other controller. This allows the reserving controller to deselect, while a busy condition is maintained on the alternate port.

PRIORITY RESERVE

Priority Reserve causes an unconditional reserve of the drive for this port. A Selection from the alternate port with the Priority Select bit set will override a Priority Reserve.

RELEASE

The release function causes the drive to be released from this port and to enter the neutral mode. This function takes effect when the controller deselects from the port. Both ports are initially released at power on and following a reset.

PORT ENABLE/DISABLE

Ports may be individually enabled or disabled by command and by manual switches located on the I/O board. When a port is disabled, it is made not operational at the physical interface. Both ports are initially enabled when power is applied, if not disabled by the manual switches.

If a controller gains selection and issues a Disable Alternate Port command, the alternate port is made not operational at the physical interface until the selected port receives an Enable Alternate Port command. If a port is disabled by command, changing the manual switch from Disable to Enable will cause the port to be enabled. However, the disabling of a port by the manual switch cannot be overridden by command.

The disabling of a port, either by command or switch, will cause all reservations to be cleared and will cause any status associated with the disabled port to be reset.

ATTENTION

When the drive is in the neutral mode, Attention is sent to both ports. When the drive is switched, the Attention is sent to the switched port. The generation of Attention from the interrupts may be enabled/disabled on a port basis by command. All Attention generation is enabled by a reset.

SPINDLE SYNCHRONIZATION

The user's manual identifies two ways to establish a drive as a master (supplying the sync reference signal to all drives connected for spindle sync):

- Connect the master select plug.
- Issue that drive an Enable Master Sync command on the IPI interface.

Only one drive in the daisy chain can be established as the master. The master drive can be located anywhere along the daisy chain cable as long as both ends of the cable are terminated. The following topics provide more information on master/slave selection.

DESIGNATING A MASTER USING THE MASTER SELECT PLUG

The Master Select Plug connects both jumper pins when the drives are shipped from the factory. Leave the plug connected to designate that drive as a master. It will then provide the spindle sync reference signal to all drives and controllers in the string. Remove the plug (or connect it to one jumper pin only) on all other drives in the string.

The spindles will synchronize to an external source if the Master Select Plug is disconnected on all drives and the cable is connected to an external reference.

DESIGNATING A MASTER USING BUS CONTROLS

A drive can be designated a master using Bus Controls issued on the IPI-2 interface, rather than using the Master Select Plug on the I/O board. Bus Control 'Load Drive Function' (01) with function code 'Enable Master Sync' (1F) causes the selected drive to become a master. As such, it provides the spindle sync reference signal to the other drives in the string. If the 'Enable Master Sync' function is presented to a drive that is designated as a master using the Master Select Plug, it rejects the 'Enable Master Sync' function and provides Slave Ending status 'Bus Control Exception'. This sets bit 5 of octet 0 in Status Response 'Bus Control Exception', and bit 6 of octet 2 in Status Response 'Invalid Parameter'.

A Bus Control 'Load Drive Function' (01) with 'Disable Master Sync' function code (2E) causes the selected drive to cease being a master and disable providing the sync reference signal. If the drive has been designated a master using the Master Select Plug, it rejects the 'Disable Master Sync' function and provides Slave Ending status 'Bus Control Exception'. This condition sets bit 5 of octet 0 in Status Response 'Bus Control Exception' and bit 6 of octet 2 in Status Response 'Invalid Parameter'.

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