Installation and Operation Manual

KENNEDY
A Division of Shugart Corporation

Digital Tape System

SCSI Controller

For Models 96X2 Series

93-09612-101

FCC CERTIFIED COMPUTER EQUIPMENT

This equipment, freestanding with shielded Data and Control Cables, complies with Part 15, Subpart J of FCC Rules Governing Class A Computing Devices Operated In A Commercial Environment. However, the equipment generates radio frequency energy and, when operated in a residential area, the user must take adequate precautions against interference to radio communications.

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SMALL COMPUTER SYSTEM INTERFACE SUPPLEMENT
TABLE OF CONTENTS

SECTION I - GENERAL DESCRIPTION AND APPLICATION DATA

Section	Page
1.1 General Description	1-1
1.2 Host Interface	1-1
1.3 Microcomputer Based Design	1-1
1.4 Diagnostics and Fault Isolation	1-1
1.5 Specifications	1-1
1.5.1 Power Requirements	1-1
1.6 Interface Specifications	1-2
1.6.1 General	1-2
1.6.2 Interface Connectors	1-2
1.6.3 Interface Cable Length	1-2
1.6.4 Interface Signal Character	1-3
1.6.4.1 Input	1-3
1.6.4.2 Output	1-3
1.6.5 Receiver/Driver Configuration and Termination	1-3
1.6.6 Multiple Hosts/Drives	1-4
1.7 Interface Signals	1-4
1.8 SCSI Bus	1-5
1.8.1 SCSI Bus General Description	1-5
1.8.2 Signal Descriptions	1-5
1.8.2.1 Data Bus, DB(0-7,P)	1-5
1.8.2.2 Select, SEL	1-6
1.8.2.3 Busy, BSY	1-6
1.8.2.4 Input/Output, I/O	1-6
1.8.2.5 Command/Data, C/D	1-6
1.8.2.6 Request, REQ	1-6
1.8.2.7 Acknowledge, ACK	1-6
1.8.2.8 Attention, ATN	1-6
1.8.2.9 Message, MSG	1-6
1.8.2.10 Reset, RST	1-6
1.8.3 Addressing	1-6
1.8.4 SCSI Phase Protocol Description	1-6
1.8.4.1 Bus Phases	1-7
1.8.5 Bus Phases, Detail Descriptions	1-7
1.8.5.1 Arbitration Sequence	1-7
1.8.5.2 Selection/Reselection	1-8
1.8.5.2.1 Arbitrating System	1-8
1.8.5.2.2 Non-Arbitrating System	1-8
1.8.5.2.3 Single Initiator Option	1-8
1.8.5.2.4 Reselection (optional)	1-9
1.8.5.2.5 Selection/Reselection Timeout	1-9
1.8.5.3 Information Transfer Phase	1-9
1.8.5.4 Information Xfer Handshake	1-10
1.8.5.5 Commands Phase	1-10
1.8.5.6 Data Phase	1-11
1.8.5.7 Status Phase	1-11
1.8.5.8 Message Phase	1-12
1.8.6 Bus Conditions	1-12
1.8.6.1 Attention	1-12
1.8.6.2 Reset	1-12
1.9 Message System Description	1-12
1.9.1 Single Byte Messages	1-13
1.9.1.1 Cmd Complete (00 Hex)	1-14
1.9.1.2 Save Data Pointer (02 Hex)	1-14
1.9.1.3 Restore Pointers (03 Hex)	1-14
1.9.1.4 Disconnect (04 Hex)	1-14
1.9.1.5 Abort (06 Hex)	1-14
1.9.1.6 Message Reject (07 Hex)	1-14
1.9.1.7 No Operation (08 Hex)	1-14
1.9.1.8 Message Parity Error (09 Hex)	1-14
1.9.1.9 Linked Command Complete (0A Hex)	1-15
1.9.1.10 Linked Command Complete (With Flag) (0B Hex)	1-15
1.9.1.11 Bus Device Reset (0C Hex)	1-15
1.9.1.12 Identify (80-FF Hex)	1-15
1.10 Commands	1-16
1.10.1 Test Unit Ready (Hex 00)	1-16
1.10.2 Rewind	1-17
1.10.3 Request Sense	1-17
1.10.3.1 Request Sense Bytes	1-18
1.10.3.2 Read Block Limits	1-23
1.10.3.3 Read	1-24
1.10.3.4 Write	1-25
1.10.3.5 Read Reverse	1-27
1.10.3.6 Write File Mark	1-27
1.10.3.7 Space	1-28
1.10.3.8 Inquiry	1-29
1.10.3.9 Verify	1-31
1.10.3.10 Recover Buffered Data	1-32
1.10.3.11 Mode Select	1-32
1.10.3.12 Reserve Unit	1-34
1.10.3.13 Release Unit	1-35
1.10.3.14 Erase	1-36
1.10.3.15 Mode Sense	1-36
1.10.3.16 Load\Unload	1-38
1.10.3.17 Receive Diagnostic Results	1-39
1.10.3.18 Send Diagnostic	1-40
1.10.3.19 Write Data Buffer	1-43
1.10.3.20 Read Data Buffer	1-45
1.11 Host Interface Timing	1-47
1.12 SCSI Timing Considerations	1-51
1.12.1 Sustained Data Transfer Rate	1-51
1.12.2 Command Reinstruct Timing	1-51
1.12.2.1 Repeat Cmd Assumptions	1-51
1.12.2.2 Repeat Cmd Timing Variables Definitions	1-51
1.12.2.3 Repeat Command Timing Expression	1-52

SECTION II - INSTALLATION/ADJUSTMENTS

Section		Page
2.0	General	2-1
2.1	Installation	2-1
2.2	Adjustments, General	2-1
2.2.1	SCSI Controller Switch Settings	2-1

SECTION III - DIAGNOSTICS

SECTION IV - MAINTENANCE

LIST OF ILLUSTRATIONS

Figure		Page
1-1	Interface Termination Configurations	1-3
1-2	SCSI Network (Typical)	1-4
1-3	SCSI Timing Diagram, Arbitration and Selection Phases	1-48
1-4	SCSI TIming Diagram, Command and Data Phases	1-49
1-5	SCSI Timing Diagram, Status, Message, and Bus-Free Phases	1-50
2-1	SCSI Controller PCBA	2-2

LIST OF TABLES

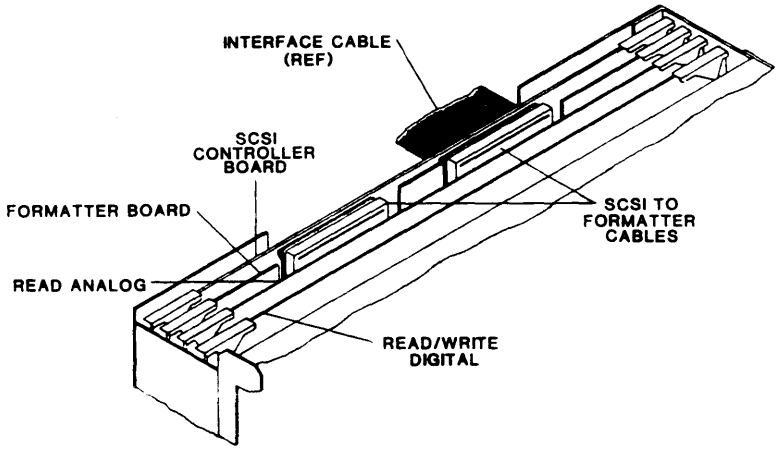
Table		Page
1-1	Model 9602/9652 and 9612/9662 Power Requirements	1-2
1-2	Single-Ended Interface Connector J3	1-4
1-3	Differential Interface Connector J4	1-5
1-4	Information Transfer Modes	1-10
1-5	Status Byte Format	1-11
1-6	Message Codes	1-13
1-7	SCSI Commands	1-16
1-8	Test Unit Ready (00 Hex)	1-17
1-9	Rewind (01 Hex)	1-17
1-10	Request Sense (03 Hex)	1-18
1-11	Sense Byte Data Format	1-18
1-12	Sense Key Descriptions	1-20
1-13	Additional Sense Data	1-21
1-14	Read Block Limits (05 Hex)	1-23
1-15	Read Block Limits Data	1-23
1-16	Read Command (08 Hex)	1-24
1-17	Read Conditions of Data Transfer	1-24
1-18	Write (0A Hex)	1-26
1-19	Read Reverse Command (0F Hex)	1-27
1-20	Write File Mark Cmd (10 Hex)	1-27
1-21	Space Command (11 Hex)	1-28
1-22	Inquiry Command (12 Hex)	1-29
1-23	Inquiry Command Data	1-30
1-24	Verify Command (13 Hex)	1-31
1-25	Recover Buff Data Cmd (14 Hex)	1-32
1-26	Mode Select Command (15 Hex)	1-33
1-27	Mode Select Data Parameter List	1-33
1-28	Descriptor List	1-33
1-29	Reserve Unit Command (16 Hex)	1-34
1-30	Release Unit Command (17 Hex)	1-35
1-31	Erase Command (19 Hex)	1-36
1-32	Mode Sense Command (1A Hex)	1-36
1-33	Mode Sense Data Format	1-37
1-34	Unload Command (1B Hex)	1-38
1-35	Receive Diagnostic Results Command (1C Hex)	1-39
1-36	Diagnostic Results Data	1-39
1-37	Diagnostic Results Status Bytes	1-40
1-38	Send Diagnostic Cmd (1D Hex)	1-41
1-39	Parameter List Data Format	1-42
1-40	Write Data Buffer Cmd (3B Hex)	1-43
1-41	Read Data Buffer Cmd (3C Hex)	1-45
1-42	Read Buffer Header	1-46
1-43	Descriptor Mode Information	1-46
1-44	Density/Speed and Data Transfer	1-51
2-1	Switch SW1 Functions	2-1
2-2	Switch SW2 Functions	2-4
2-3	Device Qualifier	2-5

SECTION I

GENERAL DESCRIPTION AND APPLICATION DATA

1.1 GENERAL DESCRIPTION

The Kennedy Models 96X2 are automatic load, tape drives that include an embedded Small Computer System Interface (SCSI) Tape Controller capable of communicating between an industry standard SCSI Interface Bus and ANSI-compatible PE 1600 and 3200 CPI, NRZI 800 CPI, and GCR 6250 CPI (9612, 9632, 9642, 9662, 9862, 9692 ONLY), tapes. The drives can operate in Streaming Mode at 100 ips or Start/Stop Mode at 50 ips, and can read in either forward or reverse direction in all densities. **The 96X2 Series are essentially 96X0 Series Tape Drives with a SCSI Controller Interface Board.** The illustration below shows the location of the SCSI Controller Board.



Card Cage with SCSI Controller Board

1.2 HOST INTERFACE

The Drive can operate in Single or Multiple Host systems, and supports all SCSI Bus functions including Arbitration, Disconnect/Reselect and Message exchanges. The Tape Drive Interface Board features two high speed DMA Controllers with a maximum transfer rate of 2MBytes/sec without degradation of tape performance.

1.3 MICROCOMPUTER BASED DESIGN

The Tape Drive uses three microprocessors: one in the SCSI Controller, one in the Formatter Board, and one in the Drive Control Electronics.

1.4 DIAGNOSTICS AND FAULT ISOLATION

The Tape Drive includes built-in diagnostics with front-panel eight-character LED readout.

1.5 SPECIFICATIONS

Physical, Environmental, and Operational Specifications are defined in the Model 96X0 Series Installation and Operation Manuals.

1.5.1 POWER REQUIREMENTS

Power requirements for the 96X2 Series Drives are listed in Table 1-1.

Table 1-1. Model 96X2 Power Requirements

Parameter	Description	
AC Units		
Input Voltage	100, 120, 220, 240 VAC +15% -10% 50 or 60 Hz +/-2 Hz	
Input current	**120 VAC**	**220 VAC**
	3.0 amps	1.5 amps
Power:		
Nominal	300 watts	300 watts
Peak	400 watts	400 watts
Fuse: (Standard)	6 amp at 110/120	3 amp at 220/240 VAC (Slo-Blo)
Heat Dissipation	1025 BTU/hr	
DC Units		
Input Voltage	48, 60VDC +20%-10%	
Input Current	**48 VDC**	**60 VDC**
	7.5 amps	5.5 amps
Power: Nominal	350 watts	350 watts
Peak	450 watts	450 watts
Fuse	12 amp	10 amp
Heat Dissipation	1194 BTU/hr	

1.6 INTERFACE SPECIFICATION

1.6.1 GENERAL

This section describes cable, connector and signal requirements for interface between the Tape Drive with SCSI Interface (Target) and the Host SCSI Controller (Initiator).

1.6.2 INTERFACE CONNECTORS

Interface between the Host and Drive can be via single-ended or differential signals. In either case however, the interface must consist of a standard 50-line (or 25 twisted-pair) shielded cable. SCSI option 1 or option 2 shielded connectors are available with daisy chain capability. **Note:** Non-shielded cables and connectors can be used but only if they are completely enclosed in a metal RFI-proof cabinet.

Option 1: Kennedy P/N: 98-00205-001
Option 2: Kennedy P/N: 98-00206-001

1.6.3 INTERFACE CABLE LENGTH

To meet FCC and ESD specifications, the maximum allowable length of the shielded cable shall be 20 feet (6 meters) for single-ended interface, 82 feet (25 meters) for differential interface. Braided shielded cables are required to meet FCC and ESD specifications.

1.6.4 INTERFACE SIGNAL CHARACTERISTICS

1.6.4.1 INPUT

Single-Ended Input Signals to the SCSI Controller must conform to the following specifications:

Levels:	1 = Low = True = 0v (+0.8 vdc) 0 = High = False = +2v (+5.25 vdc)
Input Load:	-0.4 ma at 0.4 vdc

Differential Signals are conveyed on two lines denoted: +SIGNAL and -SIGNAL. A signal is true when +SIGNAL is more positive than -SIGNAL, and a signal is false when -SIGNAL is more positive than +SIGNAL. Differential Input Signals to the SCSI Controller must conform to the following specifications:

Voltage Levels vary between -7 vdc and +12 vdc.

Input Current = +/-2.0 ma max

Note: The SCSI Controller uses a DIFFSENS signal (Differential Sense - high) as a Controller Enable. If a single-ended device or terminator is inadvertently connected to a Differential Connector, DIFFSENS is grounded, thereby disabling the interface drivers.

1.6.4.2 OUTPUT

Single-Ended Output Signals from the SCSI Controller conform to the following specifications:

Levels:	1 = Low = True = 0v (+0.4 vdc) 0 = High = False = +2v (+5.25 vdc)
Driver Output:	48 ma (sinking) at 0.5 vdc

Differential Output Signals from the SCSI Controller conform to the following specifications:

Low Level:	2.0v max at 55 ma max
High Level:	3.0v min at 55 ma max
Differential:	1.0v min with common mode range of -7v to +12v.

1.6.5 RECEIVER/DRIVER CONFIGURATION AND TERMINATION

The input lines are terminated in the SCSI Controller as illustrated in Figure 1-1 with 220 ohm and 330 ohm resistors to +5 volts and ground. The input receivers are **74LS** type circuits.

All output lines must be terminated at the Host Controller with a 220 ohm resistor to plus five volts and a 330 ohm resistor to ground. Output circuits are open collector drivers.

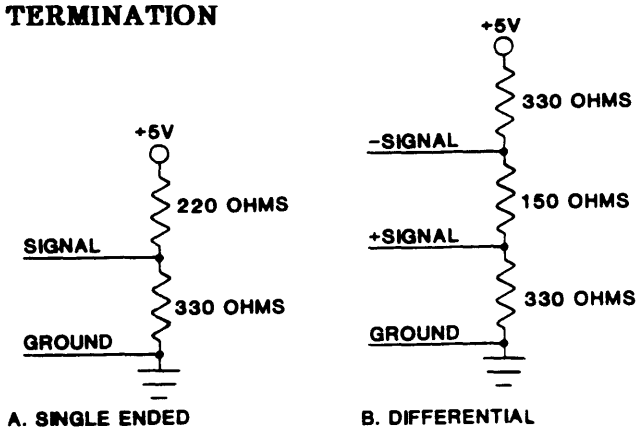


Figure 1-1. Interface Termination Configurations

1.6.6 MULTIPLE HOSTS, MULTIPLE DRIVES

A SCSI Network can include up to eight devices including one or more Hosts, Tape Drives, and any applicable devices with SCSI Controllers, normally connected in a daisy chain configuration. In such a network, the Interface Terminators must be removed from all but the device at each end of the network. Figure 1-2 illustrates typical SCSI Networks.

Terminator Locations: The Interface Terminators consist of SIP Resistor Packs installed in the SCSI Controller Board located as follows (Figure 2-1):

Single-Ended Terminators - RN3, RN9, RN10

Differential Terminators - RN1, RN2, RN4, RN5, RN6, RN7, RN8

SCSI Addressing: Each Device in a Daisy Chain must be set to an address unique from all other devices. For this purpose, DIP Switch SW1, Switch 6, 7, and 8, on the SCSI Controller Board constitutes a 3-bit binary encoder, by means of which the SCSI Device Address can be set to a number from 0 to 7. (SW1, Switch 8 constitutes the most significant Address Bit.) See section 2.2.1 for switch settings.

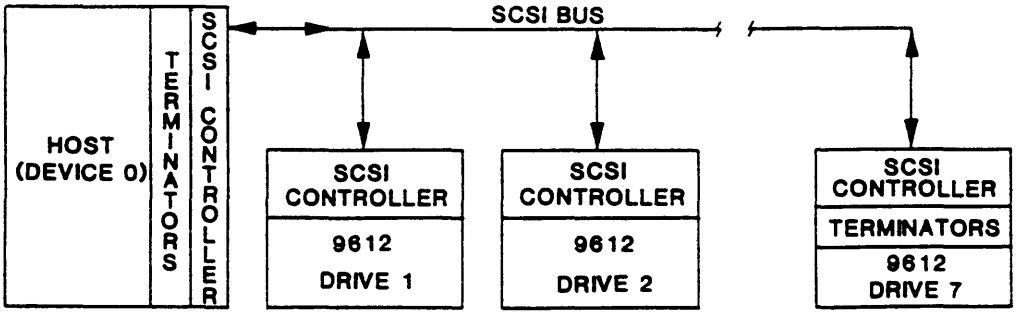


Figure 1-2. SCSI Network (Typical)

1.7 INTERFACE SIGNALS

Tables 1-2 and 1-3 list SCSI Bus Interface Signals for Single-Ended and Differential Interface Connectors respectively. The following paragraph describes the use of these Signals on the SCSI Bus.

Table 1-2. Single-Ended Interface Connector J3 Pin Assignments

Signal*	Pin**	Signal*	Pin**	Signal*	Pin**
-DB(0)	2	GROUND	20	-BSY	36
-DB(1)	4	GROUND	22	-ACK	38
-DB(2)	6	GROUND	24	-RST	40
-DB(3)	8	TERMPWR	26	-MSG	42
-DB(4)	10	GROUND	28	-SEL	44
-DB(5)	12	GROUND	30	-C/D	46
-DB(6)	14	-ATN	32	-REQ	48
-DB(7)	16	GROUND	34	-I/O	50
-DB(P)	18				

Note: * - = active low.
** All odd pins, except 25, are connected to ground. Pin 25 is unconnected.

Table 1-3. Differential Interface Connector J4 Pin Assignments

Signal*	Pin	Pin	Signal*
SHIELD GRD	1	2	GROUND
+DB(0)	3	4	-DB(0)
+DB(1)	5	6	-DB(1)
+DB(2)	7	8	-DB(2)
+DB(3)	9	10	-DB(3)
+DB(4)	11	12	-DB(4)
+DB(5)	13	14	-DB(5)
+DB(6)	15	16	-DB(6)
+DB(7)	17	18	-DB(7)
+DB(P)	19	20	-DB(P)
DIFFSENS	21	22	GROUND
GROUND	23	24	GROUND
TERMPWR	25	26	TERMPWR
GROUND	27	28	GROUND
+ATN	29	30	-ATN
GROUND	31	32	GROUND
+BSY	33	34	-BSY
+ACK	35	36	-ACK
+RST	37	38	-RST
+MSG	39	40	-MSG
+SEL	41	42	-SEL
+C/D	43	44	-C/D
+REQ	45	46	-REQ
+I/O	47	48	-I/O
GROUND	49	50	GROUND

Note: * + = active high; - = active low

1.8 SCSI BUS

The following subparagraphs describe the SCSI Bus and the interface signals it conveys between the Host Controller (referred to as the Initiator) and the Tape Drive (referred to as SCSI Controller or Target).

1.8.1 SCSI BUS GENERAL DESCRIPTION

A single SCSI Bus can handle up to eight devices; but communication can be between only two devices at any given time. When two devices communicate on the Bus, one, acting as an INITIATOR, initiates an operation; the other, acting as a TARGET, performs the operation. The SCSI Controller acts as an INITIATOR only during the Reselection Phase of operation.

The SCSI Bus consists of nine Control Lines, that coordinate transfer of data between Devices, and nine Data (with parity bit) Lines that comprise the Data Bus. Tables 1-2 and 1-3 list, and the following subparagraphs describe, the signals on the SCSI Bus.

1.8.2 SIGNAL DESCRIPTIONS

1.8.2.1 DATA BUS, DB(0-7,P)

Bi-Directional Data Bus with Parity. Transfers Command, Data, Status and Message Information between TARGET and INITIATOR.

1.8.2.2 SELECT, SEL

Signal set by an INITIATOR to select a TARGET, or by a TARGET to reselect an INITIATOR after an interruption of operation. Selected Device is identified by its Address on the Data Bus.

1.8.2.3 BUSY, BSY

Signal set by any INITIATOR or TARGET to indicate that the SCSI Bus is in use.

1.8.2.4 INPUT/OUTPUT, I/O

Signal from the TARGET to indicate direction of data movement on the bus with respect to the INITIATOR. True = Input to the INITIATOR. False = Output from the INITIATOR. Also used to distinguish between Selection and Reselection phases of operation: True = Reselection; False = Selection

1.8.2.5 COMMAND/DATA, C/D

Signal from the TARGET - indicates whether Command or Data Information is on the Bus. True = Command; False = Data.

1.8.2.6 REQUEST, REQ

Signal from the TARGET that constitutes a Request for a data transfer.

1.8.2.7 ACKNOWLEDGE, ACK

Signal from an INITIATOR that constitutes an Acknowledgement of a Request for a data transfer.

1.8.2.8 ATTENTION, ATN

Signal from an INITIATOR indicating that the INITIATOR has a message to send to the TARGET.

1.8.2.9 MESSAGE, MSG

Signal from the TARGET which, in conjunction with C/D and I/O, initiates a transfer of information between INITIATOR and TARGET. Information transferred is in the form of a Message Byte(s) on the Data Bus. Direction of flow is determined by the state of I/O.

1.8.2.10 RESET, RST

Signal from any TARGET or INITIATOR that Clears SCSI bus of all Data, Control Signals, and activity, resulting in a bus free phase.

1.8.3 ADDRESSING

As described earlier, each Device on the SCSI Bus must be identified by an Address Number (0-7) via SW1, Switch 6, 7, and 8. The Initiating Device accesses a TARGET Device by putting the TARGET Address on the Data Bus, using the correlation: DB0 = Address 0, DB1 = Address 1, etc. ... DB7 = Address 7 (DBP is not used, but must be set high).

1.8.4 SCSI PHASE PROTOCOL DESCRIPTION

This section describes the SCSI Protocol, including information on Phase Sequencing, Bus Phases, and Bus Conditions.

1.8.4.1 BUS PHASES

SCSI Bus status is a function of the Control Signals, which place the SCSI Bus in one of the following phases: a) Bus Free, b) Arbitration, c) Selection/Reselection, and d) Information Transfer, defined as follows:

a) **Bus Free** - Bus is in "Standby" Phase: no action on Bus.

b) **Arbitration** - All Devices on Bus that are ready to transfer information contend for use of the Bus. The Device with highest Address Number (priority) attains use of the Bus.

c) **Selection/Reselection** - The Device that attains control of the Bus during Arbitration has the option of **Selecting** the TARGET Device for data transfer or **Reselecting** the (previous) INITIATOR to resume an operation.

d) **Information Transfer** - The TARGET Device (selected during Selection/Reselection Phase) selects one of four Information Transfer Options: Command, Data, Status, or Message, defined as follows:

1. Command - INITIATOR issues a Command to the TARGET.

2. Data - Data transfers between INITIATOR and TARGET.

3. Status - After completion of an operation, TARGET sends Completion Status to the INITIATOR; or, after partial completion of an operation, TARGET sends Intermediate Status to the INITIATOR (to be explained in paragraph 1.9.1.9).

4. Message - Information or instructions transfered between TARGET and INITIATOR.

1.8.5 BUS PHASES, DETAILED DESCRIPTIONS

1.8.5.1 ARBITRATION SEQUENCE

A. Device waits for the Bus Free Phase.

B. When Bus Free occurs, Device asserts BSY and its own ID.

C. Device waits at least 2.2 usec, then examines the Data Bus.

D. Depending on ID Priority, one of the following occurs:

1. If a higher priority ID bit is true on the Data Bus, the Device has lost Arbitration. The Device deasserts BSY and its ID, and returns to Step 1.

2. If no higher priority ID bit is true on the Data Bus, then the Device has won Arbitration, asserts SEL, and proceeds with Step 5.

E. At the completion of the Arbitration, the winning Device has BSY, SEL and its own ID asserted. After winning Arbitration the Device waits at least 1.2 usec before proceeding with the Selection/Reselection Phase.

Note: The ID byte on the Data Bus includes one asserted bit that corresponds to the Device address (ID). Parity is not valid during Arbitration. So, Parity Bit DBP **must** be left undriven or set to the true state.

1.8.5.2 SELECTION/RESELECTION

If the INITIATOR initiates **Selection,** it **deasserts** the I/O Signal, which prepares the SCSI Controller to receive Commands from the INITIATOR. If the SCSI Controller initiates **Reselection,** it **asserts** the I/O Signal, which allows it to reselect the previous INITIATOR for further activity. After selecting the INITIATOR, the Controller deasserts I/O, and is ready to receive Commands.

1.8.5.2.1 ARBITRATING SYSTEM

The Device (with highest priority), having won Arbitration, now becomes the INITIATOR and:

A. Sets SEL, BSY, and while retaining its own ID Bit on the Data Bus, sets a TARGET ID Bit;

B. Then waits at least 100 nsec, and deasserts BSY.

C. The TARGET (in this case, the SCSI Controller) senses that it is selected when SEL and its own ID are true, and that BSY and I/O have been false for at least 400 nsec. The TARGET affirms its TARGET Status by asserting BSY.

D. The acting INITIATOR waits at least 100 nsec after detecting BSY true, then deasserts SEL and the ID Bits on the Data Bus.

   At the completion of Selection, the acting INITIATOR has no signals asserted, and the acting TARGET has BSY asserted.

1.8.5.2.2 NON-ARBITRATING SYSTEM

In systems that do **not** use Arbitration, the INITIATOR (Host Controller):

A. Waits for the Bus Free Phase, plus 800 nsec;

B. Then asserts the TARGET ID and its own ID on the Data Bus, and waits at least 90 nsec.

C. The INITIATOR then asserts SEL.

D. The TARGET senses that it is selected by the states of SEL and its own ID Bit, and the fact that BSY and I/O have been false for at least 400 ns. So, the TARGET asserts BSY.

E. The INITIATOR waits at least 100 nsec, then deasserts SEL and the ID Bits on the Data Bus.

1.8.5.2.3 SINGLE INITIATOR OPTION

A SCSI Controller that does not implement Reselection, and does not operate in a multiple INITIATOR (Multiple Host) environment may set only the TARGET ID bit during the Selection Phase. Since there is only one INITIATOR, and reselection will not occur, the INITIATOR need not identify itself.

1.8.5.2.4 RESELECTION (Part of Selection/Reselection Phase)

The Reselection Phase allows the TARGET to reconnect to an INITIATOR to continue a previous operation that was interrupted. Reselection can only be used in systems that implement the Arbitration Phase.

After winning Arbitration (SEL, BSY, and ID are true):

A. The SCSI Controller becomes a TARGET by asserting the I/O signal and setting the Data Bus to both its own ID and the INITIATOR ID.

B. The Controller waits at least 90 nsec, then deasserts BSY.

C. The intended INITIATOR recognizes that it has been Reselected when SEL, I/O, and its own ID are true, and BSY is False.

D. The INITIATOR then asserts BSY.

E. When the Controller detects the INITIATOR setting BSY, it also sets BSY; then waits at least 90 nsec, and deasserts SEL. At this point the Controller may deassert the I/O Signal and clear the Data Bus in preparation for receiving Commands.

F. After the Reselected INITIATOR detects SEL false, it may deassert immediately or continue asserting BSY until ready to release the SCSI Bus.

1.8.5.2.5 SELECTION/RESELECTION TIMEOUT

A. **Selection Timeout:** If the INITIATOR fails to detect BSY from the TARGET within 250 msec after the TARGET ID appears on the Data Bus, the INITIATOR leaves SEL asserted and deasserts its ID on the Data Bus. The INITIATOR waits at least 200 msec, then deasserts SEL, going to Bus Free.

B. **Reselection Timeout:** If the TARGET does not receive a BSY response from the reselected INITIATOR within 200 msec, the TARGET clears the SCSI Bus to the Bus Free Phase, and does not transmit an Ending Status.

1.8.5.3 INFORMATION TRANSFER PHASE

The Information Phases consist of: Command, Data, Status, and Message Phases, all of which are used to transfer Control and Data Information via the Data Bus. The essential controlling signals for the Information Transfer Phase are: MSG, C/D, and I/O, which distinguish between the different Information Transfer Modes:

MSG = Identification of Data Bus content. MSG asserted = Message Information; MSG deasserted = Command/Data Information.

C/D = Command/Data Selection - determines whether Data Bus content consists of Command or Data. C/D asserted = Control; C/D deasserted = Data.

I/O = Input/Output Selection - determines whether Data Bus content comprises Input or Output Information (Input to the initiating device, or output from the initiating device). I/O asserted = Input; I/O deasserted = Output.

C/D I/O both asserted = the Status Phase.

Table 1-4 illustrates signal configurations that represent each Information Transfer Phase.

Table 1-4. Information Transfer Modes

Signal *			Mode	Information Source
MSG	C/D	I/O		
0	0	0	Data Out	Initiator
0	0	1	Data In	Target
0	1	0	Command (Out)	Initiator
0	1	1	Status (In)	Target
1	1	0	Message Out	Initiator
1	1	1	Message In	Target
1	0	0	**	
1	0	1	**	

*0 = False, 1 = True ** Reserved

1.8.5.4 INFORMATION TRANSFER HANDSHAKE

The SCSI Controller transfers information by using one or more REQ/ACK Handshake(s). Each REQ/ACK handshake allows the transfer of one byte of information, during which BSY remains true and SEL remains false. During the Information Transfer phase the Controller continuously envelopes the REQ/ACK Handshake interchange with C/D, I/O, and MSG so that these control signals are valid for at least 400 nsec before the first REQ and remain valid until the negation of ACK at the end of the last Handshake.

1.8.5.5 COMMANDS PHASE

In the Command Phase the INITIATOR transfers Command Information to the TARGET via a 6-byte data packet called a Command Descriptor Block (CDB). The content of the CDB constitute the Command, TARGET Identification, Command Modifiers, and Control Byte, defined as follows:

(During the REQ/ACK handshake(s) that accompanies the Command Phase, the TARGET asserts the C/D signal and negates the I/O & MSG signals.)

A. Byte 0 contains the Command Code.

B. Byte 1 contains the Logical Unit Number (LUN) of the TARGET.

C. Bytes 2, 3 and 4 modify the Command Code of Byte 0; thus, convey further instructions to the TARGET as necessary.

D. Byte 5 is the Control Byte defined as follows:

1. **The two low order bits** (DB0 and DB1) constitute the Link Control Bit and the Flag Bit. These operate as follows:

   a. **The Link Bit** (DB0) instructs the TARGET to automatically link with the next Command following successful completion of the current Command. A TARGET that implements the Linked Commands responds with a Status of intermediate Status GOOD.

   b. **The Flag Bit** (DB1) instructs the TARGET as to the type of Status Message to send at the end of a transfer. A Flag Bit not set instructs TARGET to send LINKED COMMAND COMPLETE Status Message. A Flag Bit set instructs TARGET to send LINKED COMMAND complete with Flag Status Message.

2. **The remaining bits** in the Control Byte are reserved; they are always false. If the Flag and Link bits are set to zero, the Target sends the COMMAND COMPLETE message following command completion. The command may or may not have completed normally depending on completion status (see paragraph 1.8.5.12).

1.8.5.6 DATA PHASE

The Data Phase implements the transfer of data between the INITIATOR and TARGET, and includes a Data In and Data Out Phases, defined as follows:

A. **Data In:**

The Data-In Phase constitutes the means by which the TARGET transfers data from itself to the INITIATOR. During the REQ/ACK Handshake(s), the TARGET asserts the I/O Signal and negates the C/D and MSG Signals (Ref Table 1-4).

B. **Data Out:**

The Data-Out Phase constitutes the means by which the TARGET initiates the transfer of data from the INITIATOR to itself. During the REQ/ACK handshake(s), the TARGET negates the I/O, C/D and MSG Signals (Ref Table 1-4).

1.8.5.7 STATUS PHASE

In the Status Phase, the TARGET sends Status to the INITIATOR following a communications failure, or at the completion of Command Execution. The Status Phase consists of a Status Byte sent over the Data Bus accompanied by the proper Control Signals (Ref Table 1-4). Table 1-5 illustrates and defines the Status Byte. Normal (GOOD) completion status is indicated when the Status Byte = 00_H.

Table 1-5. Status Byte Format

Bit→	7	6	5	4	3	2	1	0
	0	0	0	INT STAT	BUSY	0	CHECK COND	0

Bit	Meaning
0	0
1	Check Condition. See Request Sense command.
2	0
3	The TARGET is Busy. This status is returned whenever the TARGET is unable to accept a Command from the INITIATOR. The normal INITIATOR recovery action is to issue the Command again at a later time.
4	Intermediate Status Good. This bit is set for any Intermediate Status sent during a series of Linked Commands.
5	Vendor Unique 0
6	Vendor Unique 0
7	Reserved 0
3,4	Reservation Conflict (bits 3 and 4 set). This status will be returned whenever a Device attempts to access a Logical Unit, or an Extent within a Logical Unit that is reserved for that type of access to another SCSI device.

1.8.5.8 MESSAGE PHASE

Using the REQ/ACK Handshake, the TARGET transfers information via the Data Bus to the INITIATOR. The Message Phase includes: Message In and Message Out. The first byte transferred in either phase is either a Single-Byte Message, or the first byte of a Multiple-Byte Message. Multiple byte messages are not supported by the SCSI Controller and will be rejected.

A. **Message In:**

Information is sent from the TARGET to the INITIATOR. During this phase, the TARGET asserts C/D, I/O, and MSG (Ref Table 1-4).

B. **Message Out:**

Information is sent from the INITIATOR to the TARGET. The TARGET invokes this phase as convenient, in response to the ATN Signal generated by the INITIATOR.

During the Message-Out phase, the TARGET asserts C/D and MSG, and negates I/O (Ref Table 1-4). If the last message received by the TARGET was inappropriate, illegal, or not implemented, the TARGET invokes the Message-In Phase and sends Message Reject. The TARGET then returns to the Message-Out Phase.

1.8.6 BUS CONDITIONS

1.8.6.1 ATTENTION

The Attention Condition consists of the INITIATOR asserting the ATN (Attention) Signal to inform the TARGET that the INITIATOR has a message ready for transmission. The TARGET retrieves the message at its convenience by initiating a Message-Out Phase.

1.8.6.2 RESET

The Reset Condition consists of any SCSI Device asserting the RES (Reset) Signal. This Signal immediately clears the SCSI Bus of all content. Reset takes precedence over all Phases, Modes and other Conditions. Upon detection of the Reset condition, the Controller:

a. Clears all uncompleted commands.
b. Releases all device reservations.
c. Sets Bus to the Bus Free Phase.
d. Clears Data Buffer on SCSI Controller.

1.9 MESSAGE SYSTEM DESCRIPTION

The Message system allows communication between an INITIATOR and a TARGET for physical path management.

The INITIATOR indicates its ability to support the Message system by asserting the ATN Signal during the Selection Phase. The TARGET indicates its ability to support Messages by going to the Message Out Phase after the Selection Phase in response to ATN.

If Parity is enabled, and the parity of the message proves to be incorrect, the TARGET re-enters the Message-Out Phase, awaiting transmission of a valid message (good parity). If after three attempts the message received still has incorrect parity, an abort sequence is executed.

Example:

The SCSI Controller is capable of operating in either a "Connected" or a "Disconnected" Mode of transfer during some commands. To enter the Disconnected mode, after all the relevant Commands and/or Data have been received, the Controller disconnects itself from the INITIATOR by letting the bus go to Bus Free Phase. The Controller can then continue to execute the current Command while the INITIATOR is free to select and operate another Device. When the Controller completes execution of the Command, it automatically wait for Bus Free, and then Arbitrates for the bus. After successful Arbitration, the Controller Reselects the INITIATOR to report Completion Status and Message information.

The method of allowing the Controller to operate in the Disconnect/Reselect mode is via the message system:

A. The INITIATOR asserts ATN.

B. After completing the Selection Phase, the Controller goes to the Message Out Phase.

C. The INITIATOR then sends the Identify Message and indicates its ability to enable Disconnect/Reselect (See Identify Message).

1.9.1 SINGLE BYTE MESSAGES

The Single Byte Messages supported by the Controller, their code values and definitions are listed in Table 1-6.

Table 1-6. Message Codes

Code (Hex)	Description	Direction *	
00	COMMAND COMPLETE	IN	
02	SAVE DATA POINTER	IN	
03	RESTORE POINTERS	IN	
04	DISCONNECT	IN	
06	ABORT		OUT
07	MESSAGE REJECT	IN	OUT
08	NO OPERATION		OUT
09	MESSAGE PARITY ERROR		OUT
0A	LINKED COMMAND COMPLETE	IN	
0B	LINKED COMMAND COMPLETE W/FLAG	IN	
0C	BUS DEVICE RESET		OUT
80-FF	IDENTIFY	IN	OUT

* IN = to INITIATOR; OUT = from INITIATOR

1.9.1.1 COMMAND COMPLETE (00 Hex)

The Controller sends the Command Complete Message to the INITIATOR to indicate that the execution of a Command (or series of Linked Commands) has terminated and that valid status has been sent to the INITIATOR. After successfully sending this message, the Controller goes to the Bus Free Phase.

Note: The command may have executed successfully or unsuccessfully as indicated in the Completion Status (Ref 1.8.5.12).

1.9.1.2 SAVE DATA POINTER (02 Hex)

The Controller sends the Save Data Pointer Message to direct the INITIATOR to save a copy of the present active Data Pointer for the currently attached LUN.

1.9.1.3 RESTORE POINTERS (03 Hex)

The Controller sends the Restore Pointers Message to the INITIATOR when the Controller detects a Bus Parity Error. The Controller then performs a Retry Sequence (SW1-3).

1.9.1.4 DISCONNECT (04 Hex)

The Controller sends the Disconnect Message to inform the INITIATOR that the Controller is about to break the present Physical Path (by deasserting BSY), but will later Reconnect to complete the current operation.

1.9.1.5 ABORT (06 Hex)

The INITIATOR sends the Abort Message to the Controller to terminate the present operation and clear the present Command. If the Controller has been identified (its LUN recognized), the Abort Message causes to Controller to clear all pending Data and Status being sent to the issuing INITIATOR, and the Controller goes to the Bus Free Phase. If the Controller has **not** been identified, it goes to the Bus Free Phase, and sends **no** Status or Ending Message. In no case, however, will pending Data and Status for other Initiators be cleared.

1.9.1.6 MESSAGE REJECT (07 Hex)

The Message Reject Message can be issued by an INITIATOR or a TARGET:

a) From INITIATOR, Message Reject indicates that the last Message received is illegal, inappropriate, or unimplemented. On receipt of this Message, the Controller checks the preceding Message. If this Message was a Save Data Pointer (02 Hex), the Controller does not disconnect.

b) To INITIATOR, Message Reject indicates that the last message received is not implemented in the Controller.

1.9.1.7 NO OPERATION (08 Hex)

The INITIATOR sends the No Operation Message in response to the Controller's Request for a Message, when the INITIATOR does not currently have any other Message to send.

1.9.1.8 MESSAGE PARITY ERROR (09 Hex)

The INITIATOR sends the Message Parity Error Message to the Controller to indicate that one or more bytes in the last Message it received had a Parity Error.

1.9.1.9 LINKED COMMAND COMPLETE (0A Hex)

The INITIATOR sends the Linked Command Complete Message to the Controller to indicate that the execution of Linked Commands has completed and that Status has been sent.

1.9.1.10 LINKED COMMAND COMPLETE (WITH FLAG) (0B Hex)

The Controller sends the Linked Command Complete (with Flag bit set) to the INITIATOR to indicate that the execution of a Command in a series of Linked Command has completed and that Status has been sent.

1.9.1.11 BUS DEVICE RESET (0C Hex)

The INITIATOR sends the Bus Device Reset Message to direct the Controller to clear all current Commands. Upon recognizing this message, the Controller goes to the Bus Free Phase. The message forces the Controller to a state wherein there are no operations pending for any INITIATOR.

1.9.1.12 IDENTIFY (80-FF Hex):

The Identify Message is a one byte Message that identifies the Device being addressed, and establishes the physical path connection between the INITIATOR and TARGET. This Message can be sent by either INITIATOR or TARGET. Its configuration is defined below:

Bit →	7	6	5	4	3	2	1	0
	1	DISC	RESERVED			LUN		

Byte Definition:

Bits 0-2 specify a LUN of the Controller being addressed. During reconnection these bytes indicate the LUN of the reconnecting Controller.

The Identification Message can include only one LUN for any one Selection Sequence. If more than one LUN is to be required, the second Identify message must not be issued until the Bus is released (Bus Free).

Bits 3-5 are reserved

Bit 6 may be set only by the INITIATOR. When set to one, it indicates that the INITIATOR has the ability to accommodate Disconnection and Reconnection.

Note: The Controller will disconnect only during Commands that involve tape motion. These Commands are listed below:

Rewind *	Read Reverse	Verify
Write	Write File Mark	Erase
Read	Space	Load/Unload

* Disconnect only if tape is **not** at BOT.

Bit 7 is always set to ONE (1).

1.10 COMMANDS

The INITIATOR, entering the Command Phase, sends a CDB (Command Data Block) to the Controller to request that a Device perform an operation. The Controller receives all six bytes of the CDB before it checks the CBD for validity (reserved bits must be ZEROs). The only time the Controller will not accept all six bytes is if an Interface Parity Error is detected. In this case the Controller sets the Check Condition Bit (Bit 1), in the Completion Status Byte.

After receiving the CDB the Controller checks for Command Validity. If an illegal Command has been sent, the Controller sets Check Condition Status, and sets the Sense Key in the Extended Sense bytes to Illegal Request, and the Command is cancelled.

If the Controller sets the Check Condition bit in the Completion Status Byte, the INITIATOR should issue a Request Sense Command to discover the reason for the Command failure.

Table 1-7 lists the available SCSI Commands. their associated operation codes and an index to their definitions.

Table 1-7. SCSI Commands

Command	Code (Hex)	Command	Code (Hex)
TEST UNIT READY	00	MODE SELECT	15
REWIND	01	RESERVE UNIT	16
REQUEST SENSE	03	RELEASE UNIT	17
READ BLOCK LIMITS	05	ERASE	19
READ	08	MODE SENSE	1A
WRITE	0A	LOAD/UNLOAD	1B
READ REVERSE	0F	RECEIVE DIAG RESULTS	1C
WRITE FILE MARK	10	SEND DIAGNOSTIC	1D
SPACE	11	WRITE DATA BUFFER	3B
INQUIRY	12	READ DATA BUFFER	3C
VERIFY	13		
RECOVER BUFFER DATA	14		

1.10.1 TEST UNIT READY (Hex 00)

The Test Unit Ready Command checks the Controller for On-Line and Ready. If the Controller is On-Line and Ready (not Rewinding), the Command terminates with GOOD Status in the Completion Status Byte.

Table 1-8. TEST UNIT READY (00 Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	0	0	0	0	0
Byte 1	LUN			RESERVED				
Byte 2	RESERVED							
Byte 3	RESERVED							
Byte 4	RESERVED							
Byte 5	0	0	RESERVED				FLAG	LINK

1.10.2 REWIND

The Rewind Command (Table 1-9) requests that the Controller rewind tape to Beginning Of Tape (BOT).

An IMED Bit set to ONE indicates that status should be returned as soon as the operation begins. An IMED Bit of Zero indicates that status should be returned when the operation is complete (tape rewound to BOT).

Table 1-9. REWIND (01 Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	0	0	0	0	1
Byte 1	LUN			RESERVED				IMED
Byte 2	RESERVED							
Byte 3	RESERVED							
Byte 4	RESERVED							
Byte 5	0	0	RESERVED				FLAG	LINK

1.10.3 REQUEST SENSE

The INITIATOR uses the Request Sense Command (Table 1-10) to obtain more detailed status information after a Command has been executed. The sense data will be valid for the Check Condition (or status) last presented to the INITIATOR, and will clear on the receipt of any subsequent Command to the unit in check. Byte four of this Command specifies the number of bytes to be returned to the INITIATOR.

A Request for zero bytes results in a transfer of four Sense Bytes. A request of more than zero bytes results in the transfer of the requested number of Sense Bytes, up to 20 bytes maximum.

Table 1-10. REQUEST SENSE (03 Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	0	0	0	1	1
Byte 1	LUN			RESERVED				
Byte 2	RESERVED							
Byte 3	RESERVED							
Byte 4	NUMBER OF REQUESTED SENSE BYTES							
Byte 5	0	0	RESERVED				FLAG	LINK

1.10.3.1 REQUEST SENSE BYTES

Table 1-11 illustrates Sense Byte Format, and each Sense Byte is described below:

Table 1-11. Sense Byte Data Format

Bit →	7	6	5	4	3	2	1	0
Byte 0	VALID	1	1	1	0	0	0	DEFER
Byte 1	0	0	0	0	0	0	0	0
Byte 2	FMK	EOM	ILI	0	SENSE KEY			
Byte 3	INFORMATION BYTE (MSB)							
Byte 4	INFORMATION BYTE							
Byte 5	INFORMATION BYTE							
Byte 6	INFORMATION BYTE (LSB)							
Byte 7	ADDITIONAL SENSE LENGTH (06 Hex)							
Bytes 8-11 0	0	0	0	0	0	0	0	
Byte 12	ADDITIONAL SENSE CODE							
Byte 13	ADDITIONAL SENSE CODE QUALIFIER							

Byte 0

Bits 0-6: Indicate that the error code information returned is of the Extended Sense Format.

Code 70 Hex - Exception - indicates that the Check Condition Status returned is the result of an error or exception condition on the Command that returned the Check Condition status.

Code 71 Hex - Deferred Error - indicates that the Check Condition status returned is the result of an error or exception condition on a previous command (deferred error). If during a Buffered Mode Write Operation, a Tape Error or End of Tape is encountered, the next command issued to the unit in check will return Check Condition Status (excluding the Request Sense command), and the Error Code will be set to 71 Hex (Deferred Error). The current command (the command returning Check Condition) will not have been executed.

Bit 7: The VALID bit indicates that the information bytes contain valid device information.

Byte 1

00_H is zero.

Byte 2

FMK: The current command detected a File Mark. This bit will not be set if the previous command was a Write File Mark command that completed properly.

EOM: The End-of-Media bit indicates EOT if the previous command was forward, or BOT if the previous command was reverse.

ILI: The Incorrect Length Indicator indicates that the requested data transfer length did not match the length of the data block encountered on tape.

SENSE KEY: The Sense Key gives detailed information on the completion status of the previous command. The Sense Key is defined in Table 1-12.

Bytes 03-06

INFORMATION BYTES: The Information Bytes are not defined if the VALID bit is ZERO. If the VALID bit is ONE, the Information Bytes contain the difference (residue) between the requested length and the actual length in either bytes or blocks, as determined by the command (Negative values are indicated by two's complement notation).

Byte 07

ADDITIONAL SENSE LENGTH: The Additional Sense Length specifies the amount of additional sense bytes to follow (06 Hex).

Bytes 08-11

Bytes 8 through 11 are set to 00_H.

Bytes 12 and 13

ADDITIONAL SENSE CODES: The Additional Sense Code and Additional Sense Qualifier provide additional device-specific error information. The additional sense error codes are shown in Table 1-13.

Table 1-12. Sense Key Descriptions

KEY (Hex)	Description
0	NO SENSE - Indicates that there is no error information to be reported. This occurs for a successful command, or a command that set the Check Condition because one of the FMK, EOM, or ILI bits are set to ONE.
1	RECOVERED ERROR - Indicates that the last Command completed successfully but with some recovery action performed by the Controller.
2	NOT READY - Indicates that the addressed Controller is not Ready.
3	MEDIA ERROR - Indicates a Media Error was detected during the previous Read or Write Command.
4	HARDWARE ERROR - The Controller detected an Unrecoverable Hardware Error (Write File Mark with no File Mark read back, Rewind issued with no Rewind status from Drive, Erase to EOT issued with no EOT Status reported by Drive at command completion).
5	ILLEGAL REQUEST - a) An illegal Command was included in the CDB. b) A Fixed Mode Read or Write Operation was requested when the Controller was operating in variable mode. c) A Variable Mode Read or Write was requested when the Controller was operating in Fixed Mode. d) When in Fixed or Variable Mode, a selected block length is greater than 64K bytes or less than 2 bytes.
6	UNIT ATTENTION - Indicates that the tape may have been changed (online-offline-online), or that the Controller has been reset or has not been accessed by the requesting INITIATOR since power-on.
7	DATA PROTECT - Indicates that a Write Command was attempted on a Write-Protected Drive. No data will have been transferred to the Controller.
8	BLANK CHECK - A Read Command was attempted and no data blocks were found. Indicates 25 feet of blank tape.

Table 1-12. Sense Key Descriptions (Continued)

KEY (Hex)	Description
B	ABORTED COMMAND - The Controller aborted the Command.
D	VOLUME OVERFLOW - Only applicable in Fixed Mode. Indicates that the Controller has detected End of Media, and there is data in the Controller Buffer that has not been written. The INITIATOR can issue a Recover-Buffered-Data Command to read the unwritten data from the Buffer.

Table 1-13. Additional Sense Data

Sense Key	Byte 12	Byte 13	Description
NO SENSE	00	00	No additional sense information
(0 Hex)	00	01	File Mark detected
	00	02	End of Tape detected
	00	04	Beginning of tape detected
RECOVERED ERROR			(Active only if SW1-2 is OFF and SW2-2 is ON)
	17	01	Recovered Read Data with Read Retries
(1 Hex)	0D	01	Recovered Write Data with Write Retries
	0E	00	Recovered Interface Error
NOT READY	04	00	Drive offline
(2 Hex)	04	01	Volume not ready (rewinding)
MEDIA ERROR			
(3 Hex)	11	00	Unrecoverable Read Error
	11	01	Read Retries exhausted
	11	06	No File Mark found (Read After Write)
	1F	00	Unrecoverable Write Error
	1F	01	Write Retries exhausted - Block
	1F	02	Write Retries exhausted - File Mark
	23	00	Error during Space Command
	14	00	No Record found
HARDWARE	0B	00	Time-out Error (load)
ERROR	40	00	Diagnostics failure
(4 Hex)	40	01	Ram failure
	40	03	Checksum Error
	42	00	Power-on failure
	44	00	Internal SCSI Controller Error
	51	00	Erase fault
	56	00	Failure to sense BOT

Table 1-13. Additional Sense Data (Continued)

Sense Key	Byte 12	Byte 13	Description
ILLEGAL REQUEST (5 Hex)	34	01	Invalid command operation code
	34	04	Reserved bit/field set
	34	07	Fixed bit set in variable block mode
	34	08	Fixed bit not set in fixed block mode
	34	0B	Requested block length not in valid range
	34	0C	Unsupported function
	26	00	Invalid field in Parameter List
	26	01	Requested Density not available
	26	02	Fixed Block Length not in valid range
	26	03	Not at BOT
	26	04	Requested speed not available
UNIT ATTENTION (6 Hex)	28	00	Not Ready to Ready transition (Tape changed)
	29	00	Power-on, Reset or Bus Device Reset occurred
DATA PROTECT (7 Hex)	27	00	Write Protected
BLANK CHECK 8 (Hex)	2E	00	Tape Void detected (25 feet)
ABORTED COMMAND (B Hex)	43	03	Message Parity Error
	47	00	Interface Parity Error
VOLUME OVERFLOW (D Hex)	62	00	Overflow Error

1.10.3.2 READ BLOCK LIMITS

The Read Block Limits Command (Table 1-14) requests that the Block Length Limits of the addressed Controller be returned. The Read Block Limits Data (Table 1-15) will be returned during the Data In Phase of the command.

Table 1-14. READ BLOCK LIMITS (05 Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	0	0	1	0	1
Byte 1	LUN			RESERVED				
Byte 2	RESERVED							
Byte 3	RESERVED							
Byte 4	RESERVED							
Byte 5	0	0	RESERVED				FLAG	LINK

Table 1-15. READ BLOCK LIMITS DATA

Bit →	7	6	5	4	3	2	1	0
Byte 0	RESERVED							
Byte 1	MAXIMUM BYTE COUNT (MSB)							
Byte 2	MAXIMUM BYTE COUNT							
Byte 3	MAXIMUM BYTE COUNT (LSB)							
Byte 4	MINIMUM BYTE COUNT (MSB)							
Byte 5	MINIMUM BYTE COUNT (LSB)							

If the maximum byte count equals the minimum byte count, then Fixed Length Blocks are specified, otherwise Variable Length Blocks are specified. For a Fixed Length Block of 64K bytes, the maximum byte count will be set to 64K and the minimum byte count will be set to zero.

1.10.3.3 READ

The Read Command (Table 1-16) transfers one or more blocks to the INITIATOR beginning with the next block on tape.

Table 1-16. READ Command (08 Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	0	1	0	0	0
Byte 1	LUN			RESERVED			SILI	FIXED
Byte 2	BYTES/BLOCKS TO TRANSFER (MSB)							
Byte 3	BYTES/BLOCKS TO TRANSFER							
Byte 2	BYTES/BLOCKS TO TRANSFER (LSB)							
Byte 5	0	0	RESERVED				FLAG	LINK

General:

The state of FIXED Bit determines whether the Command is for a Drive that has been set to transfer a fixed length block. FIXED Bit set = Drive must be set to transfer only fixed length blocks. FIXED Bit not set = Drive must be set to transfer variable length blocks (done via mode select).

The state of SILI (Suppressed Illegal Length Indicator) Bit combined with the state of FIXED Bit determines conditions that are described below:

The state of Command Bytes 2 thru 4 define the **length** of the data block to transfer or the **number** of blocks to transfer depending on the FIXED bit.

Table 1-17 lists and describes the conditions that determine a Read Data Transfer.

Table 1-17. Read Conditions of Data Transfer
Read Command Byte 1 Bit Configuration

Bit 1	Bit 0	Conditions/Response
0	0	**Variable Length Transfer:** 1. Transfer number of bytes specified. 2. If block length on tape differs from that specified, send Check Condition Status and set ILI and VALID Bits in Extended Sense Bytes. 3. If block length on tape is less than requested, transfer all data from tape and set Extended Sense Information Bytes to difference between requested number of bytes and actual number transferred. 4. If block length on tape is greater than that requested, transfer only requested number of bytes, and set Extended Sense Information Bytes to twos Complement of difference between bytes transferred and bytes requested.

Table 1-17. Read Conditions of Data Transfer (Continued)

Bit 1	Bit 0	Conditions/Response
1	0	**Variable Length Transfer:** Same as above, but do not set Check Conditions Status if the only error is that actual transfer length does not equal block length on tape.
0	1	**Fixed Length Transfer:** Fixed Length Commands are valid only if Drive is set to operate in Fixed Block Mode, defined as follows: a. In response to a READ BLOCK LIMITS Command, the Drive reports Minimum Block Count = Maximum Block Count; or b. The Drive has been instructed to use fixed block sizes with the Mode Select Command. 1. Transfer blocks specified. 2. If there is any variation between block length on tape and the selected block length, set Check Condition Status, and set ILI and VALID in Extended Sense Byte. 3. If File Mark is detected, set Check Condition Status, and set FMK in Extended Sense Byte. Also set Information Bytes to difference between blocks transferred and blocks requested. 4. If EOT is detected, set Check Condition Status and EOM in Extended Sense Byte. Sense key set to volume overflow. Set Information Bytes to difference between blocks transferred and the number of bytes requested.
1	1	**Fixed Length Transfer with ILI:** No data transferred. Same as above, but set Sense Key to Illegal Request.
ALL		If 25 feet of blank tape is detected, set ILI and VALID in Extended Sense Byte, and set Blank Check (8 Hex) in Sense Key. Set Information Bytes to the requested block size or number of blocks to transfer.

1.10.3.4 WRITE

The Write command (Table 1-18) transfers one or more blocks from the INITIATOR to the current block position on the addressed Drive (Logical Unit). The FIXED bit specifies both the meaning of the Transfer Length field and whether Fixed or Variable length blocks are to be transferred.

Table 1-18. WRITE (0A Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	0	1	0	1	0
Byte 1	LUN			RESERVED				FIXED
Byte 2	BYTES/BLOCKS TO TRANSFER (MSB)							
Byte 3	BYTES/BLOCKS TO TRANSFER							
Byte 2	BYTES/BLOCKS TO TRANSFER (LSB)							
Byte 5	0	0	RESERVED				FLAG	LINK

Variable Length Transfer:

When the FIXED bit is ZERO the command transfers a single block from the Initiator to the Controller to be written to the addressed unit. Bytes 2-4 of the CDB specify the size of the block to be written (minimum block size = 2 bytes, maximum block size = 64K bytes).

Variable length Write Commands are only valid when the unit is operating in Variable Mode (see Mode Select). If a Variable Length Write is attempted when the Controller is set to Fixed mode, or the requested byte count is greater than 64K bytes, Check Condition Status will be returned to the INITIATOR and the Sense Key in the Extended Sense will be set to Illegal Request.

When operating in Buffered Mode, four (4) 64K blocks can be held in the Controller Buffer. If EOT is encountered, the Controller empties all four Buffers to tape. The next Command issued causes the Controller to set Check Condition and report Deferred Error Status (EOM) (the Command was not executed). If the INITIATOR wants to continue writing past EOT, the Controller will operate in the Non-Buffered Mode (Single Block only) and report Check Condition (EOM) on all forward motion commands.

Fixed Length Transfer:

When the FIXED bit is set, the Command transfers the specified number of blocks from the INITIATOR to the addressed Controller. Bytes 2-4 of the CDB specify the number of blocks to be transferred. Fixed Mode Write Commands are valid only if the unit is operating in Fixed Block Mode (see Mode Select).

Non-Buffered:

When EOT (or an Unrecoverable Error) is encountered, the Controller sets Check Condition status, and sets EOM in the Sense Byte. If any data remains in the Controller Buffer, the Controller sets the Sense Key to Volume Overflow, and sets the Information Bytes to the difference between the requested number of blocks and the actual number of blocks written to tape.

Buffered:

When EOT (or an Unrecoverable Error) is encountered, the Controller halts transfer of data to the tape unit, assembles the Request Sense Bytes as mentioned earlier, but sets byte 0 of the Extended Sense Bytes to 71 Hex (Error Class 7 Hex, Error Code 1 Hex) Deferred Error. The next Command issued (except Request Sense) reports Check Condition Status, and the subsequent Request Sense returns the previously assembled Sense Bytes. The current Command was not executed. In both modes the INITIATOR should issue a Recover Buffered Data Command to remove the unwritten data from the buffer.

1.10.3.5 READ REVERSE

The Read Reverse Command (Table 1-19) functions identically to the Read Command except that tape motion is in the reverse direction. The bytes within the block are transferred in reverse order, and the tape will be positioned on the BOT side of the block at command completion.

Table 1-19. READ REVERSE Command (0F Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	0	1	1	1	1
Byte 1	LUN			RESERVED			SILI	FIXED
Byte 2	BYTES/BLOCKS TO TRANSFER (MSB)							
Byte 3	BYTES/BLOCKS TO TRANSFER							
Byte 2	BYTES/BLOCKS TO TRANSFER (LSB)							
Byte 5	0	0	RESERVED				FLAG	LINK

If BOT is encountered, the Controller sets Check Condition Status, the EOM Bit in the Extended Sense, and sets the Sense Key to No Sense. If the Drive is operating in Fixed Mode, the Controller sets the VALID bit, and sets the Information Bytes to the difference between the requested number of blocks and the actual number of blocks transferred (same as Read at EOT).

File Mark handling is the same as in the Read Command except that the tape is positioned on the BOT side of the File Mark.

1.10.3.6 WRITE FILE MARK

The Write File Mark command (Table 1-20) causes the specified number of File Marks to be written on the addressed unit beginning at the current tape position.

Table 1-20. WRITE FILE MARK Command (10 Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	0	0	0	0
Byte 1	LUN			RESERVED				
Byte 2	NUMBER OF FILE MARKS (MSB)							
Byte 3	NUMBER OF FILE MARKS							
Byte 4	NUMBER OF FILE MARKS (LSB)							
Byte 5	0	0	RESERVED				FLAG	LINK

The number of File Marks to be written is specified in bytes 2-4 of the CDB. A ZERO value specifies that no File Marks are to be written.

When operating in Fixed Mode, if during the execution of a Command, an Unrecoverable Parity Error is detected, the Write File Mark Command can be used to force-write any remaining Buffer Data to tape, providing an EOT was not encountered in a previous Write Operation. If the number of file marks count is zero, the remaining Buffer Data will be written to tape without File Marks. If the count is other than zero, any remaining Buffer Data will be written to tape followed by the specified number of File Marks. **The original block in error will be left on tape.**

If EOT is encountered during the execution of a Write File Mark Command, the operation terminates, and the Controller sets Check Condition Status and the EOM Bit in the Extended Sense. If any data remains in the Data Buffer, the Controller sets the Sense Key to Volume Overflow, and the Information Bytes to the number of unwritten data blocks plus File Marks.

1.10.3.7 SPACE

The Space Command (Table 1-21) provides a variety of positioning functions which are determined by the CODE and COUNT fields. When spacing over Blocks or File Marks, the COUNT field specifies the number of Blocks or File Marks to be spaced over. Both forward and reverse positioning are provided for. A positive value in the COUNT Field indicates tape motion is forward, a negative value (2's complement) in the COUNT Field indicates tape motion is reverse.

Table 1-21. SPACE Command (11 Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	0	0	0	1
Byte 1	LUN			RESERVED			CODE	
Byte 2	COUNT (MSB)							
Byte 3	COUNT							
Byte 4	COUNT (LSB)							
Byte 5	0	0	RESERVED				FLAG	LINK

CODE Field:

The Code Field bits determine the function to be executed. The Code Field is defined as follows:

CODE (Hex)	Description
0	Space Blocks
1	Space File Marks
2	Space Sequential File Marks
3	Space Physical End-of-Data

When spacing over Blocks or File Marks, bytes 2-4 of the CDB specify the number of Blocks or File Marks to be spaced over.

If a File Mark is encountered while spacing over Blocks, the Controller terminates operation and sends Check Condition Status to the INITIATOR. The Controller also sets the Information Bytes in the Extended Sense to the difference between the requested number of Blocks and the actual number of Blocks spaced over (not including the File Mark).

For both Space Blocks or Space File Marks, if EOT or BOT is encountered, the above condition of setting the difference in the Information Bytes again applies.

When Spacing over sequential File Marks, the COUNT Field should be set to the required number of sequential File Marks to be found before termination. For example, if the COUNT Field was set to a positive value of 3, three consecutive File Marks must be encountered in the forward direction before successful completion.

When Spacing to Physical End-of-Data, the COUNT field is ignored. Forward tape movement occurs until 25 feet of blank tape (or EOT) is encountered. When blank tape is encountered, the unit is repositioned immediately after the last data block on tape (at the start of the 25 feet of blank tape).

With switch SW2-5 (ref Switch Settings, Section 2.2.1) in the ON position, physical End-of-Data is defined as 25 feet of blank tape or an Unrecoverable Tape Error. If an Unrecoverable Tape Error is detected before encountering 25 feet of blank tape, the Command terminates, and the tape is positioned prior to the Block in error (BOT side).

With switch SW2-5 in the OFF position, 25 feet of blank tape must be encountered for successful command completion.

1.10.3.8 INQUIRY

The Inquiry Command (Table 1-22) requests that the Controller send parameter information (Inquiry Data) to the Initiator.

Table 1-22. INQUIRY Command (12 Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	0	0	1	0
Byte 1	LUN			RESERVED				
Byte 2	RESERVED							
Byte 3	RESERVED							
Byte 4	ALLOCATION LENGTH							
Byte 5	0	0	RESERVED				FLAG	LINK

Byte four of the CDB specifies the number of bytes that the INITIATOR has allocated for returned Inquiry Data. The Controller has Forty bytes of Inquiry Data available for transfer to the INITIATOR. If the Allocation Length exceeds forty bytes, only forty bytes will be transferred. If Allocation Length is zero, no bytes will be transferred. The format of Inquiry Data is shown in Table 1-23.

Table 1-23. INQUIRY Command Data

Bit →	7	6	5	4	3	2	1	0
Byte 0	1	DEVICE TYPE						
Byte 1	1	DEVICE QUALIFIER						
Byte 2	0	0	0	0	0	(ANSI IDENT) 0	0	1
Byte 3	RESERVED							
Byte 4	0	0	1	0	0	0	1	1
Bytes 5-7	0	0	0	0	0	0	0	0
Bytes 8-15	VENDOR IDENTIFICATION							
Bytes 16-31	PRODUCT IDENTIFICATION							
Bytes 32-39	SOFTWARE REVISION LEVEL							

Byte 0 - Device Type:

Byte 0 contains a code that identifies the type of device being queried. Code 01 Hex identifies the device as a sequential access device, that is powered on but not necessarily online.

Byte 1:

Bits 0-6, The Device Qualifier, is a seven bit user-specified code which may be set via switch SW2 (Ref Table 2-3).

Bit 7 indicates that the media is removable. 1 = media removable.

Byte 2:

Bits 0 thru 2 identify the Command Protocol. Set to 001 - indicates that the Controller uses approved ANSI SCSI Protocol, drawing on ANSI REV 17B, ANSI 3.131-1986 and SCSI-II Enhancements.

Byte 3: Reserved

Byte 4: Additional Length. Set to 23 Hex

Bytes 5 - 7: Reserved

Bytes 8-15: Vendor Identification

Data returned in ASCII format.
"KENNEDY_", ASCII = 4B 45 4E 4E 45 44 59 20

Bytes 16-31: Product Identification

Identifies the Device as a Tape Controller. Data is in ASCII format.
"96X2_TAPE_UNIT__" ASCII = 39 36 58 32 20 54 41 50
45 20 55 4E 49 54 20 20

Bytes 32-39: Software Revision Level

Identifies Controller's current firmware revision level. Data is in ASCII format.
"241-XXXY" ASCII = 32 34 31 2D X X X Y

Where: X = Firmware revision
Y = Unique Revision Identifier

1.10.3.9 VERIFY

The Verify Command (Table 1-24) verifies one or more Blocks, beginning with the next Block on the addressed Controller. The FIXED bit specifies both the meaning of the Verification Length Field and whether Fixed or Variable Length Blocks are to be verified.

The Controller does not support Byte Compare Mode. The verification performed is that of a media verification of the length of the Block read from tape. The operation is similar to that of a Read Command except no data is transmitted to the INITIATOR.

Table 1-24. VERIFY Command (13 Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	0	0	1	1
Byte 1	LUN			RESERVED				FIXED
Byte 2	BYTES/BLOCKS TO VERIFY (MSB)							
Byte 3	BYTES/BLOCKS TO VERIFY							
Byte 4	BYTES/BLOCKS TO VERIFY (LSB)							
Byte 5	0	0	RESERVED				FLAG	LINK

Variable Length Transfer

If the FIXED bit is a ZERO, bytes 2-4 specify the verification length of the next block on tape. If the actual block size read from tape is different than the specified number of bytes, Check Condition status will be returned to the Initiator and the ILI bit will be set in the Extended Sense. The Information Bytes will be set to the difference between the requested block length and the actual block length read from tape.

Fixed Length Transfer

If the FIXED bit is a ONE, bytes 2-4 specify the number of blocks to be verified. The Verify Command terminates when the number of blocks to verify has been satisfied. When a File Mark or EOT is encountered, Check Condition Status will be returned to the INITIATOR and the Information Bytes in the Extended Sense will be set to the difference between the requested number of blocks and the actual number of blocks verified.

1.10.3.10 RECOVER BUFFERED DATA

The Recover Buffered Data Command (Table 1-25) is used to read data that has been transferred to the Controller Buffer, but has not been written to tape. It is normally used only to recover data that was transferred to the Controller but not written to tape because EOT or a Medium Error was detected when operating in Fixed Mode or a medium error was detected in Variable Mode.

Table 1-25. RECOVER BUFFERED DATA Command (14 Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	0	1	0	0
Byte 1	LUN			RESERVED			FIXED	
Byte 2	NUMBER OF BLOCKS (MSB)							
Byte 3	NUMBER OF BLOCKS							
Byte 4	NUMBER OF BLOCKS (LSB)							
Byte 5	0	0	RESERVED				FLAG	LINK

The Recover Buffer Data Command is similar in operation to the Read Command except that data is transferred from the Controller Buffer and not from tape. Blocks will be transferred from the Controller Buffer in the same order they would have been written to tape. If an attempt is made to recover more logical blocks of data than are contained in the Controller Buffer, the Command terminates with Check Condition Status, and the EOM Bit will be set to ONE. The Sense Information Bytes will contain the number of blocks that could not be transferred.

Bytes 2-4 of the CDB should specify the number of blocks to be transferred. A value of ZERO indicates that no blocks are to be transferred.

1.10.3.11 MODE SELECT

The Mode Select Command (Table 1-26) provides a means for the INITIATOR to specify Media, Unit or Device Parameters. Byte 4 of the CDB specifies the length of a parameter list which is sent to the Controller as data. The Parameter List (Table 1-27) contains a list of Extent Descriptors. The Extent Descriptor List (Table 1-28) specifies Fixed or Variable block lengths, block size, and density code.

Table 1-26. MODE SELECT Command (15 Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	0	1	0	1
Byte 1	LUN			RESERVED				
Byte 2	RESERVED							
Byte 3	RESERVED							
Byte 4	PARAMETER LIST LENGTH							
Byte 5	0	0	RESERVED				FLAG	LINK

Table 1-27. Mode Select Data Parameter List

Bit →	7	6	5	4	3	2	1	0
Byte 0	RESERVED							
Byte 1	RESERVED							
Byte 2	0	0	0	BM	SPEED			
Byte 3	LENGTH OF DESCRIPTOR LIST							

Table 1-28. Descriptor List

Bit →	7	6	5	4	3	2	1	0
Byte 0	DENSITY CODE							
Byte 1	0	0	0	0	0	0	0	0
Byte 2	0	0	0	0	0	0	0	0
Byte 3	0	0	0	0	0	0	0	0
Byte 4	RESERVED							
Byte 5	BLOCK SIZE (MSB)							
Byte 6	BLOCK SIZE							
Byte 7	BLOCK SIZE (LSB)							

Buffered Mode:

If the BM Bit is set to a ONE, the Controller will report GOOD Status on Write Commands as soon as the data block has been transferred to the Controller Buffer.

During a Write File Mark Command, if the BM Bit is a ONE, and the tape is not at EOM, all unwritten data blocks will be force written onto tape.

Speed Select

Speed (Hex)	Speed Selected
0	Default, low speed
1	Low Speed Select
2	High Speed Select
3-F	Reserved

Density Select

Density (Hex)	Density Selected
00	Default (no change)
01	Select NRZI (800 bpi)
02	Select PE (1600 bpi)
03	Select GCR (6250 bpi)
06	Select 2XPE (3200 bpi)

Block Size and Variable/Fixed Mode Select:

The contents of Bytes 5-7 of the Descriptor List determine Block Size and whether Variable or Fixed Mode is selected.

A Block Size Field of zero specifies Variable Mode, with a minimum Block Length of 2 bytes and a maximum of 64k bytes.

A Block Size Field of 2 to 64k bytes inclusive selects Fixed Mode operation with a Block Length as specified. A specified Block Length outside of this ranges results in Check Condition Status and the Sense Key in the Extended Status to be set to Illegal Operation.

1.10.3.12 RESERVE UNIT

The Reserve Unit Command (Table 1-29) reserves the specified Controller for the exclusive use of the requesting INITIATOR or, if Third-Party Reservation is selected, for use by another specified SCSI Device.

Table 1-29. RESERVE UNIT Command (16 Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	0	1	1	0
Byte 1	LUN			3 PTY	3 PARTY ID			RES
Byte 2	RESERVED							
Byte 3	RESERVED							
Byte 4	RESERVED							
Byte 5	0	0	RESERVED				FLAG	LINK

If the 3 PTY Bit is ZERO, then the third-party reservation option is not requested. If the 3 PTY Bit is ONE, then the Reserve Unit Command reserves the specified Controller for the Device specified in the 3rd Party ID Field.

The reservation will remain in effect until superseded by another Reserve Unit Command from the same INITIATOR or until released by a Release Unit Command from the same INITIATOR , or a Bus Device Reset Message from any INITIATOR, or a "Hard" Reset condition.

A Bus Device Reset Message, or a Hard Reset causes the Controller to set the Unit Attention Code in the next Sense Key for the next Request Sense Command following the condition. It is not an error to issue this Command to a Controller that is currently reserved by the requesting INITIATOR. If the logical unit has been previously reserved by another INITIATOR, then the Controller sends Reservation Conflict Status.

The Third-Party Reservation Option for the Reserve Unit Command allows an INITIATOR to reserve a specific Controller for another Device. This option is intended for use in multiple INITIATOR systems that use the Copy command.

An INITIATOR that holds a current reservation may modify that reservation (change third parties) by issuing another Reserve Unit Command.

1.10.3.13 RELEASE UNIT

The Release Unit Command (Table 1-30) releases the Controller if it is currently reserved by the requesting INITIATOR.

Table 1-30. RELEASE UNIT Command (17 Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	0	1	1	1
Byte 1	LUN			3 PTY	3 PARTY ID			RES
Byte 2	RESERVED							
Byte 3	RESERVED							
Byte 4	RESERVED							
Byte 5	0	0	RESERVED				FLAG	LINK

An INITIATOR can release the Controller specified in the 3RD PARTY ID Field if it had originally reserved that Controller for a third party (Controller) using the Third Party Reservation Option. Third Party release is obtained by setting the 3 PTY Bit to ONE.

An INITIATOR can legally attempt to release a Controller that was reserved by another INITIATOR, but will be unable to do so. It is not an error.

1.10.3.14 ERASE

The Erase Command (Table 1-31) erases all or part of the remaining tape, beginning at the current tape position.

Table 1-31. ERASE Command (19 Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	1	0	0	1
Byte 1	LUN			RESERVED				LONG
Byte 2	RESERVED							
Byte 3	RESERVED							
Byte 4	RESERVED							
Byte 5	0	0	RESERVED				FLAG	LINK

The distance to be erased is controlled by the LONG bit. If the LONG bit is ZERO, 3.5 inches of tape will be erased. If the LONG bit is a ONE, tape will be erased from its current position to EOT. At the completion of the command, tape will be positioned approximately 3 feet past EOT.

1.10.3.15 MODE SENSE

The Mode Sense Command (Table 1-32) provides a means for the Controller to report its media and device type parameters to the INITIATOR.

Table 1-32. MODE SENSE Command (1A Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	1	0	1	0
Byte 1	LUN			RESERVED				
Byte 2	RESERVED							
Byte 3	RESERVED							
Byte 4	LENGTH OF DATA LIST							
Byte 5	0	0	RESERVED				FLAG	LINK

The Length of Data List specifies the maximum number of bytes that may be sent by the Controller as data. The format of the data is shown in Table 1-33.

Table 1-33. Mode Sense Data Format

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	0	1	0	1	1
Byte 1	0	0	0	0	0	0	0	0
Byte 2	WP	0	0	BM	SPEED			
Byte 3	0	0	0	0	1	0	0	0
Byte 4	DENSITY CODE							
Byte 5	0	0	0	0	0	0	0	0
Byte 6	0	0	0	0	0	0	0	0
Byte 7	0	0	0	0	0	0	0	0
Byte 8	RESERVED (ZEROS)							
Byte 9	BLOCK LENGTH (MSB)							
Byte 10	BLOCK LENGTH							
Byte 11	BLOCK LENGTH (LSB)							

Byte 0:

Sense Data Length: Length in bytes of the following data (0B Hex)

Byte 1:

Medium Type (00 Hex)

Byte 2:

Bits 0-3 (SPEED): Code values for the Speed field are as follows:

Code (Hex)	Speed
0	Default Speed (low)
1	Low Speed
2	Hi-Speed

Bit 4 (BM): If the BM (Buffered Mode) Bit is set to ONE, the Controller reports Good Status on Write Commands as soon as the data has been transferred to the Controller Buffer.

Bit 7 (WP): If the WP (Write Protect) Bit is set to ONE, it indicates that the tape is Write Protected.

Byte 3:

Block Descriptor Length (08 Hex)

Byte 4:

DENSITY CODE: Code values for the Density field are as follows:

Code (Hex)	Density	Code (Hex)	Density
01	NRZI (800 bpi)	03	GCR (6250 bpi)
02	PE (1600 bpi)	06	DDPE (3200 bpi)

Bytes 5-8:

Bytes 5-8 will be returned as all ZEROs

Bytes 9-11:

Block Length: If the Block Length bytes are returned as zero, the specified unit is operating in Variable mode.

If the Block Length bytes are returned as non-zero, the specified unit is operating in Fixed Mode. The Fixed Block Length is specified by the value of the Block Length Bytes.

1.10.3.16 LOAD/UNLOAD

The LOAD/UNLOAD Command (Table 1-34) will either Load or Unload a tape depending on the value of the LOAD bit.

Table 1-34. UNLOAD Command (1B Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	1	0	1	1
Byte 1	LUN			RESERVED				IMED
Byte 2	RESERVED							
Byte 3	RESERVED							
Byte 4	RESERVED							LOAD
Byte 5	0	0	RESERVED				FLAG	LINK

An IMED Bit of ONE causes the Drive to send Status immediately upon reception of a Command.

An IMED Bit of ZERO causes the Drive to disconnect upon receipt of a Command, and reconnect and send Completion Status when the Command execution is complete.

A LOAD Bit of ONE loads and positions the mounted tape to the BOT Marker and sets the Controller Online.

A LOAD Bit of ZERO rewinds the tape to BOT, and sets the specified Tape Drive to Off-Line. The Drive then rewinds tape from the take-up reel onto the supply reel, and the tape reel can be removed from the Drive.

1.10.3.17 RECEIVE DIAGNOSTIC RESULTS

The Receive Diagnostics Results Command (Table 1-35) requests that analysis data be sent to the Initiator after completion of a Send Diagnostic command.

Table 1-35. RECEIVE DIAGNOSTIC RESULTS Command (1C Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	1	1	0	0
Byte 1	LUN			RESERVED				
Byte 2	RESERVED							
Byte 3	ALLOCATED LENGTH (MSB)							
Byte 4	ALLOCATED LENGTH (LSB)							
Byte 5	0	0	RESERVED				FLAG	LINK

The Allocation Length specifies the number of bytes to be sent to the INITIATOR as diagnostic data.

The Controller allocates 9 bytes of data. If the Allocation Length is greater than 9 bytes, only 9 bytes are sent.

Diagnostic data sent by the Controller is shown in Table 1-36.

Table 1-36. DIAGNOSTIC RESULTS Data

Bit →	7	6	5	4	3	2	1	0
Byte 0	ERROR NUMBER							
Byte 1	TEST NUMBER							
Byte 2	INFORMATION BYTE (MSB)							
Byte 3	INFORMATION BYTE							
Byte 4	INFORMATION BYTE (LSB)							
Byte 5	EXPECTED DATA BYTE							
Byte 6	ACTUAL DATA BYTE							
Byte 7	STATUS BYTE 1							
Byte 8	STATUS BYTE 2							

Byte 0:

Error Number: If the Error Number is returned as 00 Hex, then the Command completed successfully. Any other Code indicates the cause of the error.

Code (Hex)	Failure	Code (Hex)	Failure
80	Dynamic RAM data error	85	Block Length error
81	Write File Mark error	86	Data error
82	Erase error	87	Tape Parity error
83	Rewind error	88	Read Reverse error
84	Blank Tape error	89	Abnormal status

Test Number: Any Test Number other than zero indicates that the test failed.

Information Bytes:

Bytes 2-4. - A Dynamic RAM error causes Bytes 2 thru 4 to indicate the failed RAM Address.

A Block Length Error causes Bytes 2 thru 4 to indicate the difference between the Requested Block Size and the Actual Block Size from tape.

Bytes 5, 6. - A RAM Data Error causes Byte 5 to contain the Expected Data and Byte 6 to contain the Actual Data Byte.

Status Bytes 1 and 2 indicate Status of the Tape Drive per Table 1-37.

Table 1-37. Diagnostic Results Status Bytes

Status Byte	Bit	Meaning	Status Byte	Bit	Meaning
1	7	Formatter Busy	2	7	Parity Error
	6	Data Busy		6	File Mark
	5	Check Char Gate		5	Buffer Overflow
	4	End of Tape		4	Hi Speed
	3	Ready		3	NRZI
	2	Rewinding		2	BOT
	1	File Protect		1	FBSY Int
	0	On Line		0	DBSY Int

1.10.3.18 SEND DIAGNOSTIC

The Send Diagnostic Command requests the Controller to perform diagnostic tests on itself and/or the specified tape unit.

After completion of the Send Diagnostic Command the INITIATOR should issue a Receive Diagnostic Results Command to check on the results of the diagnostics tests.

Table 1-38. SEND DIAGNOSTIC Command (1D Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	1	1	0	1
Byte 1	LUN			0	0	STEST	0	UNIT
Byte 2	RESERVED							
Byte 3	PARAMETER LIST LENGTH (MSB)							
Byte 4	PARAMETER LIST LENGTH (LSB)							
Byte 5	0	0	RESERVED				FLAG	LINK

SELF TEST: Setting the Self Test (STEST) Bit to ONE, instructs the Controller to run the Dynamic Ram test. There is no tape motion, the Controller ignores the Parameter List Length Bytes, and does not request Parameter Information. If the Self Test completes successfully, the Command terminates with the Controller sending GOOD Status, otherwise, the Command terminates and the Controller sends Check Condition Status and sets the Sense Key in the Extended Sense to Hardware Error.

UNIT TEST: If the Self Test (STEST) Bit is set to ZERO and the UNIT Bit is set to ONE, the Controller will request that the Parameter List Length information (Bytes 3 and 4) be included in the Command.

The Parameter List Length Bytes specify to the Controller the number of bytes that will comprise the parameter list (Table 1-39) that will be transferred to the INITIATOR in response to this Command.

STEST	UNIT	ACTION
0	0	No action, GOOD status returned
0	1	Motion Test 1-5
1	0	SELFTEST DRAM
1	1	SELFTEST DRAM

Table 1-39. PARAMETER LIST DATA FORMAT

Bit →	7	6	5	4	3	2	1	0
Byte 0	TEST 1 - PASS COUNT							
Byte 1	TEST 2 - PASS COUNT							
Byte 2	TEST 3 - PASS COUNT							
Byte 3	TEST 4 - PASS COUNT							
Byte 4	TEST 5 - PASS COUNT							
Byte 5	TEST 5 - BLOCK LENGTH (MSB)							
Byte 6	TEST 5 - BLOCK LENGTH (LSB)							
Byte 7	TEST 5 - DATA BYTE							
Byte 8	TEST 5 - DATA INCREMENT							

The Pass Count, Bytes 0 thru 4, specifies the number of passes that are to be performed for the Tests listed (1 thru 5). For example to perform two passes of Test 2 and three passes of Test 4, the following Bytes would be transmitted as the Parameter List:

Byte	Value (Hex)	Description
0	00	Pass Count Test 1 = 0
1	02	Pass Count Test 2 = 2
2	00	Pass Count Test 3 = 0
3	03	Pass Count Test 4 = 3
4	00	Pass Count Test 5 = 0

The Diagnostic Tests perform consecutively as listed above. The Hex value of each Byte in the list designates the number of passes for each corresponding Test. That is: Byte 0 specifies 0 pass for Test 1; Byte 1 specifies 2 passes for Test 2; etc.

If an error is detected in any of the tests, the Controller terminates the Send Diagnostic Command and sends a Check Condition Message. The INITIATOR should then send a Receive Diagnostic Command to find the reason for the failure.

Test Descriptions:

TEST 1: Test 1 tests the basic motion functions of the tape unit:

Rewind
Write File Mark
Erase
Blank Tape detection

TEST 2: Basic Read and Write functions of the Tape Drive are tested. Two hundred and fifty six (256) blocks, each 8K bytes long are written to tape. The tape is then rewound and verified in the forward and reverse directions.

TEST 3: Blocks of incrementing length are written to tape. The length of the 1st block is 16 bytes, the 2nd, 32 bytes and subsequent block lengths being incremented by 16 bytes per block until an 8K byte block is written. The tape is then rewound and its contents verified.

TEST 4: The Data Buffer is tested. Initially the entire Buffer is written and verified with a pseudo-random data pattern. The entire Buffer is then written to tape in 128-byte blocks at high speed. This process is repeated four (4) times; then the tape is rewound. The tape is then read, filling the entire Buffer, and data is verified. The Read/Verification process is repeated four (4) times.

TEST 5: This test is a field service type scope test. Bytes 5 and 6 of the Parameter List specify the length of the block to be written and read from tape. Byte 7 comprises the initial data byte; byte 8 specifies the byte increment. For example, if the User wished to Write 128 byte blocks of all 1's, bytes 5-8 of the Parameter List would be:

Byte	Value (Hex)
5	00
6	80
7	FF
8	00

Test 5 Writes the specified data and block length until EOT is detected, at which point tape is rewound and read. No Parity/Data checks are performed during Test 5.

1.10.3.19 WRITE DATA BUFFER

The Write Data Buffer Command (Table 1-40) is used in conjunction with the Read Data Buffer Command as a diagnostic function for testing the Controller Buffer Memory and SCSI Bus integrity.

Table 1-40. WRITE DATA BUFFER Command (3B Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	1	1	1	0	1	1
Byte 1	LUN			RESERVED			MODE	
Byte 2	BUFFER ID							
Byte 3	BUFFER OFFSET (MSB)							
Byte 4	BUFFER OFFSET							
Byte 5	BUFFER OFFSET (LSB)							
Byte 6	TRANSFER LENGTH (MSB)							

Table 1-40. WRITE DATA BUFFER Command (3B Hex) Continued

Bit →	7	6	5	4	3	2	1	0
Byte 7	TRANSFER LENGTH							
Byte 8	TRANSFER LENGTH (LSB)							
Byte 9	0	0	RESERVED				FLAG	LINK

A. **The Mode Field:**

The Mode Field of Byte 1 controls data transfer as listed below and described in the following subparagraphs:

Value (Hex)	Mode
0	Combined Header and Data
1	Reserved
2	Data Mode
3	Reserved

1. Combined Header-and-Data Mode (0 Hex)

Mode Bits set to 00 instructs the Controller to ignore Bytes 2 thru 5 (which should be set to 00 (Hex)), and return a four byte header consisting of Bytes 1, 6, 7, and 8 followed by the data that accompany this Command.

For a 256-Kbyte version of the Controller, if the User wishes to write to all memory locations of the Controller Buffer, the Transfer Length should be set to 4004 (Hex). If the Transfer Length exceeds the Buffer size, the Controller sends Check Condition Status and the sets the Sense Key in the Extended Sense to Illegal Request.

2. Data Mode (2 Hex)

In this mode, the INITIATOR provides the TARGET Controller with Buffer Data in one continuous data stream. The Data completely fills the Buffer in one series of contiguous bytes. The Buffer ID Byte should be set to 00 (Hex). If the Buffer ID is non-zero, the Controller sends Check Condition Status, and sets the Sense Key in the Extended Sense to Illegal Request.

B. **Buffer ID:**

The Buffer ID Byte should be set to zero, otherwise, the Controller sends Check Condition Status and sets the Sense Key in the Extended Sense to Illegal Request.

C. **Buffer Offset:**

The Buffer Offset is the address offset within the Controller Buffer where the data is to be stored (should be set to 00 (Hex)).

D. **Transfer Length:**

The Transfer Length specifies the maximum number of bytes that shall be transferred to the Controller Buffer. This value includes the number of data bytes to be transferred plus four. The four extra bytes comprise a four byte header consisting of Bytes 1, 6, 7, and 8 in the CDB.

The User should ensure that the Transfer Length * (data bytes + 4) does not exceed the capacity of the Buffer. If Buffer capacity is exceeded, the Controller sends Check Condition Status and sets the Sense Key in the Extended Sense to Illegal Request.

* If Buffer Offset is other than 00 (Hex), Transfer Length should be: data bytes + 4 + Buffer Offset.

1.10.3.20 READ DATA BUFFER

The Read Data Buffer Command (Table 1-41) is used in conjunction with the Write Data Buffer Command as a diagnostic function for testing the Controller Buffer Memory and the SCSI Bus integrity.

Table 1-41. READ DATA BUFFER Command (3C Hex)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	1	1	1	1	0	0
Byte 1	LUN			RESERVED			MODE	
Byte 2	BUFFER ID							
Byte 3	BUFFER OFFSET (MSB)							
Byte 4	BUFFER OFFSET							
Byte 5	BUFFER OFFSET (LSB)							
Byte 6	ALLOCATION LENGTH (MSB)							
Byte 7	ALLOCATION LENGTH							
Byte 8	ALLOCATION LENGTH (LSB)							
Byte 9	0	0	RESERVED				FLAG	LINK

A. **Mode Field:**

The Mode Field of Byte 1 controls data transfer as listed below and described in the following subparagraphs:

Value (Hex)	Definition	Value (Hex)	Definition
0	Combined Header and Data	2	Data Mode
1	Reserved	3	Descriptor Mode

1. Combined Header-and-Data Mode

Mode Bits set to 00 instructs the Controller to ignore Bytes 2 thru 5 (which should be set to 00 (Hex)), and send a four-byte header, per Table 1-43, followed by Buffer Data previously transferred with the Write Buffer Command.

The Controller terminates Data transfer when the four-byte header plus Buffer Data have been transferred, or when the header and all available data have been transferred to the INITIATOR, whichever is less.

The Read Buffer Header:

The Read Buffer Header (Table 1-42) that precedes the Data in a Combined-Header-and-Data Transfer consists of a Reserved Byte (set to 00 Hex) and three Available-Length Bytes. The latter bytes specify the total number of Data Bytes that are available in the Controller Buffer. The number of Data Bytes transferred following the Read Buffer Header is the lesser of the Allocation Length minus four, or the Available Length.

Table 1-42. Read Buffer Header

Bit →	7	6	5	4	3	2	1	0
Byte 0	RESERVED							
Byte 1	AVAILABLE LENGTH (MSB)							
Byte 2	AVAILABLE LENGTH							
Byte 3	AVAILABLE LENGTH (LSB)							

2. Data Mode

In this mode, the Controller completely fills the Data Buffer with a series of contiguous data bytes. The Buffer ID Byte should be set to 00 (Hex). If the Buffer ID is non-zero, the Controller sends Check Condition Status, and sets the Sense Key in the Extended Sense to Illegal Request.

3. Descriptor Mode

In this Mode, the Controller is instructed to transfer a maximum of four bytes of Read Buffer Descriptor Information for the Buffer specified in the Buffer ID Byte. If the Buffer ID Byte is non-zero, the Controller sends all ZEROs to the INITIATOR. If the Allocation Length in the CDB is greater than four, the Controller sends four. Table 1-43 illustrates the Descriptor Mode Information Block.

Table 1-43. Descriptor Mode Information Block

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	0	0	0	0	0
Byte 1	BUFFER CAPACITY (MSB)							
Byte 3	BUFFER CAPACITY							
Byte 4	BUFFER CAPACITY (LSB)							

B. **Buffer ID:**

The Buffer ID Byte should be set to 00 (Hex), otherwise, the Controller sends Check Condition Status and sets the Sense Key in the Extended Sense to Illegal Request.

C. **Buffer Offset:**

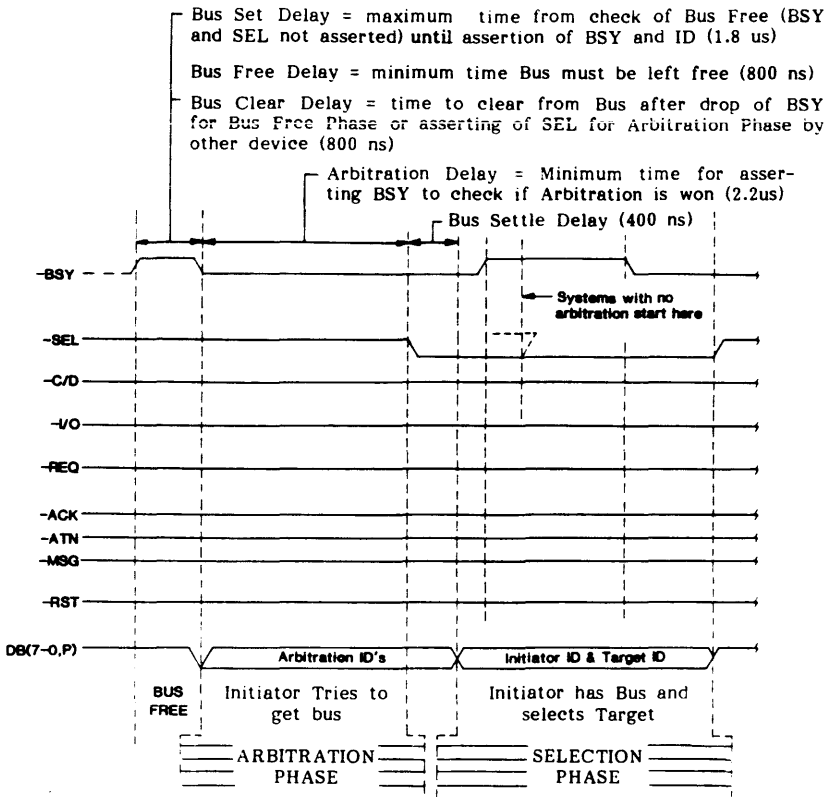
The Buffer Offset is the address offset within the Controller from where the data is to be transferred (should be set to 00 (Hex)).

D. **Allocation Length:**

The Allocation Length specifies the maximum number of bytes that the INITIATOR has allocated for the header and data. An Allocation Length of zero indicates that no header or data shall be transferred. Any other value indicates the maximum number of bytes, including Data plus Header, that shall be transferred. The User should ensure that the Allocation Length plus the Buffer Offset does not exceed the capacity of the Buffer.

1.11 HOST INTERFACE TIMING

Figures 1-3 thru 1-5 illustrate SCSI Timing.



NOTE:
DB(7) = Most Significant Bit = Highest Priority ID for Arbitration

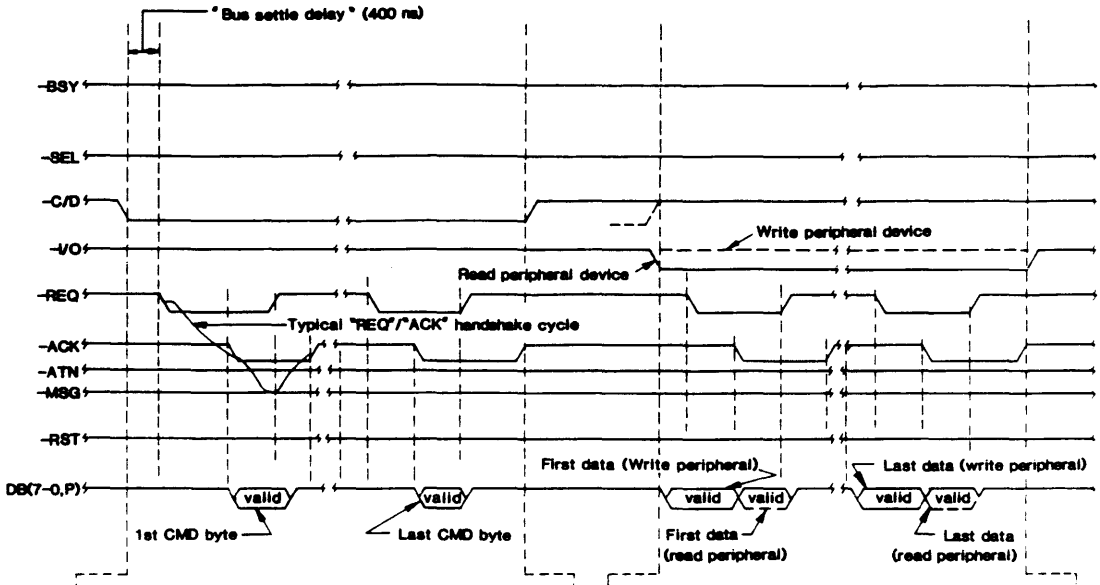
DB(P) = Data Parity (Odd). Parity is not valid during Arbitration. The use of Parity is a system option.

In a typical system, the Computer's Host Adapter is the Initiator and the I/O Device's Control Unit is the Target.

- After Initiator sees that Bus is free (BSY & SEL are not asserted), it waits a minimum of Bus Free Delay and asserts BSY and its own ID on the Data Bus.
- After the Arbitration Delay, the Initiator checks the Data Bus and clears itself from Arbitration if a higher priority ID (DB7 = highest) is on the bus.
- If SEL is asserted during Arbitration by another device, the Initiator will immediately clear itself from Arbitration within Bus Clear Delay Time.
- If the Initiator determines that its own ID is the highest asserted, then it wins arbitration and asserts SEL (it then may not change any lines until after waiting a Bus Settle Delay).

- Initiator asserts Data Bus with desired Target's ID and Initiator's ID.
- After two deskew Delays, the Initiator drops BSY.
- The selected Target sees that BSY is not asserted while SEL and its ID are asserted. The Target responds by asserting BSY.
- After two Deskew Delays, the Initiator drops SEL and may change the Data Lines.
- Note: After Initiator drops SEL, it is the only Bus Device that can assert ACK and ATN (and the Data Lines if I/O is not asserted (indicating output from the Initiator).
- Note: After Target sees SEL drop, the Target is the only Bus Device that can assert BSY, C/D, I/O, MSG, REQ, and the Data Lines if I/O is asserted (Indicating input to the Initiator).
- Note: In systems in which the Arbitration Phase is not implemented, the Initiator first detects the Bus Free Phase (BSY and SEL not asserted), and then waits for a Bus Settle Delay. Then the Initiator asserts the Data Bus with the desired Target's ID and its own ID. Then, as described above, the Target responds with BSY and the Initiator drops SEL.

Figure 1-3. SCSI Timing Diagram, Arbitration, and Selection Phases



Target requests Command from Initiator

COMMAND PHASE

- Target asserts C/D and does not assert I/O or MSG.
- After a Bus Settle Delay, Target asserts REQ.
- Initiator puts Data (Command) on the Bus and asserts ACK.
- Target waits a Deskew Delay, takes the Data and then drops REQ.
- Initiator drops ACK and Data.

Target requests Data Transfer with Initiator

DATA PHASE

- <Read Peripheral Device>
- Target asserts I/O and does not assert C/D or MSG. Target then waits at least a Bus Settle Delay before asserting REQ.
- Target also puts Data on the Bus at Deskew Delay before asserting REQ.
- Initiator takes Data and asserts ACK.
- Data is no longer guaranteed valid.
- Target drops REQ.
- Initiator drops ACK.
- <Write Peripheral Device>
- Target asserts REQ and does not assert I/O, C/D, or MSG.
- Initiator asserts ACK and Data.
- Target wait a Deskew Delay, then takes the Data; then drops REQ.
- Data is no longer guaranteed valid.
- Initiator drops ACK.

Figure 1-4. SCSI Timing Diagram, Command, and Data Phases

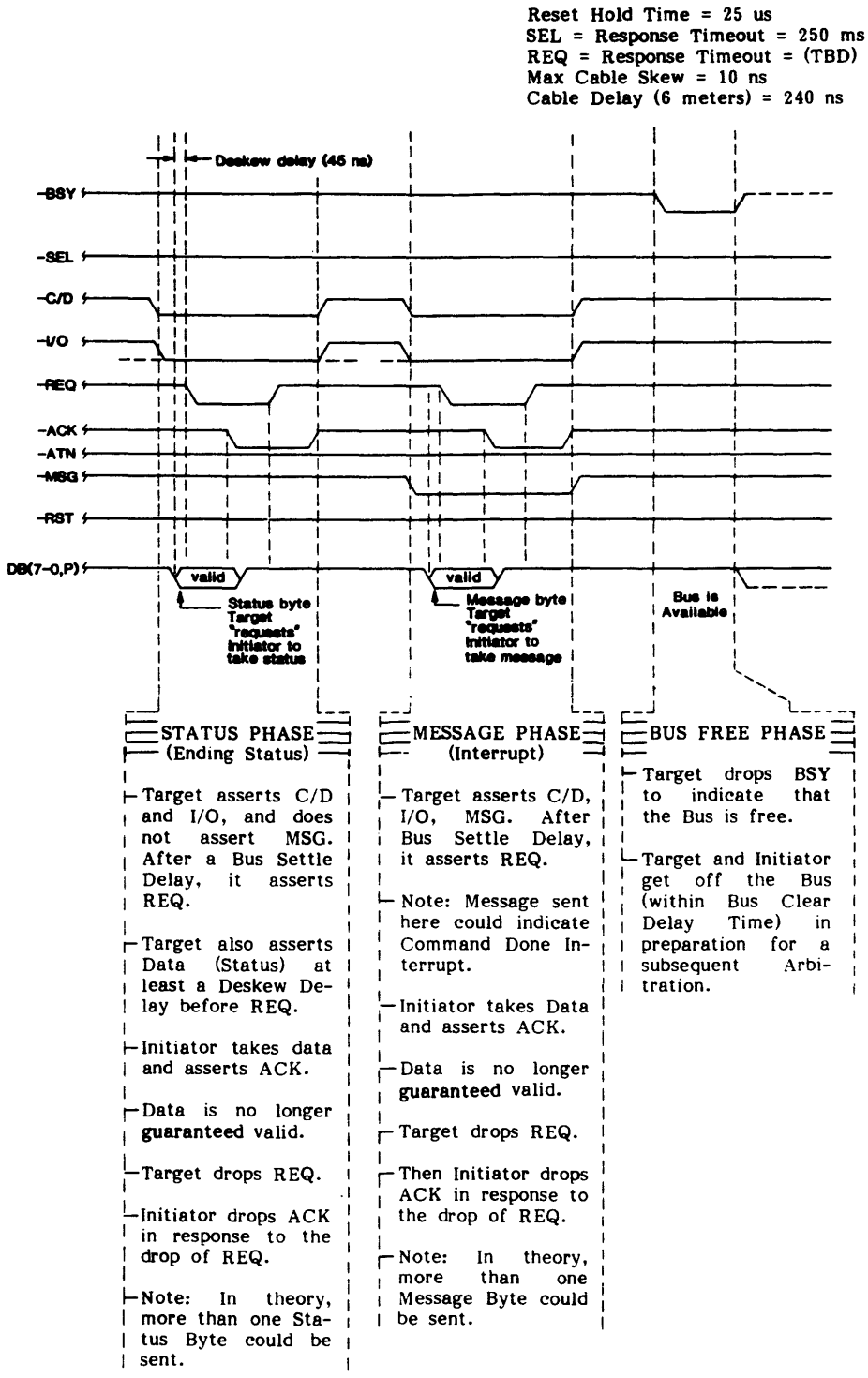


Figure 1-5. SCSI Timing Diagram, Status, Message, and Bus Free Phases

1.12 SCSI TIMING CONSIDERATIONS

1.12.1 SUSTAINED DATA TRANSFER RATE

To maintain streaming, the INITIATOR must maintain a minimum average data transfer rate to or from tape according to tape speed and density as follows:

Table 1-44. Density/Speed and Data Transfer Rate

	DENSITY (BPI) SPEED	800 (NRZI)	1600 (PE)	3200 (DDPE)	6250 (GCR)
DATA XFERRATE IBG TIME	50 IPS	40 KB/S 12 MS	80 KB/S 12 MS	160 KB/S 12 MS	312.5 KB/S 6 MS
DATA XFERRATE IBG TIME	100 IPS	40 KB/S 6 MS	160 KB/S 6 MS	320 KB/S 6 MS	625 KB/S 3 MS
	DATA TRANSFER RATE				

1.12.2 COMMAND REINSTRUCT TIMING

For the 9612 to Sustain streaming operation with GCR Density at 100 ips, the Host (INITIATOR) must meet the following Repeat Command Timing or Consecutive Command Timing constraints:

1.12.2.1 REPEAT COMMAND ASSUMPTIONS

The INITIATOR commands the Controller to issue a Mode Select Command that configures the Drive to operate at 100 ips in GCR Density. Consecutive buffered Write Commands may be Fixed or Variable.

1.12.2.2 REPEAT COMMAND TIMING VARIABLES DEFINITIONS

Variables of Time, T, are in seconds:

a. TBF - Time interval from Bus Free condition to assertion of BSY. This defines the Bus Free interval between INITIATOR/TARGET exchanges.

b. TSL - Time interval from BSY assertion to deassertion of SEL. This defines the Arbitration and Selection Phase timing overhead for the INITIATOR.

c. TMT - Time interval from REQ assertion by TARGET to ACK assertion by INITIATOR. This defines the Message Out Phase timing overhead for the INITIATOR.

d. TCT - Time interval from REQ assertion by TARGET to ACK assertion by INITIATOR for Command transfer. This defines the Command Out Phase timing overhead for the INITIATOR.

e. TDT - Time interval from REQ assertion by TARGET to ACK assertion by INITIATOR for Status transfer. This defines the Status-In Phase timing overhead for the INITIATOR.

f. N = Number of bytes in block(s) to be written.

g. M = Number of blocks to be written.

h. TTD = 1/(selected density x tape speed) [1/(6250x100)]

i. TGAP = Time required for an Interblock Gap.

j. It is assumed that: the INITIATOR/TARGET exchange is made up of two Message Phases, and the Command Descriptor Block (CBD) is made up of six bytes.

1.12.2.3 REPEAT COMMAND TIMING EXPRESSION

The following expression defines the maximum repeat command timing interval.

$$T_{BF} = T_{SL} = 2*T_{MT} = 6*T_{CT} = T_{ST} = M*N*T_{TD} < .001 + M*N*T_{TD} + (M-1)*T_{GAP}$$

The portion of the total time of all phases available to the initiator executing a repeated command, shall be less than one millisecond plus the number of blocks to be written, times the time required to transfer a block plus the number of blocks times the interblock gap time.

This expression takes into account the fact that, while being filled, the buffer is also being emptied at a rate determined by the tape speed and recording density. This means the faster the host executes its portion of the SCSI protocol and transfers data into the buffer, the more time it will have to transfer the next block of data; i.e., a longer reinstruct window.

For example, assume FIXED WRITE of two 2-kilobyte blocks are to be written at 6250 cpi and 100 ips. The initiator would then need to, on receiving the previous Command Complete Message, leave the Bus Free Phase pass through the Execution phases up to and including the Command Complete Message, in less than 8.6 milliseconds in order to maintain streaming. In Variable Block mode the factor M is 1 and the reinstruct time would be 4.2 milliseconds using 2-kilobyte blocks.

SECTION II

INSTALLATION/ADJUSTMENTS

2.0 GENERAL

This section describes installation and adjustment of the Model 96X2 Series Tape Drives as it relates to the SCSI Interface. Because the 96X2 Series are basically Model 96X0 Series Tape Drives with embedded SCSI Interface Boards, all adjustments described in the 96X0 Series Installation and Operation Manuals are applicable to the 96X2 Series. The following procedures pertain only to the SCSI PCBA.

2.1 INSTALLATION

Except for interface cabling and connectors appropriate for the SCSI Bus, and specified in Section I, installation is covered in the 96X0 Series Installation and Operation Manuals. Figure 2-1 illustrates location of the SCSI Controller, Interface Connector, Formatter Cables, Terminators, and Set-up Switches.

2.2 ADJUSTMENTS, GENERAL

Except for switch settings pertaining to the SCSI Controller Board, which are described in the following paragraphs, there are no adjustments.

2.2.1 SCSI CONTROLLER SWITCH SETTINGS

Before operating the Tape Drive, the control parameters for the SCSI Controller, listed below, are set up by means of two eight position DIP switches, SW1 and SW2, as follows. Tables 2-1 and 2-2 indicate switch section functions, which are described below:

Table 2-1. Switch SW1 Functions

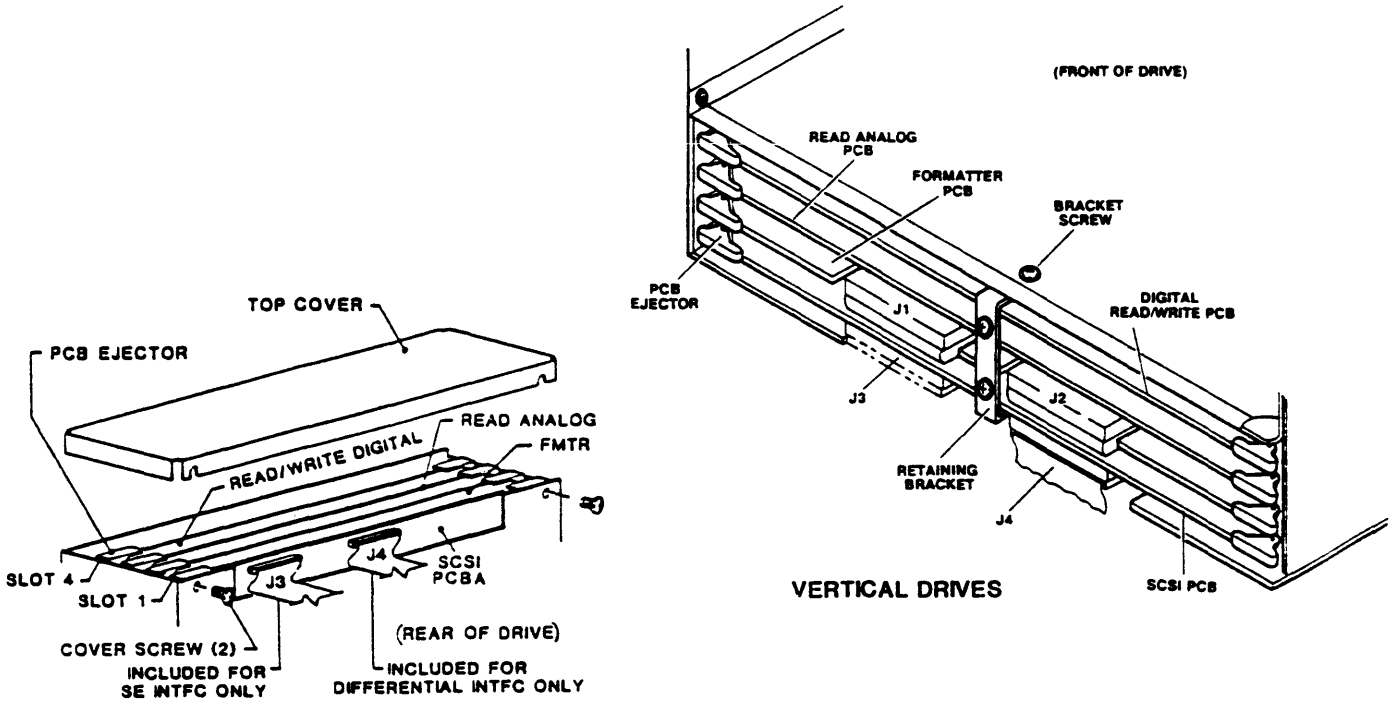
1	2	3	4	5	6	7	8
MONITOR ENABLE	RETRY INHIBIT	PARITY ENABLE	CACHE INHIBIT	WAIT	SCSI ID SELECT		

Switch SW1 Functions

SW1-1 Monitor Enable:

The SCSI control program contains RS232 Monitor Routines that, by connecting an RS232 Adapter, can read out to a Monitor Terminal, Command and Status Information related to Controller activity.

Set SW1-1 to ON to accommodate an RS232 adapter, if connected.
Set SW1-1 to OFF if no RS232 adapter is installed.



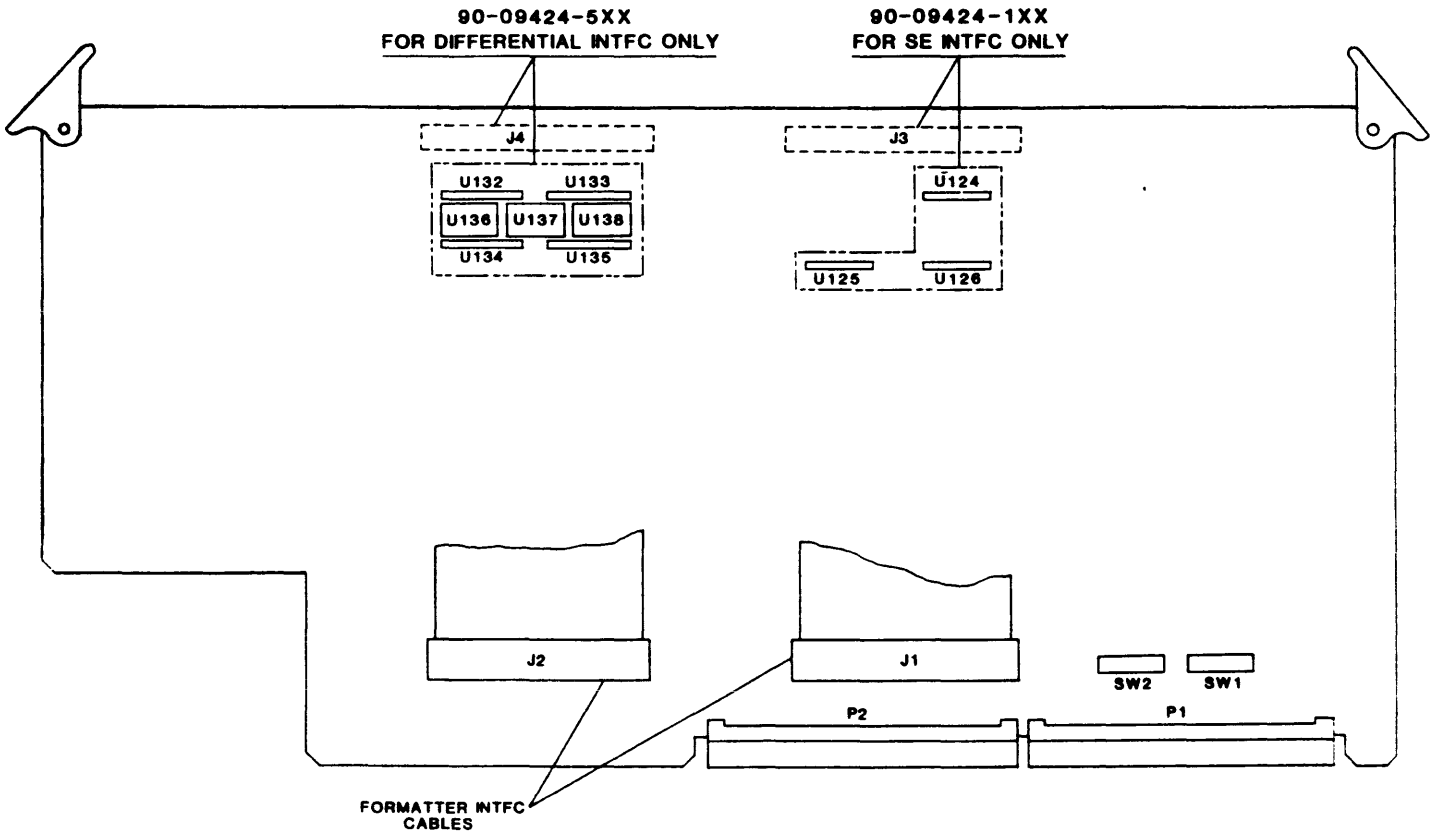


Figure 2-1. SCSI Controller PCBA

SW1-2 Retry Inhibit:

RETRY refers to Automatic Error Recovery: If an error is detected during a Write Operation, the Controller causes the Drive to backspace over the block in error, write a four (4) inch gap, and rewrite the record. If, after fourteen (14) attempts to rewrite the block, an error still exists, the Controller terminates the Write Operation. If an error is detected during a Read Operation the Controller attempts to reread the block fourteen (14) times before terminating the Operation:

Set SW1-2 to OFF to enable Automatic Error Recovery.
Set SW1-2 to ON to inhibit Automatic Error Recovery.

SW1-3 Parity Enable:

Set SW1-3 to ON to enable the Controller to check Odd Parity for every Byte received. (See SW2-4).

Set SW1-3 to OFF to disable Parity Check.

SW1-4 Variable Mode Cache Inhibit:

Set SW1-4 to OFF to enable Cache Read Commands in Variable Mode.

Set SW1-4 to ON to disable Cache Read Commands. The Controller reads one block at a time, thus preventing operation in Streaming Mode.

SW1-5 Wait:

WAIT refers to the Controller's ability to set up a Wait Condition if, when performing a Buffered Mode Write Operation, another Buffered Write Mode Command is received. (Applies only if disconnection has not been enabled.)

With Wait enabled, the Controller holds the SCSI Bus in the Command Out Phase until command execution is complete (or, if the next Command is another Buffered Write Mode Command, until Buffer space is available).

With Wait disabled. If the Controller is performing a Buffered Mode Write Operation, and another Command is received (except for another Buffered Mode Write Command, and buffers are available), the Controller sends BUSY Status and does not execute the command.

Set SW1-5 to ON to enable the WAIT capability.
Set SW1-5 to OFF to disable the WAIT capability (send BUSY).

SW1-6 thru -8 SCSI ID:

The output from switch sections 6 thru 8 constitutes a 3-bit binary code that identifies (addresses) the Controller on the SCSI Bus. SW1-8 is the MSB, SW1-6 is the LSB. Each Device on a SCSI Network must be set to a different Address via these Switches. The binary values represented by these Addresses correspond to the Bit positions in the ID Byte during the Arbitration Phase of Bus activity.

SW1	-6	-7	-8	SCSI ID	SCSI DATA BIT
	OFF	OFF	OFF	0	DB0
	ON	OFF	OFF	1	DB1
	OFF	ON	OFF	2	DB2
	ON	ON	OFF	3	DB3
	OFF	OFF	ON	4	DB4
	ON	OFF	ON	5	DB5
	OFF	ON	ON	6	DB6
	ON	ON	ON	7	DB7

Table 2-2. Switch SW2 Functions

1	2	3	4	5	6	7	8
FIXED PWR ON	RECOV'D ERROR		INHIBIT RETRY	PHYSICAL END OF DATA		INQUIRY QUALIFIER	

Switch SW2 Functions

SW2-1 Fixed Power-On:

FIXED PWR ON refers to the default condition of the SCSI Controller following a Power-On Reset or a Bus Device Reset Message:

Set SW2-1 to ON to configure the SCSI Controller to **Fixed** Length Mode, High Speed Operation, and Block Length set to 512 bytes.

Set SW2-1 to OFF to configure the SCSI Controller to the **Variable** Length Mode.

Switch SW2-2 Recovered Errors:

RECOV'D ERRORS refers to the reporting of Recovered Tape Errors.
Set SW2-2 to ON to disable Recovered Errors Report (Sense Key 01 Hex).
Set SW2-2 to OFF to enable Recovered Errors report.

SW2-3 Not used. Set to ON.

SW2-4 Inhibit SCSI Retries:

INHIB RETRY refers to the Controller's ability to retry a transaction if during a Data Out or Command Phase a parity error is detected:

Set SW2-4 to ON to disables retries.

Set SW2-4 to OFF to enable retries. The Controller sends to the INITIATOR a Restore Pointer Message and re-enters the Data or Command Phase awaiting the re-transmission of the Data or Command (Ref SW1-3).

SW2-5 Physical End of Data:

PHYSICAL END OF DATA refers to a Tape Error that could occur during SPACE Command using Code 3 Hex (Ref Section I, SPACE Command). The setting of SW2-5 determines the definition of Physical End of Data as used in the SPACE Command.

Set SW2-5 to OFF to define Physical End of Data as 25 feet of blank tape.

Set SW2-5 ON to define Physical End of Data as 25 feet of blank tape or an Unrecoverable Tape Error.

SW2-6 thru 8 Device Qualifier:

DEVICE QUALIFIER refers to the Device Qualifier Field in the INQUIRY Command Data Block Sent to the INITIATOR in response to an INQUIRY Command (Ref Section I). The output of SW2, sections 6 thru 8 correspond to the Device Type Qualifier Code as shown in Table 2-3. The Qualifier Code is a 1-bit Code in a 7-bit Field.

Table 2-3. Device Qualifier

SWITCH SW2 SECTION *			QUALIFIER	
6	7	8	BIT	CODE
0	0	0	0	00
1	0	0	1	01
0	1	0	2	02
1	1	0	3	04
0	0	1	4	08
1	0	1	5	10
0	1	1	6	20
1	1	1	7	40
* 0 = OFF; 1 = ON				

SECTION III

DIAGNOSTICS

3.0 GENERAL

Diagnostics for the 96X2 Series Tape Drives operate as described in the Model 96X0 Series Installation and Operation Manuals.

SECTION IV

MAINTENANCE

4.0 GENERAL

Except for the replacement procedure for the SCSI Controller PCBA, maintenance for the 96X2 Series Tape Drives are as described in the Model 96X0 Series Installation and Operation Manuals.

4.1 SCSI PCBA REPLACEMENT

Referring to Section II, Figure 2-1:

A. Turn power off.

B. Loosen the two Cover Screws near ends of the Card Cage, and remove Cover.

C. Grasp PCB Ejectors firmly, and pull Ejectors toward the sides of the Drive. The PCB should pop partly out of the slot.

D. Unplug two SCSI to Formatter Cables from the Formatter Board. Unplug SCSI Bus Cable from SCSI PCBA.

E. Remove the SCSI Board.

To replace - With power off:

a. Insert SCSI PCBA into slot but do not press it in all the way.

b. Plug Formatter Connectors into Formatter Board.

c. Press and seat SCSI PCBA all the way into slot.

d. Plug SCSI Bus Cable into SCSI PCBA.

e. Replace Card Cage Cover.

Warranty

The Company warrants its devices against faulty workmanship or the use of defective materials (except in those cases where the materials are supplied by OEM) for a period of one year from the date of shipment to OEM, with the exception of ¼" cartridge products which are warranted for a period of ninety (90) days.

The liability of the Company under this warranty is limited to replacing, repairing, or issuing credit (at the Company's discretion) for any devices which are returned by OEM during such period provided that (a) the Company is promptly notified in writing upon discovery of such defects by OEM; (b) the defective unit is returned to the Company, transportation charges prepaid by OEM; and (c) the Company's examination of such unit shall disclose to its satisfaction that such defects have not been caused by misuse, neglect, improper installation, repair alteration or accident.

Kennedy Company is continually striving to provide improved performance, value and reliability in its products and reserves the right to make these changes without being obligated to retrofit delivered equipment.

KENNEDY
A Division of Shugart Corporation