

KENNEDY

A Division of Shugart Corporation

Digital Tape
System

Synchronous
SCSI Controller
For Models 96X2 Series

Installation and Operation
Manual

P/N 93-09612-103

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.

Copyright © 1990 by Kennedy Company

All rights reserved. No part of this work covered by the copyright hereon may be reproduced or copied in any form or by any means - graphic, electronic, or mechanical, including photocopying, taping, or information storage and retrieval systems - without written permission of Kennedy Company.

**SECTION I - GENERAL DESCRIPTION
AND APPLICATION DATA**

<u>Section</u>	<u>Page</u>	<u>Section</u>	<u>Page</u>
1.1 General Description	1-1	1.13.4 Read Block Limits	1-28
1.2 Host Interface	1-1	1.13.5 Read.....	1-30
1.3 Microcomputer Based Design	1-1	1.13.6 Write.....	1-32
1.4 Diagnostics and Fault Isolation.....	1-1	1.13.7 Read Reverse	1-34
1.5 Specifications.....	1-1	1.13.8 Write File Mark.....	1-35
1.5.1 Power Requirements.....	1-1	1.13.9 Space.....	1-36
1.6 Interface Specifications.....	1-2	1.13.10 Inquiry	1-38
1.6.1 General	1-2	1.13.11 Verify	1-41
1.6.2 Interface Connectors.....	1-2	1.13.12 Recover Buffered Data.....	1-42
1.6.3 Interface Cable Length.....	1-2	1.13.13 Mode Select.....	1-44
1.6.4 Interface Signal Character.....	1-3	1.13.14 Reserve Unit	1-46
1.6.4.1 Input.....	1-3	1.13.15 Release Unit.....	1-48
1.6.4.2 Output.....	1-3	1.13.16 Erase	1-49
1.6.5 Receiver/Driver Configuration and Termination.....	1-3	1.13.17 Mode Sense.....	1-50
1.6.6 Multiple Hosts/Drives	1-4	1.13.18 Load\Unload.....	1-53
1.7 Interface Signals.....	1-4	1.13.19 Receive Diagnostic Results.....	1-54
1.8 SCSI Phase Protocol Desc.....	1-5	1.13.20 Send Diagnostic	1-57
1.9 Bus Phase Sequencing	1-5	1.13.21 Write Data Buffer.....	1-61
1.10 Bus Phases	1-6	1.13.22 Read Data Buffer.....	1-63
1.10.1 Arbitration Sequence	1-6	1.14 Host Interface Timing.....	1-65
1.10.2 Selection.....	1-6	1.15 SCSI Timing Considerations.....	1-69
1.10.2.1 Arbitrating System.....	1-6	1.15.1 Sustained Data Transfer Rate... ..	1-69
1.10.2.2 Non-Arbitrating System.....	1-7	1.15.2 Command Reinstruct Timing	1-69
1.10.2.3 Single Initiator Option.....	1-7	1.15.2.1 Repeat Cmd Assumptions	1-69
1.10.3 Reselection (optional)	1-7	1.15.2.2 Repeat Cmd Timing Variables Definitions.....	1-69
1.10.3.1 Selection Timeout.....	1-8	1.15.2.3 Repeat Command Timing Expression	1-70
1.10.4 Information Transfer Phases.....	1-8		
1.10.4.1 Command.....	1-9		
1.10.4.1.1 Linked Commands	1-9		
1.10.4.1.2 Intermediate Status.....	1-9		
1.10.4.2 Data	1-9		
1.10.4.2.1 Data In.....	1-10		
1.10.4.2.2 Data Out	1-10		
1.10.4.3 Status	1-10		
1.10.4.4 Message	1-11		
1.10.4.4.1 Message In.....	1-11		
1.10.4.4.2 Message Out	1-11		
1.10.4.4.3 Message Received w/Bad Parity.....	1-11		
1.11 Bus Conditions	1-11		
1.11.1 Attention.....	1-11		
1.11.2 Reset.....	1-12		
1.12 Message System Description.....	1-12		
1.12.1 Single Byte Messages	1-13		
1.12.2 Multiple Byte Message	1-17		
1.13 Commands.....	1-17		
1.13.1 Test Unit Ready	1-18		
1.13.2 Rewind	1-19		
1.13.3 Request Sense	1-20		

SECTION II - INSTALLATION/ADJUSTMENTS

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
2.2.1.1 Pre-Fetch Qualification	2-1
2.2.1.2 Pre-Fetch Action on File Mark Detection.....	2-2
2.2.1.3 Write Buffer Limits	2-2
2.2.1.4 Mode	2-2
2.2.1.5 Maximum Block Length.....	2-3
2.2.1.6 Read Retries.....	2-3
2.2.1.7 Write Retries	2-3
2.2.1.8 Interface Parity.....	2-4
2.2.1.9 Recovered Errors.....	2-4
2.2.1.10 EOT.....	2-4
2.2.1.11 Inquiry Qualifier	2-4
2.2.1.12 Synchronous Request	2-5

LIST OF TABLES

<u>Section</u>	<u>Page</u>
2.2.1.13 SCSI I.D.	2-5
2.2.1.14 SCSI LUN.....	2-5
2.3 Summary of Options.....	2-5
2.4 Physical Description.....	2-7
2.4.1 SCSI Bus Termination.....	2-7
2.4.2 Combination Bd. Config.....	2-9

SECTION III - DIAGNOSTICS

SECTION IV - MAINTENANCE

LIST OF ILLUSTRATIONS

<u>Figure</u>	<u>Page</u>
1-1 Interface Termination Configurations	1-3
1-2 SCSI Network (Typical)	1-4
1-3 SCSI Timing Diagram, Arbitration and Selection Phases	1-66
1-4 SCSI Timing Diagram, Command and Data Phases.....	1-67
1-5 SCSI Timing Diagram, Status, Message, and Bus-Free Phases..	1-68
2-1 9502 Sync. SCSI Controller	2-8
2-2 9502 Sync. SCSI Controller	2-9

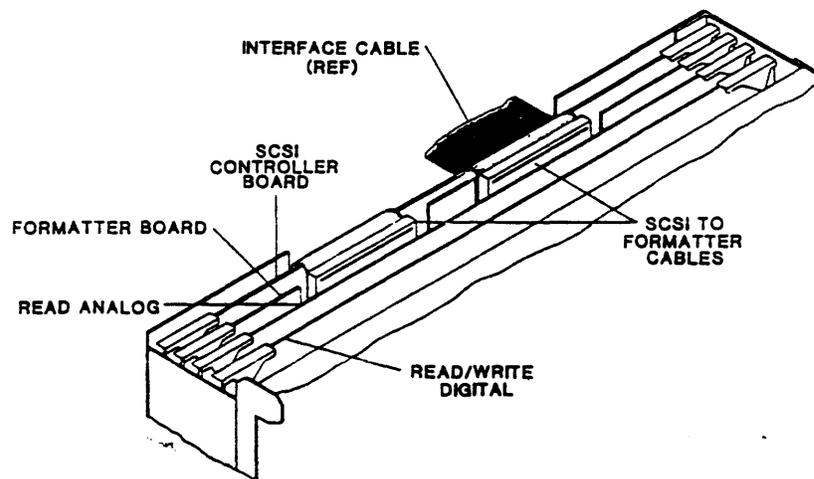
<u>Table</u>	<u>Page</u>
1-1 Model 96X2 Power Requirements.....	1-2
1-2 Single-Ended Interface Connector J3.....	1-4
1-3 Differential Interface Connector J4.....	1-5
1-4 Information Transfer Phases.....	1-8
1-5 Status Byte Format.....	1-10
1-6 Single Byte Message Codes.....	1-13
1-7 Synchronous Transfer Rates.....	1-14
1-8 SCSI Commands and Codes.....	1-18
1-9 Test Unit Ready (00H).....	1-18
1-10 Rewind (01H).....	1-19
1-11 Request Sense (03H).....	1-20
1-12 Sense Bytes Data Format.....	1-21
1-13 Sense Key Descriptions.....	1-24
1-14 Additional Sense Data	1-25,26,27
1-15 Read Block Limits (05H).....	1-28
1-16 Read Block Limits Data.....	1-28
1-17 Read Command (08H).....	1-30
1-18 Write Command(0AH).....	1-32
1-19 Read Reverse Command (0FH).....	1-34
1-20 Write File Mark Cmd (10H).....	1-35
1-21 Space Command (11H).....	1-37
1-22 Inquiry Command (12H).....	1-38
1-23 Inquiry Command Data.....	1-39
1-24 Verify Command (13H)	1-41
1-25 Recover Buff Data Cmd (14H).....	1-42
1-26 Mode Select Command (15H).....	1-44
1-27 Mode Select Data.....	1-45
1-28 Reserve Unit Command (16H)	1-46
1-29 Release Unit Command (17H).....	1-48
1-30 Erase Command (19H).....	1-49
1-31 Mode Sense Command (1AH).....	1-50
1-32 Mode Sense Data Format.....	1-51
1-33 Unload Command (1BH).....	1-53
1-34 Receive Diagnostic Results Command (1CH)	1-54
1-35 Diagnostic Results Data	1-55
1-36 Send Diagnostic Cmd (1DH)	1-57
1-37 Parameter List Data Format.....	1-59
1-38 Write Data Buffer Cmd (3BH)	1-61
1-39 Read Data Buffer Cmd (3CH).....	1-63
1-40 Read Buffer Header	1-65
1-41 Read Buffer Data.....	1-65

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, 9682, 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. In addition both synchronous and asynchronous transfers are supported with a maximum transfer rate of 4.8 MBytes/sec.

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	<u>120 VAC</u>	<u>220 VAC</u>
	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	<u>48 VDC</u>	<u>60 VDC</u>
	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

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.

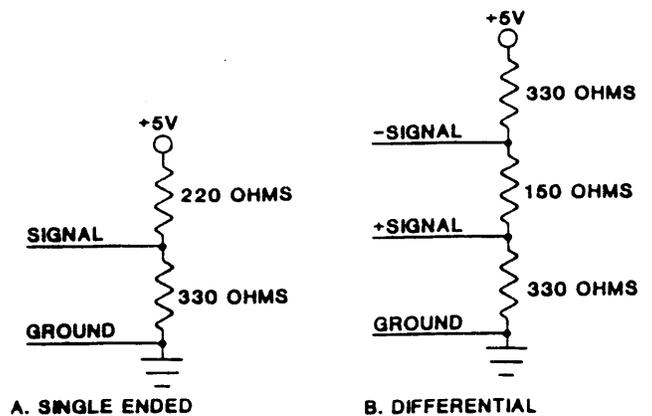


Figure 1-1. Interface Termination Configurations

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 - U8, U9, U10

Differential Terminators - U4, U5, U11, U12, U13, U16, U17

SCSI Addressing: Each Device in a Daisy Chain must be set to an address unique from all other devices. For this purpose, a front panel menu option is available: Host I/O -> SCSI ID. See Section 2.1.13 and 2.1.14 for explanation of SCSI Addressing.

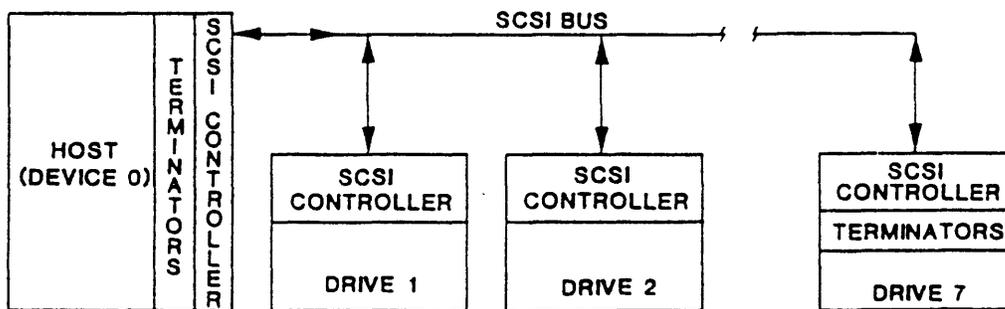


Figure 1-2. SCSI Network (Typical)

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 21 and 25, are connected to ground.
 Pins 21 and 25 are 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)
GROUND	23	22	GROUND
TERMPWR	25	24	GROUND
GROUND	27	26	TERMPWR
+ATN	29	28	GROUND
GROUND	31	30	-ATN
+BSY	33	32	GROUND
+ACK	35	34	-BSY
+RST	37	36	-ACK
+MSG	39	38	-RST
+SEL	41	40	-MSG
+C/D	43	42	-SEL
+REQ	45	44	-C/D
+I/O	47	46	-REQ
GROUND	49	48	-I/O
		50	GROUND

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

1.8 SCSI PHASE PROTOCOL DESCRIPTION

This section describes the SCSI protocol, it includes information on SCSI Bus Phases and Phase Sequencing. This section is divided into three subsections, as listed below.

Subsection	Title
1.9	SCSI Bus Phase Sequencing
1.10	SCSI Bus Phases
1.11	SCSI Bus Conditions

1.9 BUS PHASE SEQUENCING

The status of the SCSI Bus is a function of the control signals. These signals place the SCSI Bus in one of the following phases: Bus Free, Arbitration, Selection/Reselection, or Information Transfer.

All SCSI command sequences start with the Bus Free phase. The normal progression is from the Bus Free phase to the Arbitration phase. During Arbitration, SCSI controllers contest for control of the SCSI bus. Priority is given to the contestant with the highest SCSI bus address.

Once the SCSI controller has control of the bus, it becomes the Initiator and causes the bus to enter the Selection/Reselection phase. This phase allows the Initiator to select a specific device for communication. An Initiator can select a Target to initiate an operation (Selection), or a Target may reselect an Initiator to continue an operation (Reselection).

After an Initiator has selected a Target, the Target causes the bus to go to one of the Information Transfer phases (Command, Data, Status, or Message). After the command has been executed the bus goes to the Status phase and completion status is sent to the Initiator. The bus then enters the Message phase and the Target sends the Command Complete message. The Target then releases the bus, causing the Bus Free phase.

1.10 BUS PHASES

1.10.1 ARBITRATION

The Arbitration phase allows one SCSI device to gain control of the SCSI bus so that it can assume the role of an Initiator or Target.

The procedure for Arbitration is as follows:

1. Wait for the Bus Free phase to occur.
2. When Bus Free occurs, assert BSY and the arbitrating device SCSI ID.
3. Wait at least 2.2 usec, then examine the bus.
4. If a higher priority SCSI ID bit is true on the Data Bus (DB(7) is highest), then the SCSI device has lost Arbitration. BSY and its SCSI ID should be released. Return to step 1.
5. If no higher priority SCSI ID bit is true on the Data Bus, then the SCSI device has won Arbitration and it should assert SEL.
6. At the completion of the Arbitration phase, the winning Initiator will have BSY, SEL and its own SCSI ID asserted. After winning Arbitration the SCSI device should wait at least 1.2 usec before changing any signals.

Note: The SCSI ID bit is a single bit on the Data Bus that corresponds to the SCSI device's unique SCSI address. Parity is not valid during the Arbitration phase. During the Arbitration phase, DB(P) may be undriven or driven to the true state, but should not be driven to the false state.

1.10.2 SELECTION

The Selection phase allows an Initiator to select a Target for the purpose of initiating a Target function (i.e. Read or Write Command).

Note: During the Selection phase the I/O signal is negated so that this phase can be distinguished from the Reselection phase.

1.10.2.1 ARBITRATING SYSTEMS

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

1. The Initiator sets the Data Bus to the OR of its own SCSI ID and the Target's SCSI ID.
2. The Initiator waits at least 100 nsec, then releases BSY.
3. The 9502 senses that it is selected when SEL and its SCSI ID are true and that BSY and I/O have been false for at least 400 nsec. The 9502 then asserts BSY.

4. The Initiator waits at least 100 nsec after detecting BSY is true, then releases SEL and the Data Bus.

At the completion of the Selection phase:

1. The Initiator has no signals asserted.
2. The Target has BSY asserted.

1.10.2.2 NONARBITRATING SYSTEMS

In systems with the Arbitration phase not implemented, the Initiator:

1. Waits for the Bus Free phase, plus 800 nsec.
2. Then asserts the Target's SCSI ID and its own SCSI ID and waits at least 90 nsec.
3. The Initiator then asserts SEL.
4. Follow the procedure in Sec. 1.10.2.1, starting at step 3.

1.10.2.3 SINGLE INITIATOR OPTION

Initiators that do not implement the Reselection phase and do not operate in a multiple Initiator environment are allowed to set only the 9502's SCSI ID bit during the Selection phase. This makes it impossible for the 9502 to determine the Initiator's SCSI ID and disconnection may not be performed.

1.10.3 RESELECTION (optional)

Reselection is an optional phase that allows the 9502 to reconnect to an Initiator for the purpose of continuing an operation that was previously started by the Initiator but was suspended by the 9502.

Reselection can only be used in systems that have the Arbitration phase implemented.

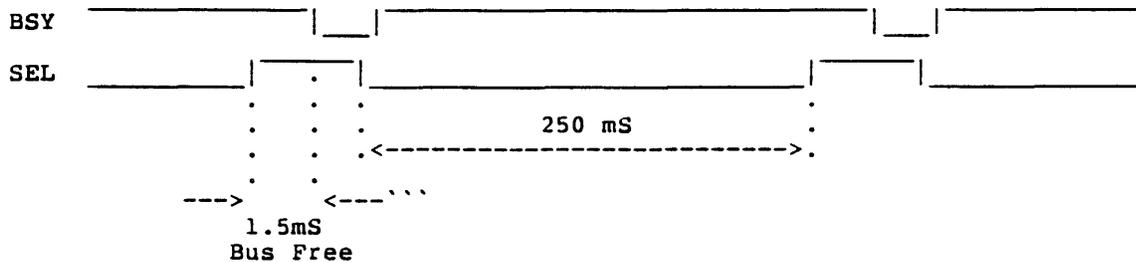
After winning Arbitration (SEL, BSY, and the 9502's SCSI ID are true):

1. The 9502 asserts the I/O signal and sets the Data Bus to the OR of its own SCSI ID and the Initiators ID.
2. The 9502 waits at least 90 nsec, then releases BSY.
3. The Initiator determines that it has been Reselected when SEL, I/O, and its SCSI ID are true, and that BSY is False.
4. The Initiator then asserts BSY.
5. When the 9502 detects the Initiator setting BSY, it will also set BSY. The 9502 waits at least 90 nsec, then releases SEL. At this point the 9502 may change the I/O signal and the Data Bus.
6. After the Reselected Initiator detects SEL false, it should release BSY. The 9502 will continue asserting BSY until the 9502 is ready to relinquish the Bus.

1.10.3.1 RESELECTION TIMEOUT

If the 9502 fails to detect BSY being set by the Initiator within 250 msec:

1. The 9502 leaves SEL and I/O asserted and releases the Data Bus (SCSI IDs).
2. If a BSY response is not received from the Initiator within 250 msec, the 9502 will let the bus go to the Bus Free phase. No ending status will be transmitted and the 9502 will be awaiting selection. If, after a pause of approximately 1.5 msec, the 9502 has not been selected, it will again try to reselect the Host. This retry sequence continues ad infinitum.



1.10.4 INFORMATION TRANSFER PHASES

The Command, Data, Status, and Message phases are grouped together as Information Transfer phases because they are all used to transfer Data or Control information via the SCSI data bus.

The C/D, I/O, and MSG signals are used to distinguish between the different Information Transfer phases. The 9502 drives these three signals and therefore controls all changes from one phase to another. The Initiator can request a Message Out phase by asserting ATN, while the 9502 can cause the Bus Free phase by releasing MSG, C/D, I/O, and BSY.

Table 1-4. INFORMATION TRANSFER PHASES

Signal*			Phase Name	Direction of Xfer	Phase
MSG	C/D	I/O			
0	0	0	DATA OUT	Initiator to 9502	\ Data
0	0	1	DATA IN	9502 to Initiator	/ Phase
0	1	0	COMMAND	Initiator to 9502	
0	1	1	STATUS	9502 to Initiator	
1	1	0	MESSAGE OUT	Initiator to 9502	\ Data
1	1	1	MESSAGE IN	9502 to Initiator	/ Phase
1	0	0	**		
1	0	1	**		

* 0 = False, 1 = True, ** = Reserved

The Information Transfer phases use one or more REQ/ACK handshake(s) to control the information transfer. Each REQ/ACK handshake (in an asynchronous operation) allows the transfer of one byte of information.

In a synchronous transfer, the initiator can accept REQ's without issuing corresponding ACK's, each REQ transferring one byte. When the transfer is complete the target must have received the same number of ACK's as REQ's issued.

The 9502 can issue a maximum of 15 REQ's before receiving a single ACK.

During the Information Transfer phases BSY will remain true and SEL will remain false. During the Information Transfer phases the 9502 will continuously envelope the REQ/ACK handshake(s) 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.

1.10.4.1 COMMAND

The Command phase allows the 9502 to request command information from the Initiator. An Initiator issues SCSI commands to the 9502 by transferring a command packet, called a Command Descriptor Block (CDB). The length of the SCSI command and meaning of the information in the command packet depends on which command is being transferred (See Section 1-13 for definitions of SCSI commands and all SCSI CDBs supported by the 9502).

During the Command phase the 9502 will assert the C/D signal and negate the I/O & MSG signals during the REQ/ACK handshake(s), irrespective of whether the transfer is synchronous or asynchronous.

1.10.4.1.1 LINKED COMMANDS

The last byte of every CDB is a control byte. The low order two bits control the ability of linking commands in a sequence and notifying the Initiator when a particular command step is completed.

The linking of commands allows the Initiator/Target to avoid the arbitration and selection phases of the SCSI protocol.

Following the completion of the Command and Data Phases of the first command of a linked sequence, the target responds to the initiator with an Intermediate Status Good followed by a Linked Command Complete Message with or without Flag. (refer Section 1.10.4.3) The target will then reenter the Command Phase to receive the next CDB. The final CDB of the linked sequence shall return a completion Status byte with Good status followed by a Command Complete Message.

1.10.4.1.2 INTERMEDIATE STATUS

This status will be returned for every command in a series of linked commands (except the last command), unless an error, exception, or abnormal condition causes a Check Condition status to be set.

1.10.4.2 DATA

The Data phase controls the transfer of data between the Initiator and the 9502. The Data phase includes both Data In and Data Out phases.

1.10.4.2.1 DATA IN

The Data In phase allows the 9502 to request transfer of data from the 9502 to the Initiator. During the Data In phase the 9502 asserts the I/O signal and negates the C/D and MSG signals during the REQ/ACK handshake(s).

1.10.4.2.2 DATA OUT

The Data Out phase allows the 9502 to request transfer of data from the Initiator to the 9502. During the Data Out phase the 9502 negates the I/O, C/D, and MSG signals during the REQ/ACK handshake(s).

1.10.4.3 STATUS

The Status phase is used by the 9502 to send completion information to the Initiator at the end of a command or a set of linked commands. Intermediate status is returned to the Initiator at the completion of a linked command. Any abnormal conditions encountered during command execution will cause command termination and the transmission of ending status.

The completion status byte indicates whether the previously executed command terminated properly. If the status byte indicates an abnormal termination, the Initiator should issue a Request Sense command for more detailed error information.

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 status (02H). See Request Sense command.							
2	0							
3	The 9502 is Busy (08H). This status will be returned whenever the 9502 is unable to accept a Command from the INITIATOR. The normal INITIATOR recovery action is to issue the Command again at a later time. Busy status will be reported on any command that follows an Immediate Command that hasn't finished executing. The one exception to this rule is a Rewind Immediate. Any command that follows a Rewind Immediate, and the rewind has not completed, will return Check Status (02H). A request sense will reveal Not Ready.							
4	Intermediate Status Good (10H). This bit is set for any Intermediate Status sent during a series of Linked Commands. This bit is not set for any ending status.							
5,6,7	0 Reservation Conflict (18H bits 3 and 4 set). This status will be returned whenever a SCSI device attempts to access a Logical Unit that is reserved for that type of access to another SCSI device.							

1.10.4.4 MESSAGE

The Message phase is used to transfer information about command conditions between the Initiator and the 9502. The Message phase references either a Message In, or a Message Out phase. Messages may be single or multiple byte. The first message sent by the initiator after Selection shall be an Identify, Abort, or Bus Device Reset message.

1.10.4.4.1 MESSAGE IN

The Message In phase allows the 9502 to request that messages be sent from the 9502 to the Initiator. During the Message In phase, the 9502 will assert C/D, I/O, and MSG.

1.10.4.4.2 MESSAGE OUT

The Message Out phase allows the 9502 to request that a message be sent from the Initiator to the 9502. The 9502 will invoke this phase at its convenience in response to the ATN condition (Section 1.11.1) created by the Initiator.

During the Message Out phase, the 9502 will assert C/D and MSG and negate I/O. If the last message received by the 9502 was inappropriate or not yet implemented, the 9502 will invoke the Message In phase and send Message Reject. The 9502 will then return to the Message Out phase.

1.10.4.4.3 MESSAGE RECEIVED WITH BAD PARITY

With the front panel option "PARITY" set to RETRY, any message received, with bad parity, will cause the 9502 to stay in the message out phase until 3 unsuccessful attempts by the host to send a good message have been tried. The 9502 will then release BSY and go to Bus Free.

It is then the Host's responsibility to issue a Request Sense command to determine why the 9502 went Bus Free. The 9502's response data will have Sense Key "B" set - Aborted Command with 43 03 Message Parity Error in the additional sense bytes.

If the front panel option "PARITY" is set to CHECK, then on receipt of a parity incorrect message the 9502 will go to Bus Free immediately. Again a request sense command should be issued.

If for any reason a request sense is not issued, then a Check Condition will be returned on the next command with the deferred error bit set. If any other sequence of events occurs after the 9502 goes Bus Free then the sense data (Message Parity Error) cannot be guaranteed to be returned and the reason for going Bus Free will be lost.

1.11 BUS CONDITIONS

1.11.1 ATTENTION

The Attention condition allows an Initiator to inform the 9502 that the Initiator has a message ready. The 9502 will retrieve the message at its convenience by performing a Message Out phase.

1.11.2 RESET

The Reset condition is used to immediately clear all SCSI devices from the bus. This condition takes precedence over all other phases and conditions.

The 9502 implements the "HARD" Reset Option. Upon detection of the Reset condition the 9502 will:

1. Clear the current uncompleted command.
2. Release all device reservations.
3. Return all operating modes (Mode Select, etc.) to their power-on default conditions.
4. Return to the Bus Free phase.

Note: Any write data resident in the buffer, that good completion status has been returned to the initiator on, when a reset is received shall be unaffected by the reset. That data will be written to tape via the normal write mechanism, and is independent of the reset.

1.12 MESSAGE SYSTEM DESCRIPTION

The Message system allows communication between an Initiator and the 9502 for the purpose of physical path management.

The Initiator indicates its ability to support the entire Message system by asserting the ATN signal during the Selection phase. The 9502 indicates its ability to support Messages by going to the Message Out phase after the Selection phase in response to ATN.

The 9502 has the capability of operating in either a "connected" or a "disconnected" method of transfer. The method of enabling the 9502 to operate in the Disconnect/Reselect mode is achieved via the Message system.

During Selection time:

1. The Initiator should assert ATN.
2. After completing the Selection phase, the 9502 will go to the Message Out phase.
3. The Initiator should then send the Identify message and indicate its ability to enable Disconnect/Reselect (See Identify message).

1.12.1 SINGLE BYTE MESSAGES

The single byte messages supported, their code values and definitions are listed in Table 1-6.

Table 1-6. SINGLE BYTE MESSAGE CODES

Code	Description	Direction*	
00H	COMMAND COMPLETE	IN	
01H	EXTENDED MESSAGE	IN	OUT
02H	SAVE DATA POINTER	IN	
03H	RESTORE POINTERS	IN	
04H	DISCONNECT	IN	
05H	INITIATOR DETECTED ERROR		OUT
06H	ABORT		OUT
07H	MESSAGE REJECT	IN	OUT
08H	NO OPERATION		OUT
09H	MESSAGE PARITY ERROR		OUT
0AH	LINKED COMMAND COMPLETE	IN	
0BH	LINKED COMMAND COMPLETE W/FLAG	IN	
0CH	BUS DEVICE RESET		OUT
80H-87H	IDENTIFY	IN	OUT
C0H-C7H	IDENTIFY	IN	OUT

* IN = 9502 to Initiator, OUT = Initiator to 9502

COMMAND COMPLETE (00H):

This message is sent from the 9502 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 9502 will go the Bus Free phase.

Note: The command may or may not have executed successfully as indicated in the Completion Status (See 1.10.4.3).

EXTENDED MESSAGE (01H):

This message is sent by either the Initiator or the 9502 for the purposes of negotiating for a Synchronous Data Transfer

The message will have the following format:

Byte 0	01	Extended message
1	03	Extended message length
2	01	Synchronous data transfer request
3	N	Transfer period
4	F	Req/Ack offset

The values of 'N' in byte 3 that the 9502 will set are as follows:

Table 1-7. SYNCHRONOUS TRANSFER RATES

Returned Transfer Period	Actual Transfer Rate (nS)	Actual Transfer Rate (MHz)
34,	208.33 nS	4.80 MHz
3e,	250.00 nS	4.00 MHz
48,	291.67 nS	3.43 MHz
53,	333.33 nS	3.00 MHz
5d,	375.00 nS	2.67 MHz
68,	416.67 nS	2.40 MHz
72,	458.33 nS	2.18 MHz
7d,	500.00 nS	2.00 MHz
87,	541.67 nS	1.85 MHz
91,	583.33 nS	1.71 MHz
9c,	625.00 nS	1.60 MHz
a6,	666.67 nS	1.50 MHz
b1,	708.33 nS	1.41 MHz
bb,	750.00 nS	1.33 MHz
c5,	791.67 nS	1.26 MHz
d0,	833.33 nS	1.20 MHz
da,	875.00 nS	1.14 MHz
e5,	916.67 nS	1.09 MHz
ef,	958.33 nS	1.04 MHz
fa,	1000.00 nS	1.00 MHz

If the initiator responds with a value less than 1.00Mb/sec, then the 9502 will respond with a Message Reject and asynchronous operation will be implied.

Host Initiated Negotiation - Example

If the Host were to initiate Synchronous Transfer Negotiation by issuing a Message with a Transfer Period and Offset, of say 3E 07. The 9502 would respond by reflecting that Transfer Period and Offset back to the Host, implying acceptance.

If however, the Host issues a Transfer Period and Offset that is beyond the 9502's capabilities, then it will respond with its maximum rate of: 34 0F.

9502 Initiated Negotiation - Example

With the front panel option "SYNC NEG" set to ENABLE the 9502 will always try to negotiate at its maximum rate: 34 0F. (provided the host hasn't previously negotiated an acceptable period and offset.)

The 9502 will accept, (by transferring at its closest lower rate), any responded Transfer Period and Offset. See Table 1-7 above.

REQ/ACK OFFSET

The 9502 can accommodate an offset of 15 REQ/ACK pulses. In other words, an offset interlock of 15 bytes. If an initiator responds with the same value then agreement is implied.

If the response is less than or equal to F_H bytes then the 9502 will use that responded offset.

If a response of zero is received, then asynchronous transfer is implied.

SAVE DATA POINTER (02_H):

This message is sent from the 9502 to direct the Initiator to save a copy of the present active data pointer for the currently attached LUN. This message is typically sent prior to a disconnect.

RESTORE POINTERS (03_H):

This message is sent to the Initiator when the 9502 detects a Bus Parity Error, or other errors requiring retries. The 9502 will perform a retry sequence.

DISCONNECT (04_H):

This message is sent from the 9502 to inform the Initiator that the present Physical path is going to be broken (the 9502 plans to Disconnect by releasing BSY), but that a later Reconnection will be performed in order to complete the current operation.

INITIATOR DETECTED ERROR (05_H):

This message causes the 9502 to issue a restore pointers message to retry the last command.

ABORT (06_H):

This message is sent from the Initiator to the 9502 to clear the present SCSI Bus operation.

On receipt of an Abort Message the 9502 goes to the Bus Free state.

It is conceivable that tape motion may still be in progress - writing buffered data to tape, after the Abort message has been received and the bus is in a bus free state. If that write was unsuccessful, the Abort Message will not destroy the deferred error status for that write. That status will be relayed to the initiator on the next command received.

MESSAGE REJECT (07_H):

- a) Initiator to 9502. Indicates that the last message received was inappropriate or has not been implemented. On receipt of this message, the 9502 checks the last message sent. If the last message sent was a Save Data Pointer (02_H), the 9502 will not disconnect.
- b) 9502 to Initiator. Indicates that the last message received is not implemented in the 9502.

NO OPERATION (08H):

This message is sent from an Initiator in response to the 9502's request for a message, when the Initiator does not currently have any other valid message to send.

MESSAGE PARITY ERROR (09H):

This message is sent from the Initiator to the 9502 to indicate that one or more bytes in the last message it received had a parity error. On receipt of this message the 9502 will re-issue its last message.

LINKED COMMAND COMPLETE (0AH):

This message is sent from the 9502 to the Initiator to indicate that the execution of a Linked command has completed and that status has been sent.

LINKED COMMAND COMPLETE (WITH FLAG) (0BH):

This message is sent from the 9502 to the Initiator to indicate that the execution of a Linked command (with the Flag bit set to one) has completed and that status has been sent.

BUS DEVICE RESET (0CH):

This message is sent from an Initiator to direct the 9502 to clear all current commands. This message forces the 9502 to an initial state with no operations pending for any Initiator (same as the power-on or the Reset Signal). Upon recognizing this message, the 9502 will go to the Bus Free phase.

IDENTIFY 80H - 87H, C0H - C7H:

These messages are sent by either the Initiator or the 9502 to establish the physical path connection between an Initiator and the 9502.

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

BIT 0-2: These bits must match the LUN address as selected in the HOST I/O, SCSI LUN menu.

BIT 3-5: Reserved.

BIT 6: This bit may only be set to one by the Initiator. When set to one, it indicates that the Initiator has the ability to accommodate disconnection and reconnection.

Not all commands cause the 9502 to disconnect itself from the Initiator. Only commands which involve tape motion may cause disconnection. The commands are listed below:

Rewind (Only if tape is NOT at BOT)
Write
Read
Read Reverse
Write File Mark
Space
Verify
Erase
Load\Unload

BIT 7: Always set to one (1).

1.12.2 MULTIPLE BYTE MESSAGE

A value of one in the first byte of a message indicates the beginning of a multiple-byte message. The 9502 supports Synchronous data transfer capability and the SCSI message system establishes the proper parameters.

1.13 COMMANDS

The SCSI Initiator defines the task for the target to perform by transferring a CDB in the Command phase. The 6 bytes of the CDB are checked and interpreted by the 9502. The only time the 9502 will not accept all six bytes is if an interface parity error is detected. In this case the 9502 will re-enter the message phase and send a Restore Pointers message (03) to the initiator. If after 3 attempts the CDB still has a parity error, check status will be reported and the SCSI Bus will be released.

Checking and interpretation of the CDB may yield an illegal condition; e.g. Reserved bit fields not set to logical 0. If an illegal condition exists, Check Condition will be set in the Completion Status byte.

If the Check Condition bit is set in the completion status byte, a Request Sense command should then be issued to discover the reason for the previous command failure. In the above situation, the Request Sense returned sense information would inform the initiator that an illegal command had been issued.

All bits, bytes, and fields are checked for legitimate values or zeros. Illegal values will result in a Check Condition Status and an Illegal Request Sense Key set in extended sense.

The following table lists the available SCSI Commands and their associated operation codes by section and page number.

Table 1-8. SCSI COMMANDS AND CODES

Section	SCSI Command	Code	Page
1.13.1	TEST UNIT READY	00H	18
1.13.2	REWIND	01H	19
1.13.3	REQUEST SENSE	03H	20
1.13.4	READ BLOCK LIMITS	05H	28
1.13.5	READ	08H	30
1.13.6	WRITE	0AH	32
1.13.7	READ REVERSE	0FH	34
1.13.8	WRITE FILE MARKS	10H	35
1.13.9	SPACE	11H	36
1.13.10	INQUIRY	12H	38
1.13.11	VERIFY	13H	41
1.13.12	RECOVER BUFFERED DATA	14H	42
1.13.13	MODE SELECT	15H	44
1.13.14	RESERVE UNIT	16H	46
1.13.15	RELEASE UNIT	17H	48
1.13.16	ERASE	19H	49
1.13.17	MODE SENSE	1AH	50
1.13.18	LOAD\UNLOAD	1BH	53
1.13.19	RECEIVE DIAGNOSTIC RESULTS	1CH	54
1.13.20	SEND DIAGNOSTIC	1DH	57
1.13.21	WRITE DATA BUFFER	3BH	61
1.13.22	READ DATA BUFFER	3CH	63

1.13.1 TEST UNIT READY

The Test Unit Ready command is used to check the unit for On-Line and Ready, as well as outstanding check conditions. If the LUN is On-Line and Ready (not Rewinding), the command will be terminated with GOOD Status or Intermediate GOOD Status in the Completion Status Byte.

Table 1-9. TEST UNIT READY (00H)

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	

1.13.3 REQUEST SENSE

This command is used to obtain more detailed status information for a an error condition (02_H status returned in the last command) after a command has been completed. The sense data will be valid for the Check Condition (or status) last presented to the Initiator. Sense data will be cleared on receipt of any subsequent command (except Inquiry) to the unit in check except when the tape drive is at the Beginning of Tape (BOT).

Byte four, Allocation Length, specifies the number of bytes to be returned to the initiator. The 9502 can support from 0 up to 40 bytes of Request Sense information. An Allocation Length of zero shall return zero bytes of request sense information. A Request Sense length greater than 40 will not be considered an error, however, only 40 bytes will be returned.

Table 1-11. REQUEST SENSE Command (03_H)

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	ALLOCATION LENGTH							
Byte 5	0	0	RESERVED			FLAG		LINK

The format of the Sense Bytes returned is shown in Table 1-12.

Table 1-12. SENSE BYTES 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							
Bytes 8-11	0	0	0	0	0	0	0	0
Byte 12	ADDITIONAL SENSE CODE							
Byte 13	ADDITIONAL SENSE CODE QUALIFIER							
Byte 14	0	0	0	0	0	0	0	0
Byte 15	SKSV	RESERVED						
Byte 16	(MSB)	ACTUAL RETRY COUNT						
Byte 17								(LSB)
Bytes 18-39	PADDED WITH ZERO's (RESERVED FOR FUTURE USE)							

Byte 0

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

Code 70H 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 71H 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, an Medium Error or End of Tape is encountered, the next command issued to the unit will return Check Condition status (excluding the Request Sense command), and the Error Code will be set to 71H (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 SEGMENT NUMBER: The Segment Number is zero.

Byte 2

FMK: The last command failed because a File Mark was detected. 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.

ILL: 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 1-13.

Bytes 3-6

INFORMATION BYTES: The Information Bytes are not defined if the VALID bit is zero. If the VALID bit is one, the information bytes contain valid information as follows:

For Reads, Recovered Buffered Data, ...

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).

For Fixed Writes

The number of data blocks and filemarks in the buffer and the untransferred block count.

For Variable Writes

The number of data bytes in the buffer, not including filemarks.

Byte 7

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

Bytes 8-11

Bytes 8 through 11 are set to zero.

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 1-14.

Byte 14

This byte is set to zero.

Bytes 15-17

SENSE KEY SPECIFIC BYTES:

If the Sense Key (Byte 2) is Recovered Error (01) and if the SKSV bit is set to one, then bytes 16 & 17 contain the actual number of retries used in attempting to recover the error.

The SKSV bit could be set to zero when no specific information is valid or defined.

Bytes 18-39

ADDITIONAL SENSE BYTES: These bytes will be filled with zero's; their use is reserved for future enhancements.

Table 1-13. SENSE KEY DESCRIPTIONS

KEY	Description
0H	NO SENSE - Indicates that there is no error information to be reported. This occurs for a successful command, or a command that set Check Condition because one of the FMK, EOM, tape unit at BOT, or ILI bits are set to one.
1H	RECOVERED ERROR - Indicates that the last command completed successfully but with some recovery action performed.
2H	NOT READY - Indicates that the LUN is not Ready and On-Line. (Not_Rdy or Not_Onl or Rewinding)
3H	MEDIUM ERROR - Indicates an unrecoverable Tape error was detected during the previous Write, Read, WFMK or Space command.
4H	HARDWARE ERROR - The 9502 detected an unrecoverable hardware error, (Rewind issued with no Rewind status from drive, Erase to EOT issued with no EOT status reported by drive at command completion).
5H	ILLEGAL REQUEST - <ul style="list-style-type: none"> a) An illegal command was requested in the CDB. b) A Fixed Mode Read or Write operation was requested when the 9502 was operating in variable mode. c) A Variable Mode Read or Write was requested when the 9502 was operating in Fixed Mode. d) When in Fixed or Variable Mode, a selected block length is greater than maximum selected in the HOST I/O menu.
6H	UNIT ATTENTION - Indicates that the tape may have been changed (on-line - off-line - on-line), or that the 9502 has been reset or has not been accessed by the requesting Initiator since power-on.
7H	DATA PROTECT - Indicates that a Write, WFMK, or Erase command was attempted on a Write-Protected LUN. No data will be written by the 9502.
8H	BLANK CHECK - A Read, Read Reverse, Verify or Space command was attempted and no data blocks were found. Indicates 25 feet of blank tape.
9H	VENDOR UNIQUE - Error conditions unique to the Kennedy Tape Drive.
AH	COPY ABORTED - A Copy command was aborted due to an error condition on either the source or destination device.
BH	ABORTED COMMAND - The 9502 aborted the command.
DH	VOLUME OVERFLOW - A write to tape was unsuccessful (end of media detected) and data still remains in the buffer. A Recover Buffered Data command may be issued to read the unwritten data from the buffer.

Table 1-14. ADDITIONAL SENSE DATA

Sense Key NO SENSE (0H)		
Byte #		
12	13	Description
00	00	No additional sense information
00	01	File Mark Detected
00	02	End of Tape detected
00	04	Beginning of Tape detected
00	05	End of Data detected
Sense Key RECOVERED ERROR (1H)		
Byte #		
12	13	Description
17	01	Recovered read data with read retries
0D	01	Recovered write data with write retries
0E	00	Recovered Interface Error
Sense Key NOT READY (2H)		
Byte #		
12	13	Description
04	00	Drive Off-line
04	01	Volume Not Ready (rewinding)
<p>Note: If the Tape Unit is on-line and positioned at BOT, regardless of how it may have reached there, a Request Sense Command will return Sense Key NO SENSE (0H) with Additional Sense Code, Bytes 12, 13 = 00H and 04H, Beginning of Tape Detected, and the EOM bit not set. Receipt of any further Request Sense commands or any other non-motion commands shall not clear the BOT status. Only a command which causes movement away from the beginning of tape marker shall cause the BOT status to be cleared. A Space Reverse command into BOT will also set the EOM bit in The Request Sense returned information.</p>		
Sense Key MEDIUM ERROR (3H)		
Byte #		
12	13	Description
11	00	Unrecoverable Read Error
11	01	Read retries exhausted
14	00	No Record Found
1F	00	Unrecoverable Write Error
1F	01	Write retries exhausted - Block
1F	02	Write retries exhausted - File mark
23	00	Error During Space command

Table 1-14
ADDITIONAL SENSE DATA
(Continued)

Sense Key HARDWARE ERROR (4H)

Byte #

12	13	Description
----	----	-------------

40	01	Ram Failure
44	00	Internal 9502 Error
44	01	Buffer Parity Failure
51	00	Erase Fault
53	00	Media Load Failure
53	01	Media Unload Failure
56	00	Failure to Sense BOT

Sense Key ILLEGAL REQUEST (5H)

Byte #

12	13	Description
----	----	-------------

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
26	06	Density not enabled
34	01	Invalid command operation code
34	04	Reserved bit/field used
34	07	Fixed bit set while in variable block mode
34	08	Fixed bit not set while in fixed block mode
34	0B	Requested block length not in valid range
34	0C	Unsupported function
34	0D	Immed bit set in unbuffered mode

Sense Key UNIT ATTENTION (6H)

Byte #

12	13	Description
----	----	-------------

28	00	Not Ready to Ready transition (Tape changed)
29	00	Power-on, Reset or Bus Device Reset occurred, will be reported if unit is off-line.

Table 1-14
ADDITIONAL SENSE DATA
(Continued)

Sense Key DATA PROTECT (7H)		
Byte #		
12	13	Description
27	00	Write Protected
Sense Key BLANK CHECK (8H)		
Byte #		
12	13	Description
2E	00	Tape Void detected (25 feet)
Sense Key VENDOR UNIQUE (9H)		
Byte #		
12	13	Description
11	08	Incomplete Blk Read (Max blk size < Actual blk size)
Sense Key ABORTED COMMAND (BH)		
Byte #		
12	13	Description
43	03	Message Parity Error
47	00	Interface Parity Error
Sense Key VOLUME OVERFLOW (DH)		
Byte #		
12	13	Description
62	00	Overflow Error

Memory Size	Front Panel Option	Returned Block Limits	
	32K	00 00 80 00 00 01	max = 32K bytes
	64K	00 01 00 00 00 01	max = 64K bytes
	128K	00 02 00 00 00 01	max = 128K bytes
256K PCB	256K	00 03 FE EE 00 01	max = 256K minus 257 bytes
512K PCB	256K	00 04 00 00 00 01	max = 256K bytes
1MEG PCB	256K	00 04 00 00 00 01	max = 256K bytes

MAXIMUM will allow the maximum memory size minus 257 bytes.

256K PCB	MAXIMUM	00 03 FE EE 00 01	max = 256K minus 257 bytes
512K PCB	MAXIMUM	00 07 FE EE 00 01	max = 512K minus 257 bytes
1MEG PCB	MAXIMUM	00 0F FE EE 00 01	max = 1MEG minus 257 bytes

In all cases the minimum size is 1 byte.

If the maximum byte count equals the minimum byte count, then Fixed length blocks are specified, otherwise Variable length blocks are specified.

I.E. the following returned block limits would show a Fixed Mode 32K blk.

00 00 80 00 80 00

A problem exists in specifying Fixed length blocks of 64K or greater. Since the Maximum count has to equal the Minimum count, then with only 2 bytes (bytes 4 & 5 above) to specify the Minimum, a 64K block cannot be entered into a 2 byte field. A 64K or larger Fixed Length block will result in zero in the Minimum count and selected byte count (HOST I/O, MAX SIZE) in the Maximum count.

1.13.5 READ

The Read command (Table 1-17) transfers one or more blocks to the Initiator beginning with the next block on the logical unit. The FIXED bit specifies both the meaning of the Transfer Length field and whether Fixed Length or Variable Length blocks are to be transferred.

Table 1-17. READ Command (08H)

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 4	BYTES/BLOCKS TO TRANSFER (LSB)							
Byte 5	0	0	RESERVED			FLAG	LINK	

Fixed Length Transfer:

If the FIXED bit is one, Fixed Length blocks will be transferred to the Initiator. The number of blocks to be transferred is specified in bytes 2-4 of the CDB. Fixed mode Read commands are valid only if the unit is currently operating in Fixed Block mode. units are in Fixed Block mode when either of the following conditions are true:

- a) The unit reports the same value for Minimum Byte Count and Maximum Byte Count in response to the Read Block Limits command.
- b) The unit has been instructed to use fixed block sizes with the Mode Select command.

If the unit reads a File Mark prior to completing the Fixed Mode Read command, the 9502 will send Check Condition status to the Initiator, and set the FMK bit in the Extended Sense. The Information Bytes will be set to the difference between the requested number of blocks and the actual number of blocks read (not including the File Mark).

If the unit encounters EOT prior to completing the Fixed Mode Read command, the 9502 will send Check Condition status to the Initiator, and set EOM in the Extended Sense. The Information Bytes will be set to the difference between the requested number of blocks read and the actual number of blocks read. A transfer length of zero indicates no data will be transferred.

Variable Length Transfer:

When the FIXED bit is zero, Variable Length blocks will be transferred to the Initiator. Bytes 2-4 of the CDB specify the number of bytes the Initiator has allocated for the returned data.

Suppress Incorrect Length Indicator:

The SILI bit is only valid when not in Fixed mode. The following combinations of Fixed bit and SILI bit are valid:

SILI = 1 FIXED = 0

The 9502 will not return Check Condition status if the only error is that the transfer length is not equal to the actual block length. However, if the actual block is longer than the requested, then the requested number of bytes will be returned. If the actual block is shorter than the requested, then the actual number of bytes will be returned. For clarity, the 9502 returns the smaller of the two values.

SILI = 0 FIXED = 1

The 9502 will return Check Condition status and the ILI and Valid bits will be set to one in the sense data, if an incorrect length block is read. The information bytes will be set to the difference (residue) of the requested number of blocks minus the actual number of blocks read.

SILI = 0 FIXED = 0

The 9502 will return Check Condition status and the ILI and Valid bits will be set to one in the sense data, if an incorrect length block is read. The information bytes will be set to the difference (residue) of the requested length minus the actual block length.

Note: A transfer length of zero will result in no data being transferred. This will not be considered as an error condition.

For both Fixed and Variable length modes:

If 25 feet of blank tape is detected, the VALID bits will be set in the Extended Sense and the Sense Key will be set to 8_H (Blank Check). If operating in Variable mode, the Information Bytes will be set to the difference between the requested transfer length and the zero bytes read from tape. If operating in Fixed mode, the Information Bytes will indicate the number of blocks not transferred to the Initiator. For both cases no data will be transferred.

Completion Status Codes for Read Command:

Good (00 _H)	Good Status
Busy (08 _H)	The 9502 is busy executing a command.
Reservation Conflict (18 _H)	
Check (02 _H)	Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

Not Ready	Hardware Error
Illegal Request	Unit Attention
Aborted Command	EOM, ILI, FM
Blank Check	Deferred Error
Recovered Error	Medium Error

1.13.6 WRITE

The Write command transfers one or more blocks from the Initiator to the current position on the logical unit. The FIXED bit specifies the meaning of the Transfer Length field.

Table 1-18. WRITE Command (0AH)

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 4	BYTES/BLOCKS TO TRANSFER (LSB)							
Byte 5	0	0	RESERVED			FLAG	LINK	

Variable Length Transfer:

When the FIXED bit is zero the command will transfer a single block from the Initiator to the 9502. Bytes 2-4 of the CDB specify the size of the block to be written (minimum block size = 1 byte, maximum block size = front panel option dependent).

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 unit is set to Fixed mode, or the requested byte count is greater than that specified in the front panel option, Check Condition status will be returned to the Initiator and the Sense Key in the Extended Sense will be set to Illegal Request.

Note: A transfer length of zero will not be considered as an error. No data will be transferred between the initiator and the 9502.

Buffered:

When operating in Buffered Mode, many blocks can be held in the 9502 buffer. If EOT is encountered, (with the EOT option set to STOP) the 9502 will complete the writing of that block and STOP. On receipt of the next command the 9502 will report Check Condition - Deferred Error with EOM set and a residual count of the number of bytes remaining in the buffer. The initiator can flush the remaining blocks to tape by issuing any "WFMK" command.

With the EOT option set to CONTINUE, the 9502 will write all buffered data to tape, stopping beyond EOT if necessary.

Further writes past EOT will reduce the buffer to 1. Check condition with EOM set will be reported.

Fixed Length Transfer:

When the FIXED bit is one, the command will transfer a number of blocks from the Initiator to the 9502 to be written to the addressed unit. 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 Read command).

Non-Buffered:

When EOT (or an unrecoverable error) is encountered, Check Condition status is returned and EOM (or Medium Error Sense key) is set in the sense byte. If any data remains in the 9502 buffer, the Sense Key will be set to Volume Overflow and the Information Bytes will be set to the difference between the requested number of blocks and the actual number of blocks written to tape.

Buffered:

When EOT (STOP), (or an unrecoverable error) is encountered, the transfer of data from the 9502 to the tape unit is halted, the Request Sense bytes are assembled as mentioned earlier, but byte 0 of the extended sense bytes could be set. This is very much a timing dependent situation.

If the next command is received before EOT is detected during a previous write then the returned status will be (70H).

If EOT is detected after receipt of the command but prior to the status phase then (F1H) or (71H) could be returned - deferred error. The current command will not have been executed.

The information bytes can contain more than just the amount of blocks remaining in the buffer, they can also contain the as yet unreceived blocks from the host. For Example:

The host issues a fixed buffered mode write of 2 blocks. The buffer can only fit one block in it. An error occurs EOT/EOM/Medium Error. The valid information bytes will contain the untransferred block + that remaining in the buffer.

Note: In both cases, Buffered and Non-Buffered, its recommended that the initiator issue a Recover Buffer Data command to remove the unwritten data from the buffer.

Completion Status Codes for Write Command:

Good (00H)	Good Status
Busy (08H)	The 9502 is busy executing a command.
Reservation Conflict (18H)	
Check (02H)	Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

Not Ready	Hardware Error
Illegal Request	Unit Attention
Aborted Command	EOM
Write Protect	Volume Overflow
Recovered Error	Medium Error
Deferred Error	

1.13.7 READ REVERSE

The Read Reverse command functions identically to the Read command except that tape motion is in the reverse direction. The block and bytes within the block are transferred in reverse order.

Table 1-19. READ REVERSE Command (0FH)

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 4	BYTES/BLOCKS TO TRANSFER (LSB)							
Byte 5	0	0	RESERVED			FLAG	LINK	

If BOT is encountered, Check Condition will be returned to the Initiator. The EOM bit will be set in the Extended Sense and the Sense Key will be set to No Sense.

In Fixed Mode, the VALID bit will be set and the Information Bytes will be set to the difference between the requested number of blocks or bytes and the actual number of blocks or bytes transferred (same as Read at EOT).

If the tape is positioned past EOT and a Read Reverse command is issued then no check condition for EOT being detected will be posted. A check condition for detecting EOT is only issued by a FORWARD motion command.

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

Completion Status Codes for Read Reverse Command:

- Good (00H) Good Status
- Busy (08H) The 9502 is busy executing a command.
- Reservation Conflict (18H)
- Check (02H) Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

- Not Ready
- Illegal Request
- Aborted Command
- Blank Check
- Hardware Error
- Unit Attention
- EOM, ILI, FM, BOT
- Medium Error

1.13.8 WRITE FILE MARK

The Write File Mark command causes the specified number of File Marks to be written to the media.

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

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	0	0	0	0
Byte 1	LUN			RESERVED			IMMED	
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.

This command is also used to force any data in buffer to be written to tape. During the previous Write command, if operating in Fixed mode, and a Medium Error was detected and a number of unwritten blocks remain in the buffer, Write File Mark can be used to force write these data blocks, provided good tape media exists. If the number of File Marks count is zero, the unwritten data will be written to tape and no File Marks will be written. If the count is other than zero, any unwritten data will be written to tape and the requested number of File Marks will then be written.

Encountering EOT

If, when writing Filemarks, EOT is encountered, and the EOT option is set to STOP the command will terminate with Check Condition status and the EOM bit in the Extended Sense will be set to one. Further, the Sense Key will be set to Volume Overflow, and the Information Bytes will be set to the number of unwritten File Marks (and possibly the number of write data blocks). Any buffered filemarks remaining to be written can be flushed by writing a further filemark (or a zero filemark).

Writing File Marks Past EOT

When positioned past EOT with no data in the buffer, a Write Filemark command with a count of one or more will write only ONE filemark. A subsequent Request Sense will indicate EOM, Volume Overflow and the information bytes will be set to the requested number minus one, indicating that only one filemark was written.

Immediate Bit

An immediate bit of one indicates that the 9502 will return status as soon as the CDB has been validated. An immediate bit of zero indicates that the 9502 will not return status until the operation has completed.

However, a Write Filemark command in Non-Buffered Mode with the Immediate bit set will cause the command to be rejected. Check condition status with the sense key set to Illegal Request will be sent.

Completion Status Codes for Write File Mark Command:

Good (00H)	Good Status
Busy (08H)	The 9502 is busy executing a command.
Reservation Conflict (18H)	
Check (02H)	Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

Not Ready	Hardware Error
Illegal Request	Unit Attention
Aborted Command	EOM, Deferred Error
Recovered Error	Volume Overflow
Write Protect	Medium Error

1.13.9 SPACE

The Space command 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 supported. 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. This is true for codes 0, 1 and 2. Code 3 only operates in a forward direction and does not require a Count.

Table 1-21. SPACE Command (11H)

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

<u>CODE</u>	<u>Description</u>
0H	Space Blocks
1H	Space File Marks
2H	Space Sequential File Marks
3H	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.

If a file mark is encountered while spacing over blocks, the operation will terminate with Check Condition status returned to the Initiator. The Information Bytes in the Extended Sense will be set to the difference (residue) between the requested count minus the actual number of blocks spaced over (not including the file mark). This would be a 2's complement number if it was a reverse command.

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 will again apply.

When Spacing to and over Sequential File Marks, the Count field is interpreted as follows:

1. A positive value N will cause the tape pointer to be positioned after the first occurrence of N consecutive filemarks, in a forward direction.
2. A zero value will cause no change in the logical position of the tape pointer.
3. A negative value (2's compliment) will cause the tape pointer to be logically positioned before (BOT side) the first occurrence of N consecutive filemarks, in a reverse direction.

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).

Completion Status Codes for Space Command:

Good (00H)	Good Status
Busy (08H)	The 9502 is busy executing a command.
Reservation Conflict (18H)	
Check (02H)	Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

Not Ready	Hardware Error
Illegal Request	Unit Attention
Aborted Command	EOM, FM, Blank Check

1.13.10 INQUIRY

This command requests that information regarding parameters of the 9502 and the LUN be sent to the Initiator.

Table 1-22. INQUIRY Command (12H)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	0	0	1	0
Byte 1	LUN			RESERVED				0
Byte 2	0	0	0	0	0	0	0	0
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 data. Forty bytes of Inquiry data are available to the Initiator. If the Allocation Length requests zero bytes, zero bytes will be returned. This is not considered an error. A request of n bytes less than or equal to 40 bytes will return n bytes. If the Allocation Length exceeds forty bytes, only forty bytes will be transferred to the Initiator. The format of the returned Inquiry data is shown in Table 1-23.

Note: An Inquiry command can be issued at anytime, even when the 9502 is disconnected.

An Inquiry command never destroys sense data assembled in the 9502, nor does it destroy pending Check status information.

Table 1-23. INQUIRY Command DATA

Bit →	7	6	5	4	3	2	1	0
Byte 0	DEVICE TYPE							
Byte 1	1	DEVICE QUALIFIER						
Byte 2	0	0	0	0	0	ANSI VERSION ID 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	REVISION LEVEL							

Byte 0 - Device Type

Byte 0 = 01_H Unit connected, powered on but not necessarily on-line, and identified as a sequential access device.

Byte 0 = 7F_H Device not present.

Byte 1

Bit 7 indicates the media is removable. Bits 0-6, the Device Qualifier is a seven bit user-specified code which may be set via the front panel.

Byte 2

Bits 0-2 Indicates that the 9502 employs the approved ANSI SCSI protocol, drawing on ANSI REV 17B, ANSI 3.131-1986 and SCSI-II enhancements.

Byte 3

Reserved.

Byte 4 Additional Length

Additional Length = 23FH

Bytes 5 - 18 Vendor I.D.

Returned data = KENNEDY

ASCII = 4B 45 4E 4E 45 44 59 20

Bytes 16-31 Product Identification

Returned Data = 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

Returned Data = UUU-xxxY

Where UUU = the Kennedy Software Identifier assigned to this piece of code. A numeric (257)

xxx = the released revision level of the code. A numeric.

Y = the unreleased modification revision. A letter.
All released code will be 'A'.

Completion Status Codes for Inquiry Command:

Good (00H)	Good Status
Busy (08H)	The 9502 is busy executing a command.
Reservation Conflict (18H)	
Check (02H)	Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

Aborted Command	Hardware Error
Illegal Request	Unit Attention

1.13.11 VERIFY

The Verify command verifies one or more blocks, beginning with the next block on the LUN. The FIXED bit specifies both the meaning of the Verification Length field and whether Fixed or Variable length blocks are to be verified.

The 9502 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_H)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	0	0	1	1
Byte 1	LUN			RESERVED		IMMED	0	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 EOD 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.

Note: Verify does not stop nor report EOT when EOT is encountered.

Completion Status Codes for Verify Command:

Good (00H)	Good Status
Busy (08H)	The 9502 is busy executing a command.
Reservation Conflict (18H)	
Check (02H)	Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

Not Ready	Hardware Error
Illegal Request	Unit Attention
Aborted Command	EOM, ILI, FM
Recovered Error	Blank Check
Medium Error	

1.13.12 RECOVER BUFFERED DATA

The Recover Buffered Data command is used to read data that has been transferred to the 9502 buffer, but has not been written to tape. It is normally only used to recover data that was transferred to the 9502 but not written to tape because EOT or a Medium Error was detected.

Table 1-25. RECOVER BUFFERED DATA (14H)

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

This command is similar in operation to the Read command except that data is transferred from the 9502 buffer and not from tape.

Blocks will be transferred from the 9502 buffer in the same order they would have been written to tape.

The 9502 however supports Recovered Buffer Data commands for the exact number, greater than or less than the amount of data in the buffer.

The following table illustrates the Recovered Buffer Data options that are supported:

- 1) Fixed Mode - Requested # blks > Actual # blks in buffer
- 2) Fixed Mode - Requested # blks = Actual # blks in buffer
- 3) Fixed Mode - Requested # blks < Actual # blks in buffer
- 4) Var Mode - Requested length > Actual length in buffer
- 5) Var Mode - Requested length = Actual length in buffer
- 6) Var Mode - Requested length < Actual length in buffer

In scenarios 1) and 4) above, all the data in the buffer is transferred to the initiator. Check Condition will be reported with the information Bytes set to the difference between the requested number and the number of blocks/bytes held in the Data Buffer.

In scenarios 3) and 6) above, a portion of the data in the buffer is transferred to the initiator. Check Condition will be reported with the information Bytes set to the difference between the requested number and the number of blocks/bytes held in the Data Buffer. It should be understood that the un-recovered portion of the buffer will be lost; therefore when in doubt use scenarios 1 & 4 or 2 & 5.

Scenarios 2) and 5) transfer with good status the requested blocks / bytes.

Note: A Write File Mark command executed at EOM with data still remaining in the data buffer will cause all the data resident in the buffer to be flushed to tape.

Completion Status Codes for Recovered Buffered Data Command:

Good (00H)	Good Status
Busy (08H)	The 9502 is busy executing a command.
Reservation Conflict (18H)	
Check (02H)	Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

Not Ready	Hardware Error
Illegal Request	Unit Attention
Aborted Command	EOM, ILI

1.13.13 MODE SELECT

The Mode Select command provides a means to specify media, unit or device parameters. Byte 4 of the CDB specifies the length of a parameter list which is sent to the 9502 as data. The parameter list contains a list of extent descriptors. Each extent specifies Fixed or Variable block lengths, block size, and density code. The format of the data transmitted to the 9502 is listed in Table 1-27.

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

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

The 9502 does not support Saved Pages. If the Saved Pages bit is set, the 9502 will ignore that bit and the Mode Select will execute as if the bit were not set.

The Page Format bit is not supported at this time. If the PF bit is set, the 9502 will ignore that bit and the Mode Select will execute as if the bit were not set. It is planned however to eventually support the Device Configuration Page - Page Code 10H. This manual will be revised when that feature is incorporated.

Completion Status Codes for Mode Select Command:

- Good (00H) Good Status
- Busy (08H) The 9502 is busy executing a command.
- Reservation Conflict (18H)
- Check (02H) Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

- Not Ready
- Illegal Request
- Aborted Command
- Hardware Error
- Unit Attention

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 LIST							

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 9502 will report GOOD status on Write commands as soon as the data block has been transferred to the 9502 buffer.

During a Write File Mark command, all unwritten data blocks will be force written (flushed) to tape, except at EOM. If EOM is detected, an 02_H Status followed by a Request Sense with EOM bit set to one is returned.

Speed Select

<u>Speed Code</u>	<u>Speed Selected</u>
0H	Default, no change
1H	Low Speed Select
2H	High Speed Select
3H - FH	Reserved

Density Select

<u>Density Code</u>	<u>Density Selected</u>
00H	Default (as selected by drive)
01H	Select NRZI (800 cpi)
02H	Select PE (1600 cpi)
03H	Select GCR (6250 cpi)
06H	Select 2XPE (3200 cpi)

Variable/Fixed Mode Select

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

A block size field of zero specifies Variable Mode, with a minimum block length of 1 bytes and a maximum as selected from the front panel.

A block size field up to and including 256K bytes will select Fixed Mode operations with a block length specified as that of the block size bytes (minimum block size is 1 byte). A field outside these ranges will result in Check Condition status and the Sense Key in the Extended Status will be set to Illegal Operation.

1.13.14 RESERVE UNIT

The Reserve Unit command reserves the specified logical unit for the exclusive use of the requesting Initiator or, if third-party reservation is selected, for use by another specified SCSI controller.

Table 1-28. RESERVE UNIT Command (16H)

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	

Completion Status Codes for Reserve Unit Command:

Good (00 _H)	Good Status
Busy (08 _H)	The 9502 is busy executing a command.
Check (02 _H)	Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

Not Ready	Hardware Error
Illegal Request	Unit Attention
Aborted Command	

Reservation Conflict Status (18 _H)	The unit is already reserved by another initiator.
--	--

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 logical unit for the SCSI 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. The occurrence of the last two conditions is indicated by a Sense Key of Unit Attention on the next command following the condition. It is not an error to issue this command to a logical unit that is currently reserved by the requesting Initiator. If the logical unit has been previously reserved by another Initiator then the 9502 returns Reservation Conflict status.

The third-party reservation option for the Reserve Unit command allows an Initiator to reserve a logical unit for another SCSI 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 (switch third parties) by issuing another Reserve Unit command.

1.13.15 RELEASE UNIT

The Release Unit command releases the logical unit if it is currently reserved by the requesting Initiator.

Table 1-29. RELEASE UNIT Command (17H)

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	

It is not an error to attempt to release a logical unit that is not currently reserved by the requesting Initiator. However, it will not be released if it is reserved by another Initiator. The third-party release allows an Initiator to release a logical unit that was previously reserved using the third-party reservation.

If the 3 PTY bit is zero, then the third-party release option is not requested. If the 3 PTY bit is one, then the 9502 will release the specified logical unit, but only if the reservation was made using the third-party reservation option by the same Initiator for the same SCSI device as specified in the 3rd Party ID field.

Completion Status Codes for Release Unit Command:

- Good (00H) Good Status
- Busy (08H) The 9502 is busy executing a command.
- Check (02H) Refer to Request Sense extended status
(Non-Buffered Mode Only)

Possible conditions are:

- Not Ready Hardware Error
- Illegal Request Unit Attention
- Aborted Command

Reservation Conflict Status (18H)

The unit is already reserved by another initiator.

1.13.16 ERASE

The Erase command erases all or part of the remaining tape, beginning at the current tape position.

Table 1-30. ERASE Command (19H)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	1	0	0	1
Byte 1	LUN			RESERVED			IMMED	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 5 feet past EOT.

Note: Individual Write operations that occur after EOT may cause data to be written further than 5 feet past EOT, this data will not be erased by the Long Erase command.

If the IMMED bit is set, completion status will be returned immediately. If a subsequent command is issued, before the erase immediate completes, the 9502 will report BUSY.

The Erase will flush any buffered data and will report deferred error if the flush fails. The erase will not have been executed.

Completion Status Codes for Erase Command:

Good (00H)	Good Status
Busy (08H)	The 9502 is busy executing a command.
Reservation Conflict (18H)	
Check (02H)	Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

Not Ready	Hardware Error
Illegal Request	Unit Attention
Aborted Command	Write Protect

1.13.17 MODE SENSE

The Mode Sense command provides a means for the 9502 to report its media and device type parameters to the Initiator.

Table 1-31. MODE SENSE Command (1AH)

Bit →	7	6	5	4	3	2	1	0
Byte 0	0	0	0	1	1	0	1	0
Byte 1	LUN			RESVD	0	RESERVED		
Byte 2	PC		PAGE CODE					
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 returned by the 9502 as data. The format of the data returned is shown in Table 1-32.

The PC and Page Code fields are ignored at this time. It is planned however to support these features in the future. This manual will be updated to reflect those changes.

Completion Status Codes for Test Unit Ready Command:

- Good (00H) Good Status
- Busy (08H) The 9502 is busy executing a command.
- Reservation Conflict (18H)
- Check (02H) Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

- Not Ready
- Illegal Request
- Aborted Command
- Hardware Error
- Unit Attention

Table 1-32. 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							
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 (OB_H)

Byte 1

Medium Type (00_H)

Byte 2

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

<u>Code</u>	<u>Speed</u>
0 _H	Default Speed - Autospeed *
1 _H	Low Speed
2 _H	Hi-Speed

- * Default Speed - Autospeed. The tape drive incorporates the ability to change speed from 50ips to 100ips after execution of 3 reads or writes. The 9502 extends that feature by starting at 100ips if it knows its going to be executing at least 3 reads or writes.

Bit 4 (BM):

If the BM (Buffered Mode) bit is set to one, the 9502 will report Good status on Write commands as soon as the data has been transferred to the 9502 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 Length (08H) - Valid parameter list length.

Byte 4

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

<u>Code</u>	<u>Density</u>
01H	NRZI (800 cpi)
02H	PE (1600 cpi)
03H	GCR (6250 cpi)
06H	2XPE (3200 cpi)

Bytes 5-7

Bytes 5-7 will be returned as all zeros

Byte 8

Byte 8 reserved

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.

1.13.18 LOAD\UNLOAD

The Load\Unload command will either Load or Unload a tape depending on the value of the LOAD bit.

Table 1-33. LOAD/UNLOAD Command (1BH)

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

Completion Status Codes for Load/Unload Command:

Good (00H)	Good Status
Busy (08H)	The 9502 is busy executing a command.
Reservation Conflict (18H)	
Check (02H)	Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

Aborted Command	Hardware Error
Illegal Request	Unit Attention

A LOAD bit of one will load and position the mounted tape to the BOT marker and go on-line.

A LOAD bit of zero rewinds the tape to BOT, with the specified unit going off-line. Tape is then unwound from the take-up reel onto the supply reel, thus allowing the tape to be removed from the unit.

An IMMED bit of one will return completion status as soon as the 9502 receives and interprets the command. A subsequent command issued to a drive while in the process of loading immediately will return BUSY status. When the IMMED bit is zero, the unit will disconnect upon receipt of the command and reconnect and send completion status when the operation is complete.

An Unload will flush any buffered data to tape. If the flush should fail a deferred error will be posted and the Unload will not have been executed.

1.13.19 RECEIVE DIAGNOSTIC RESULTS

The Receive Diagnostics Results command requests that analysis data be sent to the Initiator after completion of a Send Diagnostic command.

Table 1-34. RECEIVE DIAGNOSTIC RESULTS Command (1C_H)

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	

Completion Status Codes for Receive Diagnostic Results:

- Good (00_H) Good Status
- Busy (08_H) The 9502 is busy executing a command.
- Reservation Conflict (18_H)
- Check (02_H) Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

- Not Ready Hardware Error
- Illegal Request Unit Attention

The Allocation Length specifies the number of bytes to be returned to the Initiator as diagnostic data.

The 9502 allocates 9 bytes of data, if the Allocation Length is greater than 9 bytes, only 9 bytes are returned.

The diagnostic data sent by the 9502 during the Data In phase is shown in Table 1-35.

Table 1-35. 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 00H, then the command completed successfully. Non-Zero codes indicate the cause of the error.

<u>Code</u>	<u>Failure</u>
80H	Dynamic RAM data error
81H	Write File Mark error
82H	Erase error
83H	Rewind error
84H	Blank Tape error
85H	Block Length error
86H	Data error
87H	Tape Parity error
88H	Read Reverse error
89H	Abnormal status

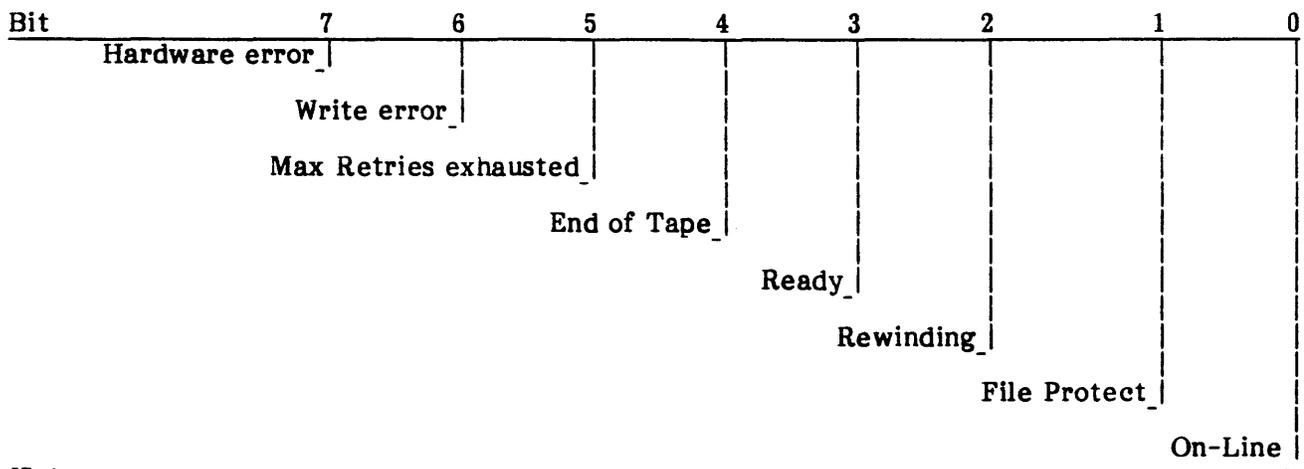
Test Number: If the Error Number is non-zero, this indicates the failing test.

Information Bytes (2-4): If the error is a Dynamic RAM error, the Information Bytes indicate the failing RAM address. If the error is a Block Length error, the Information Bytes indicate the difference between the requested block size and the actual block size from tape.

Bytes 5-6: If the error is a RAM data error, or a data error, Byte 5 contains the Expected Data and byte 6 contains the Actual Data byte.

Status Bytes: Status Bytes 1 & 2 indicate status signals from the tape unit.

Status Byte 1



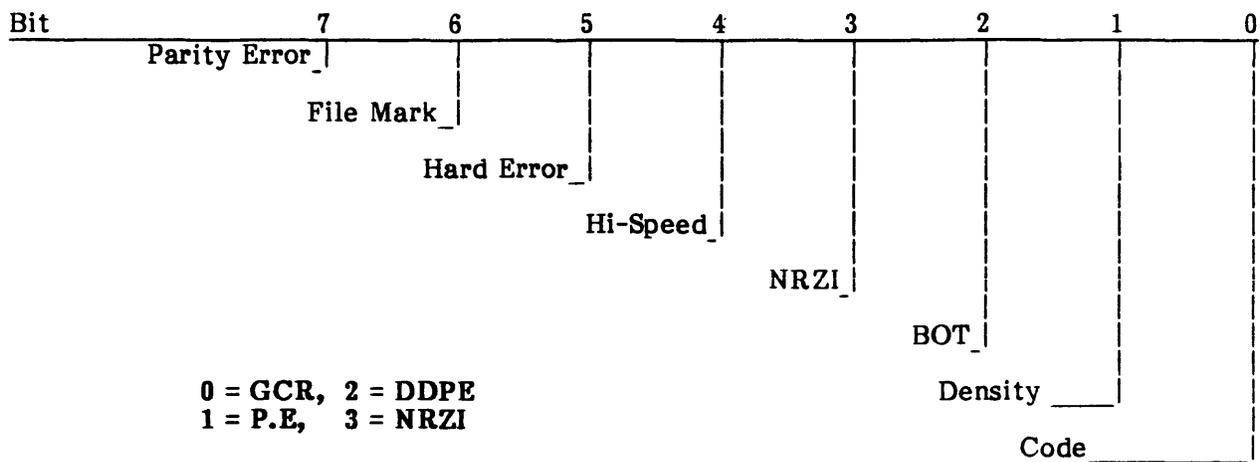
Notes:

Hardware Error = Internal Parity Error or
Failing RAM Test or
Failing Self Test

Write Error = Exhausted Write Retries

Max Retries = Exhausted Write / Read Retries

Status Byte 2



1.13.20 SEND DIAGNOSTIC

The Send Diagnostic command requests the 9502 to perform diagnostic tests on itself and/or the specified tape unit. After completion of the Send Diagnostic command the User should issue a Receive Diagnostic Results command to check on the success or failure of the command.

Table 1-36. SEND DIAGNOSTIC Command (1D_H)

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

Completion Status Codes for Send Diagnostic Command:

Good (00H)	Good Status
Busy (08H)	The 9502 is busy executing a command.
Reservation Conflict (18H)	
Check (02H)	Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

Illegal Request

SELF TEST: If the Self Test (STEST) bit is a one, the 9502 Dynamic Ram test is performed. No tape motion is performed, the Parameter List Length bytes are ignored and no Parameter Information is requested by the 9502. If the Self Test completes successfully, the command will be terminated with GOOD status, otherwise, the command will be terminated with Check Condition status and the Sense Key in the Extended Sense will be set to Hardware Error.

UNIT TEST: If the Self Test (STEST) bit is set to zero and the UNIT bit is set to one, the 9502 will request that the Parameter List be transferred.

The Parameter List Length bytes specify the length in bytes of the parameter list that will be transferred during the Data Out phase.

<u>SELF TEST</u>	<u>UNIT TEST</u>	
0	0	No Action Good Status Returned
0	1	Motion Test 1 - 5
1	0	Self Test DRAM
1	1	Self Test DRAM

Table 1-37. 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 specifies the number of passes of any particular test. 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:

<u>Byte</u>	<u>Value</u>	<u>Description</u>
0	00H	Pass Count Test 1 = 0
1	02H	Pass Count Test 2 = 2
2	00H	Pass Count Test 3 = 0
3	03H	Pass Count Test 4 = 3
4	00H	Pass Count Test 5 = 0

All diagnostic tests are performed consecutively. In the previous example, two passes of Test 2 will be performed before beginning three passes of Test 4. If an error is detected in any of the tests, the Send Diagnostic command will be terminated with Check Condition. A Receive Diagnostic command should then be performed to find the reason for the failure.

TEST 1: Test 1 tests the basic motion functions of the tape unit. The functions tested are:

Rewind Write File Mark Erase

Blank Tape Detection

- TEST 2:** Basic Read and Write functions of the 9502/96XX 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 verified.
- TEST 4:** The data buffer is tested. Initially the entire buffer is written and verified with a pseudo-random pattern. The entire buffer is then written to tape in 1K byte blocks at high speed. This process is repeated until one (1) megabyte has been written and then the tape is rewound. The tape is then read and 128K of the buffer is filled with the data read from tape before verification begins. The Read/Verification process is performed eight (8) 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 specifies 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:

<u>Byte</u>	<u>Value</u>
5	00H
6	80H
7	FFH
8	00H

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.

1.13.21 WRITE DATA BUFFER

The Write Data Buffer command is used in conjunction with the Read Data Buffer command as a diagnostic function for testing the 9502 memory and SCSI Bus integrity.

Table 1-38. WRITE DATA BUFFER Command (3BH)

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)							
Byte 7	TRANSFER LENGTH							
Byte 8	TRANSFER LENGTH (LSB)							
Byte 9	0	0	RESERVED			FLAG	LINK	

The MODE field is defined as follows:

<u>Value</u>	<u>Description</u>
0H	Combined Header and Data
1H	Reserved
2H	Data Mode
3H	Reserved

Completion Status Codes for Test Unit Ready Command:

Good (00 _H)	Good Status
Busy (08 _H)	The 9502 is busy executing a command.
Reservation Conflict (18 _H)	
Check (02 _H)	Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

Not Ready	Hardware Error
Illegal Request	Unit Attention
Aborted Command	

COMBINED HEADER AND DATA MODE:

In this mode, data to be transferred is preceded by a four byte header. The Buffer Id and Buffer Offset bytes are ignored and should be set to zero. The Transfer Length specifies the maximum number of bytes that shall be transferred during the Data Out phase. This number includes the four byte header, so the data length to be stored in the 9502 buffer is the transfer Length minus four.

If the User wishes to write to all memory locations of the 9502 buffer, the Transfer Length should be set to 4004_H. If the Transfer Length exceeds the 9502 buffer size plus four, Check Condition status will be returned and the Sense Key in the Extended Sense will be set to Illegal Request.

The four byte header consists of all reserved bytes. No check is performed by the 9502 on the validity of the header data transferred.

DATA MODE:

In this mode, the Data Out phase contains buffer data. The buffer within the 9502 is arranged as one contiguous buffer, the Buffer ID byte should be set to zero. If the Buffer ID byte is non-zero, Check Condition status will be returned and the Sense Key in the Extended Sense will be set to Illegal Request.

The Buffer Offset is the byte offset within the 9502 where the data will be stored. The Transfer Length specifies the maximum number of bytes that shall be transferred during the Data Out phase and stored in the 9502 buffer. The User should ensure that the Transfer Length plus the Buffer Offset does not exceed the capacity of the 9502 buffer. If the Transfer Length plus Buffer Offset specify a length that exceeds the 9502 buffer size, Check Condition status will be returned and the Sense Key in the Extended Sense will be set to Illegal Request.

1.13.22 READ DATA BUFFER

The Read Data Buffer command is used in conjunction with the Write Data Buffer command as a diagnostic function for testing the 9502 memory and the SCSI Bus integrity.

Table 1-39. READ DATA BUFFER Command (3CH)

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

The MODE field is defined as follows:

<u>Value</u>	<u>Definition</u>
0H	Combined Header and Data
1H	Reserved
2H	Data Mode
3H	Descriptor Mode

Completion Status Codes for Test Unit Ready Command:

Good (00H)	Good Status
Busy (08H)	The 9502 is busy executing a command.
Reservation Conflict (18H)	
Check (02H)	Refer to Request Sense extended status (Non-Buffered Mode Only)

Possible conditions are:

Not Ready	Hardware Error
Illegal Request	Unit Attention
Aborted Command	

COMBINED HEADER AND DATA MODE:

In this mode, a four byte header (see Table 1-40), followed by data bytes are returned to the Initiator during the Data In phase. The Buffer ID and the Buffer Offset are reserved. The Allocation Length specifies the maximum number of bytes that the Initiator has allocated for the returned 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 that shall be transferred.

The 9502 terminates the Data In phase when the Allocation Length bytes of header plus data have been transferred, or when all available header and data has been transferred to the Initiator, whichever is less.

DATA MODE:

In this mode, the Data In phase contains buffer data. The buffer within the 9502 is arranged as one contiguous buffer, the buffer ID byte should be set to zero. If the Buffer ID is non-zero, Check Condition status will be returned and the Sense Key in the Extended Sense will be set to Illegal Request.

The Buffer Offset is the byte offset within the 9502 from where data will be transferred.

The Allocation Length specifies the maximum number of bytes that shall be transferred during the Data In phase. The Initiator should ensure that the Transfer Length plus the Buffer Offset does not exceed the capacity of the 9502 buffer.

The Available Length specifies the total number of data bytes that are available in the 9502's buffer. This number is not reduced to reflect the Allocation Length, nor is it reduced to reflect the number of bytes written using the Write Buffer command. Following the Read Buffer Header, the 9502 transfers data from the buffer. The number of data bytes transferred following the Read Buffer Header will be the lesser of the Allocation Length minus four, or the Available Length.

Table 1-40. 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)							

DESCRIPTOR MODE:

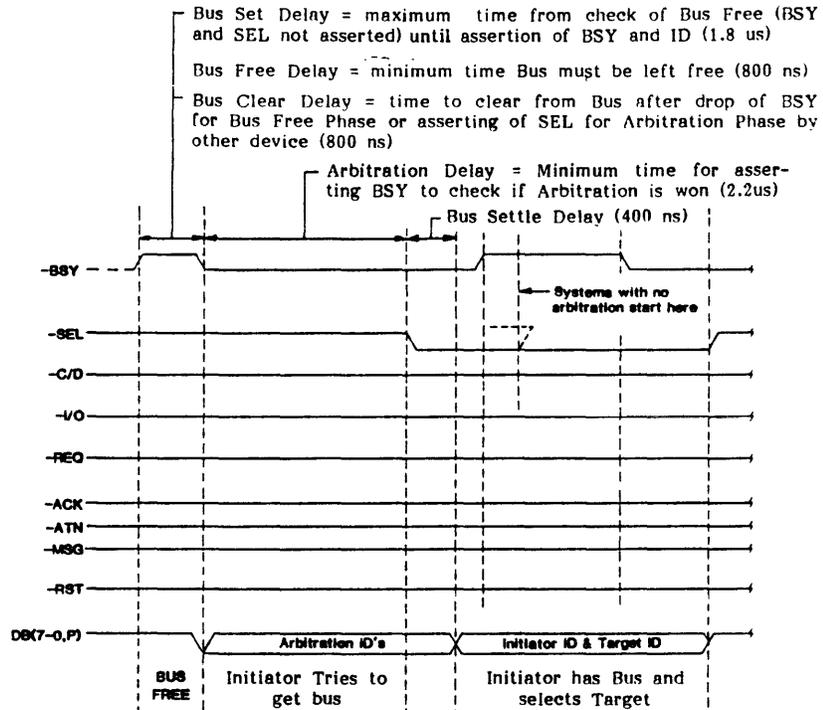
In this mode, a minimum of four bytes of Read Buffer information are returned. The 9502 returns information for the buffer specified by the buffer ID. Since the 9502 is organized as one contiguous buffer and if the buffer ID byte is non zero, the 9502 will return all zeros. If the initiator selects an allocation length of greater than four bytes, only four bytes are transferred to the initiator. The Read Data Buffer is defined as follows:

Table 1-41. READ BUFFER DATA

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

1.14 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.

ARBITRATION PHASE

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).

SELECTION PHASE

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

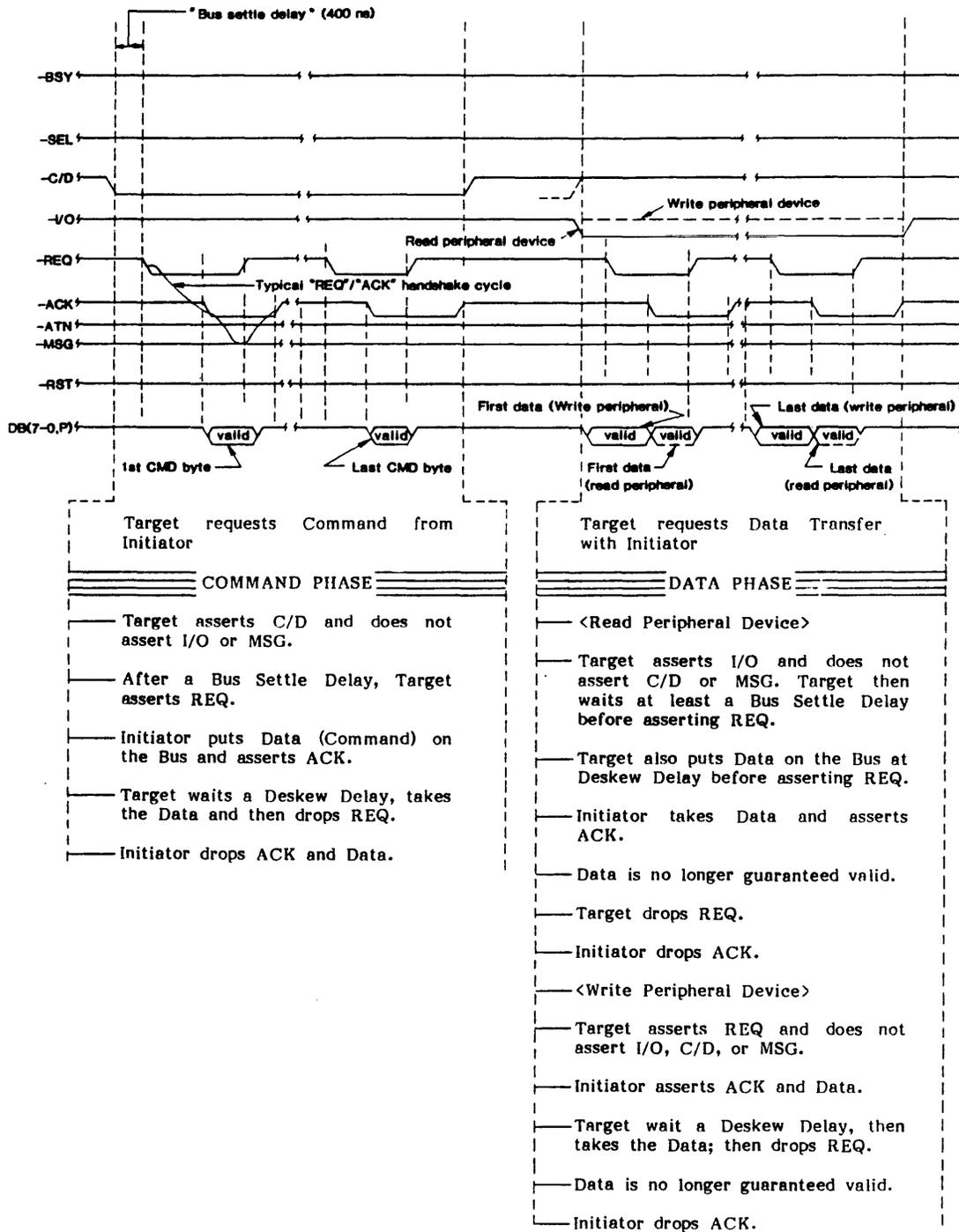


Figure 1-4. SCSI Timing Diagram, Command, and Data Phases

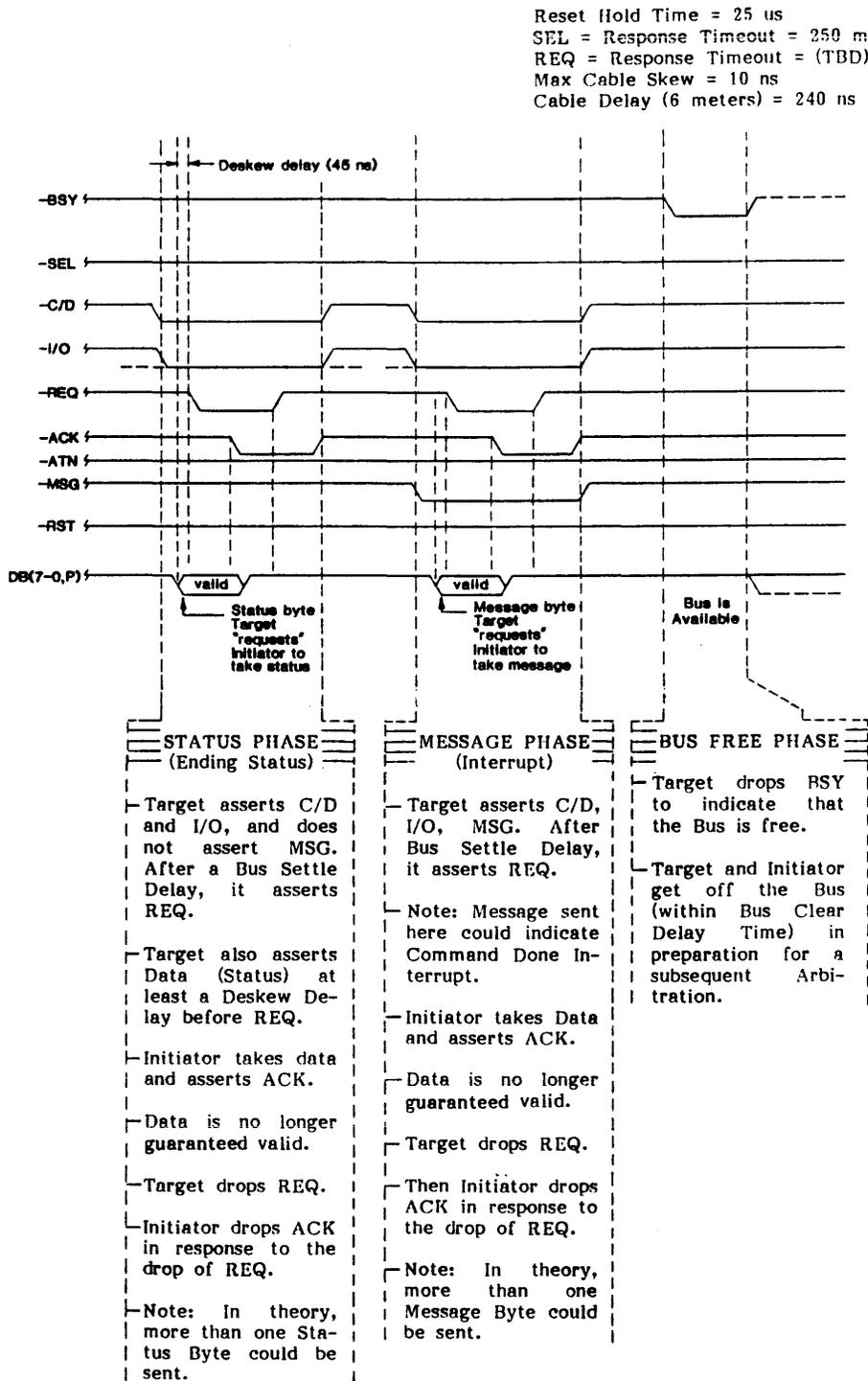


Figure 1-5. SCSI Timing Diagram, Status, Message, and Bus Free Phases

1.15 SCSI TIMING CONSIDERATIONS

1.15.1 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 1-42. DENSITY/SPEED AND DATA TRANSFER RATE

	DENSITY (CPI) 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					

1.15.2 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:

1.15.2.1 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.

1.15.2.2 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 = $1/(\text{selected density} \times \text{tape speed})$ $[1/(6250 \times 100)]$

- 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.

1.15.2.3 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.

2.2 ADJUSTMENTS, GENERAL

Except for configuring the 9502 for differential or single-ended operation when a combination board is installed, 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 the front panel Host I/O Menu.

The following describes the various options in the order found within the Host I/O Menu:

2.2.1.1 PRE-FETCH QUALIFICATION

The qualification criteria to invoke a read pre-fetch of tape data to cache can be selected from the front panel. Possible options are:

- a. Disable pre-fetching.
- b. Pre-fetch after receiving 1 Host read command.
- c. Pre-fetch after receiving 2 Host read commands.
- d. Pre-fetch after receiving 3 Host read commands.

If either (b), (c) or (d) of the above is selected, then read pre-fetching will be invoked after receipt of the selected number of read commands. These read commands must be received sequentially. For instance, if qualification has been set for receipt of 3 read commands and the host sends 2 reads followed by a write, then the host will still be required to issue 3 sequential read commands before pre-fetching is initiated.

2.2.1.2 PRE-FETCH ACTION ON FILE MARK DETECTION

The user is given the choice of stopping pre-fetching on detection of a single or double file mark, or to continue regardless.

If pre-fetching is to stop on detection of a file mark (single or double), then pre-fetching won't start again until the host reinitiates read commands and the pre-fetch qualification has been met.

The following options exist:

- Stop pre-fetching on detection of a single file mark.
- Stop pre-fetching on detection of a double file mark.
- Continue pre-fetching.

2.2.1.3 WRITE BUFFER LIMITS

The maximum number of blocks written to the buffer, when operating in Buffered Mode without initiating tape motion, can be specified from the front panel.

The minimum will always be 1 block. That is, a host write will transfer a complete block to the cache before tape motion is initiated.

Possible write buffer limits are:

1 blk, 2 blks, 4 blks, 8 blks, 16 blks

A timeout of 250 msec is generated to force write the buffer if, for instance, a limit of 4 blks was selected but only 2 blks were received.

2.2.1.4 MODE

Verification of written data is a user selectable option.

If **VERIFY** is selected, then the reading (verifying) of previously written data is made by a read of the physical tape.

If **CACHE** selected, then reading (verifying) of previously written data is automatically performed from the cache.

EXAMPLE:

If a User command sequence is Write 10 blocks, Read Reverse 10 blocks, Read Forward 10 blocks, the Cache may operate in either of the following two methods, depending upon the menu selection.

- a. **VERIFY** - When the last block has been written, the Drive will read the tape in the reverse direction for 10 blocks. Ten blocks will then be read from the cache in the forward direction.
- b. **CACHE** - when the last block has been written, ten blocks of the original write data may still remain in the buffer. When the Read Reverse is issued, the data is read out of the buffer reverse instead of actually reading the tape reverse. When the Read Forward is issued, the data is read out of the buffer in the forward direction. No tape motion would occur.

2.2.1.5 MAXIMUM BLOCK LENGTH

A front panel option is available to select the maximum permissible block size. The following selections can be made:

32 KByte blocks	(32768 _D , 8000 _H)
64 KByte Blocks	(65536 _D , 10000 _H)
128 KByte Blocks	(131072 _D , 20000 _H)
256 KByte Blocks	(261887 _D , 3FEFF _H)
MAXIMUM	(Same as entire Cache size)

Note: For boards configured with 256K of memory, the maximum block size available would be:

261887_D, 3FEFF_H

Which is: 256K - 257 bytes

For boards configured with larger memory 512K or 1Mb, then a full 256K block could be accepted.

2.2.1.6 READ RETRIES

A Read Retry shall consist of re-reading the block in the opposite direction followed by a read in the original direction; until either the read is successful or the retry count is exhausted. If the error occurred in the forward direction, and was successfully read in reverse, the data will be reversed in the Cache and passed to the Host as if it were read forward.

The user is given the ability to set the number of retry sequences (retry count) by a front panel switch option.

Rd Retries = 8 or 16 sequences

2.2.1.7 WRITE RETRIES

A Write Retry sequence shall consist of a backspace followed by a fixed length erase, followed by another attempt to write the block. This sequence will continue until either the write is successful or the retry count is exhausted.

The user is given the ability to set the number of retry sequences (retry count) by a front panel switch option.

Wr Retries = 8 or 16 sequences

2.2.1.8 INTERFACE PARITY

The checking of SCSI interface parity on the data lines can be enabled or disabled. The action to be taken if a parity error is detected may also be selected.

The following options can be set from the front panel.

RETRY - Causes parity checking plus Restore Pointer Message to be sent on error.

If during a Data Out Phase or Command Phase a parity error is detected on the SCSI bus and RETRIES are enabled, the 9502 will send to the Initiator a Restore Pointer Message and re-enter the Data or Command Phase awaiting the re-transmission of the erroneous transfer. This sequence is repeated a maximum of 3 times. If after the 3rd attempt a parity error is still detected, the unit will go to the Bus Free state.

CHECK - Causes parity checking and status reporting of the error.

If CHECK is enabled, then the 9502 will report status of sense key B_H with 47 00_H set in the extended sense bytes.

IGNORE - Parity errors are ignored.

2.2.1.9 RECOVERED ERRORS

Recoverable (corrected) errors may be reported to the host that cover a variety of different situations. The following Additional Sense Codes would be returned:

Sense Key 01_H

0D 01 Recovered Write Error with write retries.

17 01 Recovered Read Error with read retries.

0E 00 Recovered Interface Error (retries enabled see Section 2.2.1.8)

The user has the option of reporting the above errors.

REPORT or IGNORE

2.2.1.10 EOT

The user can select whether the tape drive will STOP or CONTINUE on detection of EOT for Writes or WFMK commands. The operation is functionally identical in both Fixed and Variable mode. See Section 1.13.6 for further details.

2.2.1.11 INQUIRY QUALIFIER

The user can select the device type qualifier which will be returned in Byte 1 of the Inquiry command (sec. 1.13.10) as data. The Device Qualifier Code is selectable from the front panel. The following values are available:

00_H 01_H 02_H 04_H 08_H 10_H 20_H 40_H

2.2.1.12 SYNCHRONOUS REQUEST

The user can select whether the tape drive is allowed to initiate Synchronous negotiation or not.

ENABLE or DISABLED

Note: The 9502 will always accept a Synchronous negotiation

2.2.1.13 SCSI I.D.

The SCSI address can be set via the front panel options menu. Every SCSI controller is assigned an individual SCSI address. Target addresses from 0 to 7 can be selected. In addition the ID can be set equal to the UNIT Number.

Note: The Unit Number is selected via the Set-Up menu.

2.2.1.14 SCSI LUN (LOGICAL UNIT NUMBER)

LUN 0:

Commands issued to any LUN address other than zero (1-7), will be rejected. The unit number shown on the front panel (UNIT X) may be set to an arbitrary value.

LUN=UNIT:

The Logical Unit Number will be assigned as shown on the front panel (UNIT X).

Note: The unit number is selected via the SET-UP menu.

2.3 SUMMARY OF OPTIONS

When the 96X2 is powered on with the 9502 board installed, several of the options contained in the "SET UP" menu will be set to default values, and will not be accessible to the USER. The following lists those options in the SET-UP menu that are not available when the 9502 board is installed.

<u>OPTION IN SET-UP MENU</u>	<u>DEFAULT VALUE WITH 9502 INSTALLED</u>	<u>OPTION AVAILABLE IN HOST I/O MENU</u>
TIMEOUT	ENABLED	NO
PARITY	CHECK	YES
GCR CER	ENABLED	YES
RZI CCG	DISABLED	NO
CLR FBSY	POSTREPO	NO
FEN	NORMAL	NO
DENS OUT	CODED	NO

For a full description of the various SET-UP menu options, refer to Kennedy publication 93-096X2-XXX Series Installation and Operation Manual or publication 93-096X0-XXX Operation and Maintenance Manual.

The following Cache options can be set from the front panel via the "HOST I/O" Diagnostic menu. The menu item is listed with the available options shown below it.

PREFETCH - Read Prefetch Qualifier

DISABLED
AFTER 1 read command
AFTER 2 read commands
AFTER 3 read commands

STP FTCH - Stop Prefetching

CONTINUE
1 FMARK - stop prefetching after encountering 1 filemark
2 FMARKS - stop prefetching after encountering 2 filemarks

WRT BUFR - Blocks held in buffer before motion occurs

1 BLOCK
2 BLOCKS
4 BLOCKS
8 BLOCKS
16 BLOCKS

MODE

VERIFY
CACHE

MAX SIZE - Maximum Block Length

32 Kb
64 Kb
128 Kb
256 Kb
MAXIMUM

RD RETRY - Read Retry Count

8 TIMES
16 TIMES

WR RETRY - Write Retry Count

8 TIMES
16 TIMES

PARITY - SCSI Interface Parity

RETRY - Perform retry on parity error detection
CHECK - Report parity error only
IGNORE - Perform no parity checking

RECOVERED

REPORT - Report recovered errors (Sense Key 01H)
IGNORE - Do not report recovered errors

EOT

STOP - Stop flushing data to tape at EOT
 CONTINUE - Continue flushing data to tape past EOT

INQ QUAL - Inquiry Qualifier Data

00
 01
 02
 04
 08
 10
 20
 40

SYNC REQ - Target initiation of Synchronous Request

ENABLE
 DISABLE

SCSI LD - SCSI Bus Address

TARGET 0
 TARGET 1
 TARGET 2
 TARGET 3
 TARGET 4
 TARGET 5
 TARGET 6
 TARGET 7
 ID=UNIT

SCSI LUN

LUN 0
 LUN=UNIT

2.4 PHYSICAL DESCRIPTION**2.4.1 SCSI BUS TERMINATION**

SCSI bus terminators are fitted in sockets to allow their removal on daisy chained systems. If the user wishes to daisy-chain to other SCSI devices, the terminators must be removed (unless the 9502 is physically the last SCSI controller on the daisy-chain). Terminators are installed in the following positions (Figure 2-1).

Single-Ended - U8, U9, U10
 Differential - U4, U5, U11, U12
 U13, U16, U17

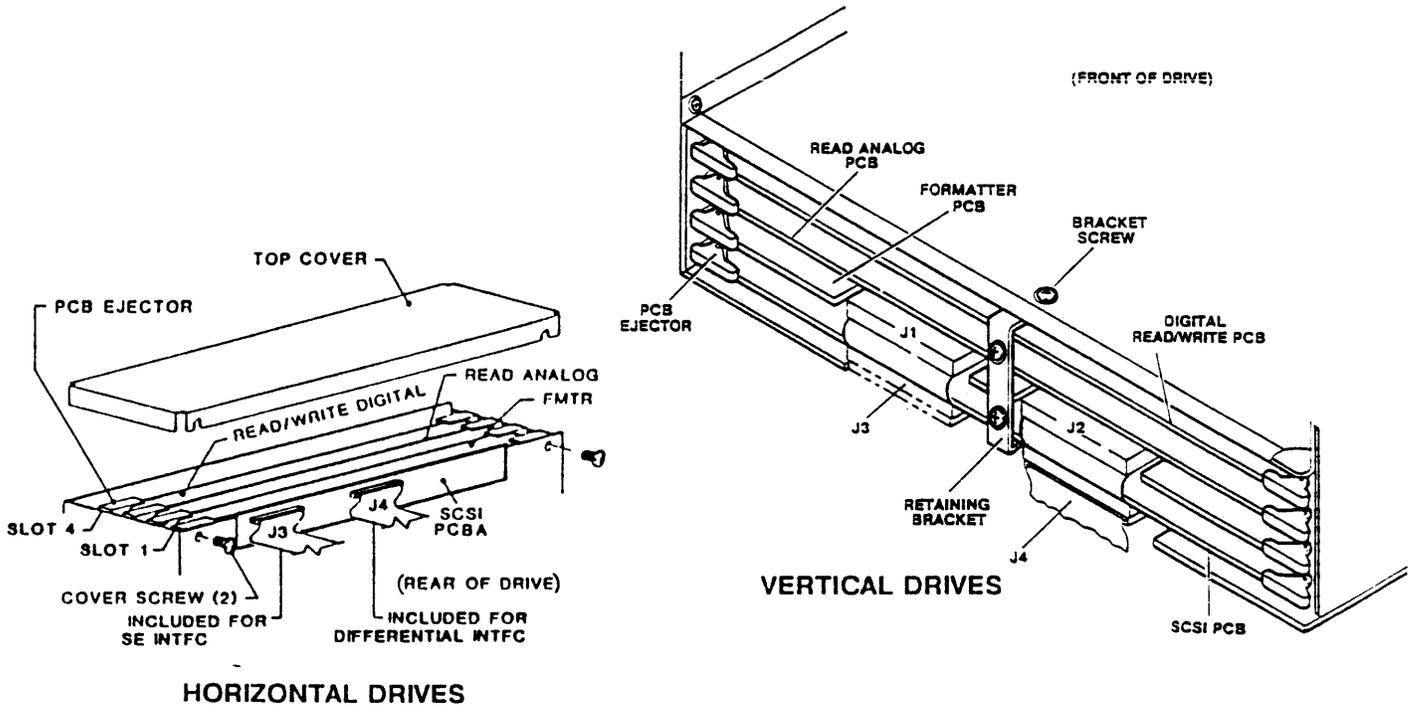
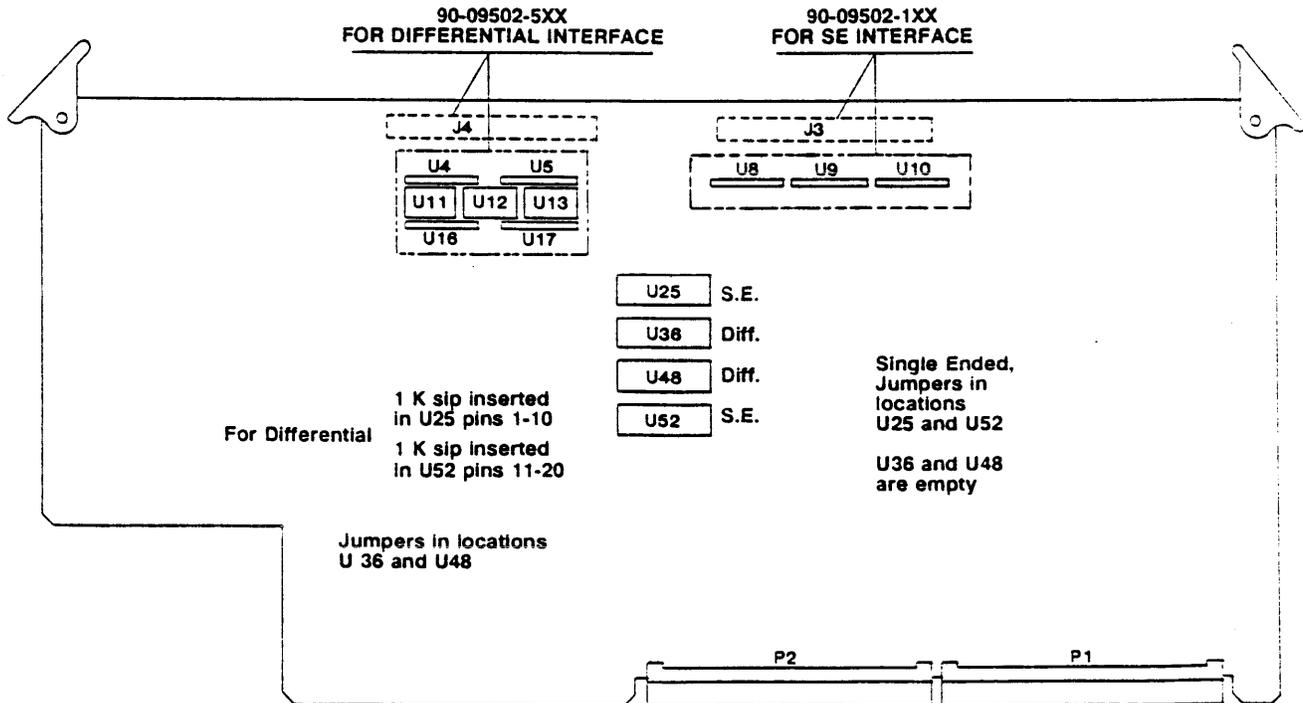


Figure 2-1. 9502 SYNCHRONOUS SCSI CONTROLLER (comp. side)



Note: ST2 may be removed by those users who don't wish the 9502 to supply terminator power to the SCSI bus.

2.4.2 COMBINATION BOARD CONFIGURATION

The combination board has DIP packaged jumpers provided for easy conversion to/from Single Ended or Differential.

To configure the board for Differential, insert jumpers in positions U36 and U48 with 1K resistor sip's in U25 and U52 as indicated on the printed circuit board. Remove the Single-Ended terminators U8, U9 and U10.

To configure the board for Single Ended, remove the 1K resistor sip's from U25 and U52 and insert the jumpers from U36 and U48 in their place. I.E. jumpers now occupy locations U25 and U52. Remove the Differential terminators U4, U5, U11, U13, U16 and U17.

Note: The 1K resistor sip's are only used for a Differential configuration.

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. Unplug two SCSI to Formatter Cables from the Formatter Board. Unplug SCSI Bus Cable from SCSI PCBA.
- D. Grasp PCB Ejectors firmly, and pull Ejectors toward the sides of the Drive. The PCB should pop partly out of the slot.
- E. Remove the SCSI Board.

To replace - With power off:

- a. Insert SCSI PCBA into slot. Press and seat SCSI PCBA all the way into slot.
- b. Plug Formatter Connectors into Formatter Board.
- c. Plug SCSI Bus Cable into SCSI PCBA.
- d. Replace Card Cage Cover.