



Echo SCSI SPECIFICATION



SCSI

TABLE OF CONTENTS

1. FEATURES	4
2. PHYSICAL DESCRIPTION.....	5
2.1 CABLE	5
2.3 ELECTRICAL CHARACTERISTICS.....	11
2.4 SCSI BUS.....	12
2.5 SCSI BUS SIGNALS.....	13
2.6 SIGNAL VALUES.....	14
2.7 OR-TIED SIGNALS	14
2.8 BUS PHASES, SIGNAL SOURCES	14
3. BUS TIMING REQUIREMENTS.....	16
4. LOGICAL CHARACTERISTICS.....	17
4.1 SCSI BUS PHASES.....	17
4.2 SCSI BUS CONDITIONS.....	22
4.3 SCSI BUS PHASE SEQUENCES.....	23
4.4 SCSI POINTERS.....	24
4.5 MESSAGE SYSTEM DESCRIPTION	25
4.6 MESSAGES.....	27
5. SCSI COMMANDS AND STATUS	37
5.1 COMMAND IMPLEMENTATION REQUIREMENTS.....	37
5.2 COMMAND DESCRIPTOR BLOCK	37
5.3 STATUS.....	39
6. SCSI COMMANDS	42
6.1 ERASE COMMAND.....	43
6.2 INQUIRY COMMAND.....	44
6.3 LOAD DISPLAY COMMAND.....	46
6.4 LOAD / UNLOAD COMMAND	47
6.5 LOCATE COMMAND	48
6.6 LOG SENSE COMMAND	49
6.7 LOOP WRITE TO READ COMMAND.....	50
6.8 MODE SELECT COMMAND.....	51
6.9 MODE SENSE COMMAND	58
6.10 PREVENT / ALLOW MEDIUM REMOVAL COMMAND	59
6.11 READ COMMAND	60
6.12 READ BLOCK LIMITS COMMAND.....	62
6.13 READ BUFFER COMMAND	63
6.14 READ POSITION COMMAND	64
6.15 READ REVERSE COMMAND	66
6.16 RECEIVE DIAGNOSTIC RESULTS COMMAND	67
6.17 RECOVER BUFFERED DATA COMMAND	68
6.18 RELEASE UNIT COMMAND	69
6.19 REQUEST SENSE COMMAND	70
6.21 RESERVE UNIT COMMAND	75
6.22 REWIND COMMAND	75
6.23 SEND DIAGNOSTIC COMMAND.....	76
6.24 SPACE COMMAND.....	78



SCSI

6.25 SYNCHRONIZE COMMAND.....	79
6.25 TEST UNIT READY COMMAND.....	80
6.26 WRITE COMMAND	81
6.28 WRITE BUFFER COMMAND.....	83
6.29 WRITE FILEMARKS COMMAND.....	85
APPENDIX A BUFFER MODE 3H.....	86



SCSI

1. Features

The embedded SCSI interface for the ECHO Cartridge Drive has the following features:

- * Conforms to a subset of ANSI X3T9/89-04, Small Computer Systems Interface (SCSI-2) 2
- * Supports transfer rates of up to 20M/sec (burst with 16 bit WIDE option, 10MB/sec with 8 bit option), 3MB/sec continuous. (Fast SCSI)
- * Optionally supports byte-wide or word-wide SCSI transfers (Wide SCSI)
- * Optionally supports either 50 or 68 conductor cables.
- * Supports a SCSI bus having up to sixteen controllers if Wide option is installed. (ID's 0-Fh).
- * Supports either single ended line driver / receivers with active termination. or differential line driver / receivers, allowing bus cable lengths of up to 25 meters
- * Performs full bus parity check on all bus operations.



SCSI

2. Physical Description

2.0.1 Interface Options

The ECHO can be supplied with one of four interface options via a daughter card slot in the rear of the drive. :

Daughter Card P/N	Pins	Bus Width	Type	Termination
XXX-XXXX	50	8	Single Ended	Passive
XXX-XXXX	50	8	Differential	Passive
XXX-XXXX	68	16	Single Ended	Active
XXX-XXXX	68	16	Differential	Passive

2.1 Cable

The characteristic impedance of the cable should be no less than 90 ohms and no greater than 140 ohms. A minimum conductor size of 26 AWG should be used to minimize noise effects and ensure proper distribution of terminator power. A smaller conductor size may be used for signals other than terminator power. To minimize discontinuities and signal reflections, cables of different impedances should not be used in the same bus. Implementations may require trade-offs in shielding effectiveness, cable length, the number of loads, transfer rates, and cost to achieve satisfactory system operation.

NOTE: The SCSI cable is a sensitive and important part of the SCSI system, especially at high data rates. Poorly made cables can have a serious detrimental effect on overall SCSI system performance. The use of twisted pair cable is strongly recommended. Without twisted pairs, even at slow data rates and very short distances, crosstalk between adjacent signals causes spurious pulses with differential signals.

2.1.1 Single-Ended Cable

Depending on the interface option, a 50 conductor (or 25 signal twisted-pair) or 68 conductor (or 34 signal twisted-pair) cable shall be used for the cable. The maximum cumulative cable length shall be 6.0 meters. If twisted-pair cables are used, then twisted pairs in the cable shall be wired to physically opposing contacts in the connector.

A stub length of no more than 0.1 meters is allowed off the mainline interconnection within any connected equipment or from any connected point.

2.1.2 Differential Cable

Depending on the interface option, a 50 conductor (or 25 signal twisted-pair) or 68 conductor (or 34 signal twisted-pair) cable shall be used for the cable. The maximum cumulative cable length shall be 25 meters. If twisted-pair cables are used, then

twisted pairs in the cable shall be wired to physically opposing contacts in the connector.

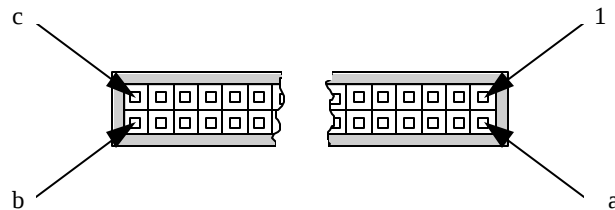
A stub length of no more than 0.2 meters is allowed off the mainline interconnection within any connected equipment or from any connected point.

2.2 50 pin Connector

The SCSI device connector is a 50 conductor Subminiature 'D' type receptacle (female) with the following part number: AMP 174225-4 (or 174341-4).

2.2.1 50 Position Single Ended Pin Assignments

Two differing methods are often used to indicate pin numbers on a subminiature 'D' style connector. The pin numbering tables shown below contain two sets of numbers which conform to each of these methods. Please consider the following diagram to



	a	b	c
Set 1	26	50	25
Set 2	2	50	49

determine the proper pin numbering scheme.



SCSI

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

Notes: A minus sign preceding a signal name indicates that the signal is active low.

This table describes the pinout on SCSI daughter card P/N #XXX-XXX



SCSI

2.2.2 50 Position Differential Pin Assignments

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

Notes: A minus sign preceding a signal name indicates that the signal is active low.
This table describes the pinout on SCSI daughter card P/N #XXX-XXXX



SCSI

2.2.3 68 Position Single Ended Pin Assignments

SignalName	Pin #	Cable Cond. #	Cable Cond. #	Pin #	Signal Name
GND	1	1	35	2	-DB12
GND	2	3	36	4	-DB13
GND	3	5	37	6	-DB14
GND	4	7	38	8	-DB15
GND	5	9	39	10	-DBP1
GND	6	11	40	12	-DP0
GND	7	13	41	14	-DB1
GND	8	15	42	16	-DB2
GND	9	17	43	18	-DB3
GND	10	19	44	20	-DB4
GND	11	21	45	22	-DB5
GND	12	23	46	24	-DB6
GND	13	25	47	26	-DB7
GND	14	27	48	28	-DB8
GND	15	29	49	30	GND
GND	16	31	50	32	GND
TERMPWR	17	33	51	34	TERMPWR
TERMPWR	18	35	52	36	TERMPWR
RESERVED	19	37	53	38	RESERVED
GND	20	39	54	40	GND
GND	21	41	55	42	-ATN
GND	22	43	56	44	GND
GND	23	45	57	46	-BSY
GND	24	47	58	48	-ACK
GND	25	49	59	50	-RST
GND	26	51	60	52	-MSG
GND	27	53	61	54	-SEL
GND	28	55	62	56	-C/D
GND	29	57	63	58	-REQ
GND	30	59	64	60	-I/O
GND	31	61	65	62	-DB8
GND	32	63	66	64	-DB9
GND	33	65	67	66	-DB10
GND	34	67	68	68	-DB11

Notes: A minus sign preceding a signal name indicates that the signal is active low.
This table describes the pinout on SCSI daughter card P/N #XXX-XXX

2.2.4 68 Position Differential Pin Assignments

SignalName	Pin #	Cable Cond. #	CableCond. #	Pin #	SignalNam
------------	-------	---------------	--------------	-------	-----------



SCSI

			e		
+DR12	1	1	35	2	-DR12
+DB13	2	3	36	4	-DB13
+DB14	3	5	37	6	-DB14
+DB15	4	7	38	8	-DB15
+DBP1	5	9	39	10	-DBP1
GND	6	11	40	12	GND
+DB0	7	13	41	14	-DB0
+DB1	8	15	42	16	-DB1
+DB2	9	17	43	18	-DB2
+DB3	10	19	44	20	-DB3
+DB4	11	21	45	22	-DB4
+DB5	12	23	46	24	-DB5
+DB6	13	25	47	26	-DB6
+DB7	14	27	48	28	-DB7
+DBP	15	29	49	30	-DBP
DIFSEN	16	31	50	32	GND
TERMPWR	17	33	51	34	TERMPWR
TERMPWR	18	35	52	36	TERMPWR
RESERVED	19	37	53	38	RESERVED
+ATN	20	39	54	40	-ATN
GND	21	41	55	42	GND
+BSY	22	43	56	44	-BSY
+ACK	23	45	57	46	-ACK
+RST	24	47	58	48	-RST
+MSG	25	49	59	50	-MSG
+SEL	26	51	60	52	-SEL
+C/D	27	53	61	54	-C/D
+REQ	28	55	62	56	-REQ
+I/O	29	57	63	58	-I/O
GND	30	59	64	60	GND
+DB8	31	61	65	62	-DB8
+DB9	32	63	66	64	-DB9
+DB10	33	65	67	66	-DB10
+DB11	34	67	68	68	-DB11

Notes: A minus sign preceding a signal name indicates that the signal is active low.
This table describes the pinout on SCSI daughter card P/N #XXX-XXX

2.3 Electrical Characteristics

2.3.1 Single Ended Alternative

Signals described as -SIGNAL are low true

All signals not described as GND, RESERVED or TERMPWR shall be terminated at both ends of the cable as described below.

2.3.1.1 Output Characteristics

All signals use open-collector or three-state drivers. Each signal driven by the SCSI interface has the following output characteristics when measured at the connector:

VOL (Low-level output voltage) = 0.0 to 0.5 VDC at 48 mA sinking (signal assertion)

VOH (High-level output voltage) = 2.5 to 5.25 VDC (signal negation)

2.3.1.2 Input Characteristics

When power is on, the following electrical characteristics apply for each signal:

VIL(Low-level input voltage) = 0.0 to 0.8 VDC (signal true)

VIH(High-level input voltage) = 2.0 to 5.25 VDC (signal false)

IIL(Low-level input current) = -0.4 to 0.0 mA at VI = 0.5 Vdc

IIH(High-level input current) = 0.0 to 0.1 mA at VI = 2.7 Vdc

2.3.1.3 Single Ended Termination

The SCSI option boards do not contain terminators. SCSI signals must be terminated at the extreme ends of the bus. Included with the ECHO single ended option boards are external active terminators. These may be used if required.

2.3.2 Differential Alternative

All signals consist of 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. All assigned signals shall be terminated at each end of the cable with a terminator network as shown below.

The DIFFSENS signal of the connector is used as an active high enable for the differential drivers. If a single-ended device or terminator is inadvertently connected, this signal is grounded, disabling the differential drivers.

The characteristic impedance of differential terminators is 122 ohms.

2.3.2.1 Output Characteristics

Each signal driven by the SCSI device has the following output characteristics when measured at the connector:

VOL(Low-level output voltage) = 1.7 V maximum at IOL(Low-level output current) = 55 mA.

VOH(High-level output voltage) = 2.7 V minimum at IOH(High-level output current) = -55 mA.



SCSI

VOD(Differential output voltage) = 1.0 V min with common-mode voltage ranges from -7 to +12 volts dc.

VOL and VOH shall be as measured between the output terminal and the SCSI device's logic ground reference.

2.3.2.2 Input Characteristics

The SCSI interface meets the following electrical characteristics on each signal (including both receivers and passive drivers):

I_I (Input current on either input) = 2.0 mA maximum.

Maximum input capacitance = 25 pF.

2.3.2.3 Differential Termination

On all differential option cards, SCSI signals are terminated internal to the device with 220 ohms to +5V and 330 ohms to ground. The terminators are factory installed and are removable by the user. Termination is required only at the extreme ends of the SCSI bus cable.

2.3.2.4 Differential Terminator Power Supply

The SCSI interface supplies terminator power to the TERMPWR pin based on the position of a jumper on the interface card. If so jumpered, the ECHO supplies

VTerm = 4.25 - 5.25 Vdc @ 1.0 A maximum.

2.3.3 Terminator Power Supply

The SCSI interface can supply terminator power to the TERMPWR pin based on the position of a jumper on the interface card. The alternate position of the jumper powers the ECHO's internal terminators from the SCSI bus TERMPWR pin. This feature prevents the necessity of powering the ECHO if it is not to be used. If properly jumpered and powered on, the ECHO will supply.

VTerm = 4.25 - 5.25 Vdc @ 1.0 A maximum.

2.4 SCSI Bus

Communication on the SCSI bus is allowed between only two SCSI devices at any given time. A maximum of eight SCSI devices may share a byte-wide bus. Wide SCSI busses can support up to sixteen devices. Each SCSI device has a unique SCSI ID bit assigned at installation. When bus communications take place, the device which begins the transaction is called the initiator, and the device which accepts the command is called the target. There may be any combination of initiators and targets provided there is at least one of each. A SCSI device usually has a fixed role as an initiator or target, but some devices may be able to assume either role.

An initiator may address up to eight peripheral devices that are connected to a target. The target may be physically housed within the peripheral device in which case the peripheral device is referred to as an embedded SCSI device.

Certain SCSI bus functions are assigned to the initiator and certain SCSI bus functions are assigned to the target. The initiator may arbitrate for the SCSI bus and select a particular target. The target may request the transfer of COMMAND, DATA, STATUS,

or other information on the DATA BUS, and in some cases it may arbitrate for the SCSI bus and reselect an initiator for the purpose of continuing an operation.

Information transfers on the DATA BUS are asynchronous and follow a defined REQ/ACK handshake protocol. One byte of information may be transferred with each handshake under the asynchronous protocol. An option is defined for synchronous data transfer which allows for additional bytes to be transferred between handshakes, increasing the throughput of the system.

2.5 SCSI Bus Signals

There are a total of 18 (or 27 for wide) signals on the bus. Nine signals are used for control and nine of eighteen are used for data (messages, commands, status, and data), including parity.

These signals are described as follows:

BSY (BUSY)	An "OR-tied" signal that indicates that the bus is being used.
SEL (SELECT)	An "OR-tied" signal used by an initiator to select a target or by a target to reselect an initiator.
C/D (CONTROL/DATA)	A signal driven by a target that indicates whether CONTROL or DATA information is on the DATA BUS. True indicates CONTROL.
I/O (INPUT/OUTPUT)	A signal driven by a target that controls the direction of data movement on the DATA BUS with respect to an initiator. True indicates input to the initiator. This signal is also used to distinguish between SELECTION and RESELECTION phases.
MSG (MESSAGE)	A signal driven by a target during the MESSAGE phase.
REQ (REQUEST)	A signal driven by a target to indicate a request for an ACK information transfer handshake.
ACK (ACKNOWLEDGE)	A signal driven by an initiator to indicate an acknowledgment for a REQ information transfer handshake.
ATN (ATTENTION)	A signal driven by an initiator to indicate the ATTENTION condition.
RST (RESET)	An "OR-tied" signal that indicates the RESET condition.
DB(7-0,P) (8-15)	Eight data-bit signals, plus a parity-bit signal that form a DATA BUS. DB(7) is the most significant bit and has the highest priority during the ARBITRATION phase. Bit number, significance, and priority decrease downward to DB(0). A data bit is defined as one when the signal value is true and is defined as zero when the signal value is false. Data parity DB(P) shall be odd. Parity is undefined during the ARBITRATION phase.
DB(15-8,P1) (DATA BUS).	Eight data-bit signals, plus a parity-bit signal that form an extension to the DATA BUS. DB(P1) is a parity bit for DB(15-8). A data bit is defined as one when the signal

value is true and is defined as zero when the signal value is false. Data parity DB(Px) shall be odd.

2.6 Signal Values

Signals may assume true or false values. There are two methods of driving these signals. In both cases, the signal shall be actively driven true, or asserted. In the case of OR-tied drivers, the driver does not drive the signal to the false state, rather the bias circuitry of the bus terminators pulls the signal false whenever it is released by the drivers at every SCSI device. If any driver is asserted, then the signal is true. In the case of non-OR-tied drivers, the signal may be actively driven false.

2.7 OR-Tied Signals

The BSY, SEL, and RST signals shall be OR-tied only. In the ordinary operation of the bus, the BSY and RST signals may be simultaneously driven true by several drivers. No signals other than BSY, RST, and DB(P) are simultaneously driven by two or more drivers, and any signal other than BSY, SEL, and RST may employ OR-tied or non-OR-tied drivers. DB(P) shall not be driven false during the ARBITRATION phase but may be driven false in other phases. There is no operational problem in mixing OR-tied and non-OR-tied drivers on signals other than BSY and RST.

2.8 Bus Phases, Signal Sources

Various true/false combinations of the nine control signals define eight bus “phases” (ten if input and output versions are distinguished). The different phases are used by the target and initiator to distinguish the type of data being passed on the DATA BUS at any given time. The following table indicates which type of SCSI device is allowed to source each signal during which phase. No attempt is made to show if the source is driving asserted, driving negated, or is passive. All SCSI device drivers that are not active sources be in the passive state. The RST signal may be asserted by any SCSI device at any time.

SCSI

BUS PHASE	BSY	SEL	C/D, I/O, MSG, REQ	ACK, ATN	DB(7-0) DB(P)
BUS FREE	None	None	None	None	None
ARBITRATION	All	Win	None	None	S ID
SELECTION	I&T	Init	None	Init	Init
RESELECTION	I&T	Targ	Targ	Init	Targ
COMMAND	Targ	None	Targ	Init	Init
DATA IN	Targ	None	Targ	Init	Targ
DATA OUT	Targ	None	Targ	Init	Init
STATUS	Targ	None	Targ	Init	Targ
MESSAGE IN	Targ	None	Targ	Init	Targ
MESSAGE OUT	Targ	None	Targ	Init	Init

- All:** The signal shall be driven by all SCSI devices that are actively arbitrating.
- S ID:** A unique data bit (the SCSI ID) shall be driven by each SCSI device that is actively arbitrating; the other seven data bits shall be released (i.e., not driven) by this SCSI device. The parity bit (DB(P)) may be released or driven to the true state, but shall never be driven to the false state during this phase.
- I&T:** The signal shall be driven by the initiator, target, or both, as specified in the SELECTION phase and RESELECTION phase.
- Init:** If driven, this signal shall be driven only by the active initiator.
- None:** The signal shall be released; that is, not be driven by any SCSI device. The bias circuitry of the bus terminators pulls the signal to the false state.
- Win:** The signal shall be driven by the one SCSI device that wins arbitration.
- Targ:** If the signal is driven, it shall be driven only by the active target.

3. Bus Timing Requirements

Phase changes and data handshaking operations are defined in a set of bus timing periods. These are defined below.

Arbitration Delay	2.4 microsec.
Assertion Period.....	90 nanosec.
Bus Clear Delay.....	800 nanosec.
Bus Free Delay.....	800 nanosec.
Bus Set Delay.....	1.8 microsec.
Bus Settle Delay.....	400 nanosec.
Cable Skew Delay.....	10 nanosec.
Data Release Delay.....	400 nanosec.
Deskew Delay.....	45 nanosec.
Disconnection Delay.....	200 msec.
Hold Time.....	45 nanosec.
Negation Period.....	90 nanosec.
Power-On to Selection Time.....	?
Reset to Selection Time.....	250 millisec.
Reset Hold Time.....	25 millisec.
Selection Abort Time.....	200 millisec.
Selection Time-out Delay.....	250 millisec. recommended
Transfer Period.....	25 - 400 microsec.
Fast Assertion Period.....	30 nanosec.
Fast Cable Skew Delay.....	5 nanosec.
Fast Deskew Delay.....	20 nanosec.
Fast Hold Time.....	10 nanosec.
Fast Negation Period.....	30 nanosec.

4. Logical Characteristics

4.1 SCSI Bus Phases

The SCSI architecture includes eight distinct phases:

BUS FREE phase
ARBITRATION phase
SELECTION phase
RESELECTION phase
COMMAND phase
DATA (IN/OUT) phase
STATUS phase
MESSAGE (IN/OUT) phase

The SCSI bus can never be in more than one phase at any given time. In the following descriptions, signals that are not mentioned shall not be asserted.

4.1.1 BUS FREE Phase

The BUS FREE phase indicates that there is no current I/O process and that the SCSI bus is available for a connection. SCSI devices shall detect the BUS FREE phase after the SEL and BSY signals are both false for at least a bus settle delay.

During normal operation the BUS FREE phase is entered when a target releases the BSY signal. However, the BUS FREE phase may be entered following the release of the SEL signal after a SELECTION or RESELECTION phase time-out.

ECHO will enter BUS FREE by releasing the BSY signal after one of the following occurrences:

- a) after a reset condition is detected;
- b) after an ABORT message is successfully received;
- c) after a BUS DEVICE RESET message is successfully received;
- d) after a DISCONNECT message is successfully transmitted;
- e) after a COMMAND COMPLETE message is successfully transmitted;
- f) after a RELEASE RECOVERY message is successfully received;

If an initiator detects the release of the BSY signal by the ECHO at any other time, this indicates an error condition. The initiator should follow such an occurrence by sending a REQUEST SENSE command.

4.1.2 ARBITRATION Phase

The ARBITRATION phase allows one SCSI device to gain control of the SCSI bus so that it can initiate or resume an I/O process. Following detection of a BUS FREE phase the SCSI device may arbitrate for the SCSI bus by asserting both the BSY signal and its own SCSI ID.

After waiting at least an arbitration delay (measured from its assertion of the BSY signal) the SCSI device shall examine the DATA BUS. If a higher priority SCSI ID bit is true on the DATA BUS (DB(7) is the highest on a byte wide SCSI bus), then the SCSI device has lost the arbitration and the SCSI device must release its signals and again wait for BUS FREE.

If no higher priority SCSI ID bit is true on the DATA BUS, then the SCSI device has won the arbitration and it shall assert the SEL signal. Any SCSI device other than the winner has lost the arbitration and shall release the BSY signal and its SCSI ID bit within a bus clear delay after the SEL signal becomes true.

ECHO supports both arbitrating and non-arbitrating systems.

4.1.3 SELECTION Phase

The SELECTION phase allows an initiator to select a target for the purpose of initiating some target function (e.g., READ or WRITE command).

The initiator shall set the DATA BUS to a value which is the OR of its SCSI ID bit and the target's SCSI ID bit and it shall assert the ATN signal (indicating that a MESSAGE OUT phase is to follow the SELECTION phase). The initiator shall then wait at least two deskew delays and release the BSY signal. The initiator shall then wait at least a bus settle delay before looking for a response from the target.

The ECHO determines that it is selected when the SEL signal and its SCSI ID bit are true. ECHO shall then assert the BSY signal. ECHO will not respond to a selection if bad parity is detected, or if more than two SCSI ID bits are asserted on the DATA BUS.

After selection, the drive shall wait until the SEL signal is false before asserting the REQ signal to enter an information transfer phase.

4.1.3.1 Single Initiator Selection

If ECHO finds that only its SCSI ID is asserted during the SELECTION phase, it will become selected, however, this will prevent its disconnection during the operation of any command.

4.1.3.2 SELECTION Without ATN

If the initiator enters the SELECTION phase without asserting the ATN signal, the ECHO will become selected. However, rather than entering MESSAGE OUT following the release of SEL, the ECHO will enter the COMMAND phase directly.

4.1.4 RESELECTION Phase

The RESELECTION phase is entered by the ECHO to reconnect to an initiator for the purpose of continuing some operation that was previously started by the initiator but was suspended. (i.e., disconnect before the operation was complete).

The ECHO will arbitrate for the SCSI bus in the above manner. Upon winning the arbitration, the ECHO asserts the I/O signal indicating RESELECTION, and sets the DATA BUS to a value that is the logical OR of its SCSI ID bit and the initiator's SCSI ID bit.

The initiator shall determine that it is reselected when the SEL and I/O signals and its SCSI ID bit are true and the BSY signal is false. The reselected initiator shall then assert the BSY. The initiator shall not respond to a RESELECTION phase if bad parity is detected. Also, the initiator shall not respond to a RESELECTION phase if more than two SCSI ID bits are on the DATA BUS.

After ECHO detects that the BSY signal is true, it shall also assert the BSY signal and wait at least two deskew delays and then release the SEL signal. The target may then change the I/O signal and the DATA BUS. After the reselected initiator detects

the SEL signal is false, it shall release the BSY signal. The target shall continue asserting the BSY signal until it relinquishes the SCSI bus.

4.1.4.1 RESELECTION Time-out Procedure

If, after entering RESELECTION there has been no BSY signal response from the initiator for 250 msec.:

- 1) The ECHO shall continue asserting the SEL and I/O signals and shall release all DATA BUS signals.
- 2) If the BSY signal is not asserted within at least 200 usec., the ECHO releases the SEL and I/O signals allowing the SCSI bus to go to the BUS FREE phase.

4.1.5 Information Transfer Phases

The COMMAND, DATA, STATUS, and MESSAGE phases are all grouped together as the information transfer phases because they are all used to transfer data or control information via the DATA BUS. The actual content of the information is beyond the scope of this section.

The C/D, I/O, and MSG signals are used to distinguish between the different information transfer phases (see Table 4-1). The target drives these three signals and therefore controls all changes from one phase to another. The initiator can request a MESSAGE OUT phase by asserting the ATN signal, while the target can cause the BUS FREE phase by releasing the MSG, C/D, I/O, and BSY signals.

The information transfer phases use one or more REQ/ACK handshakes to control the information transfer. Each REQ/ACK handshake allows the transfer of one byte of information. During the information transfer phases the BSY signal shall remain true and the SEL signal shall remain false.

MSG	C/D	I/O	Phase Name	Direction Of Transfer	Comment
0	0	0	DATA OUT	Initiator to target	Data Phase
0	0	1	DATA IN	Initiator from target	Data Phase
0	1	0	COMMAND	Initiator to target	
0	1	1	STATUS	Initiator from target	
1	1	0	MESSAGE OUT	Initiator to target	Message Phase
1	1	1	MESSAGE IN	Initiator from target	Message Phase
Key : 0 = False, 1 = True					

Table 4.1 Information Transfer Phases

4.1.5.1 Asynchronous Information Transfer

The target shall control the direction of information transfer by means of the I/O signal. When the I/O signal is true, information shall be transferred from the target to the initiator. When the I/O signal is false, information shall be transferred from the initiator to the target.

If the I/O signal is true (transfer to the initiator), the target shall first drive the DB(7-0,P) signals to their desired values, then assert the REQ signal. The DB(7-0,P) signals shall remain valid until the ACK signal is true at the target. The initiator shall read the DB(7-0,P) signals after the REQ signal is true, then indicate its acceptance of the data by asserting the ACK signal. When the ACK signal becomes true at the target, the target may change or release the DB(7-0,P) signals and shall negate the REQ signal. After the REQ signal is false the initiator shall then negate the ACK signal. After the ACK signal is false the target may continue the transfer by driving the DB(7-0,P) signals and asserting the REQ signal, as described above.

If the I/O signal is false (transfer to the target) the target shall request information by asserting the REQ signal. The initiator shall drive the DB(7-0,P) signals to their desired values, and assert the ACK signal. The initiator shall continue to drive the DB(7-0,P) signals until the REQ signal is false. When the ACK signal becomes true at the target, the target shall read the DB(7-0, P), signals then negate the REQ signal. When the REQ signal becomes false at the initiator, the initiator may change or release the DB(7-0,P) signals and shall negate the ACK signal. After the ACK signal is false the target may continue the transfer by asserting the REQ signal, as described above.

4.1.5.2 Synchronous Data Transfer

Synchronous data transfer is optional and is only used in data phases. It shall be used in a data phase if a synchronous data transfer agreement has been established. The agreement specifies the REQ/ACK offset and the minimum transfer period.

The REQ/ACK offset specifies the maximum number of REQ pulses that can be sent by the target in advance of the number of ACK pulses received from the initiator, establishing a pacing mechanism. If the number of REQ pulses exceeds the number of ACK pulses by the REQ/ACK offset, the target shall not assert the REQ signal until after the leading edge of the next ACK pulse is received. A requirement for successful completion of the data phase is that the number of ACK and REQ pulses be equal.

The minimum transfer period specifies minimum period between REQ pulses. The ECHO supports a minimum period of 100 nsec. permitting a 20 MB/sec. transfer rate using WIDE transfers, and a 10 MB/sec. rate using 8-bit transfers. See SYNCHRONOUS DATA TRANSFER REQUEST MESSAGE 4.6.22.

4.1.5.3 Wide Data Transfer

Wide data transfer is optional and may be used in the DATA phase only if a nonzero wide data transfer agreement is in effect (see WIDE DATA TRANSFER REQUEST message, 4.6.23). The messages determine the use of wide mode by both SCSI devices and establish a data path width to be used during the DATA phase. Wide data transfers of 16-bits may be established with the ECHO if the proper options are installed. Eight bit transfers are supported by all ECHO versions and will be used if the WIDE negotiation fails.

4.1.6 COMMAND Phase

The COMMAND phase is used to request command information from the initiator.

The target shall assert the C/D signal and negate the I/O and MSG signals during the REQ/ACK handshake(s) of this phase.

4.1.7 Data Phase

The data phase is a term that encompasses both the DATA IN phase and the DATA OUT phase.

4.1.7.1 DATA IN Phase

The DATA IN phase allows the target to request that data be sent to the initiator from the target.

The target shall assert the I/O signal and negate the C/D and MSG signals during the REQ/ACK handshake(s) of this phase.

4.1.7.2 DATA OUT Phase

The DATA OUT phase allows the target to request that data be sent from the initiator to the target.

The target shall negate the C/D, I/O, and MSG signals during the REQ/ACK handshake(s) of this phase.

4.1.8 STATUS Phase

The STATUS phase allows the target to request that status information be sent from the target to the initiator.

The target shall assert the C/D and I/O signals and negate the MSG signal during the REQ/ACK handshake of this phase.

4.1.9 Message Phase

The message phase is a term that references either a MESSAGE IN, or a MESSAGE OUT phase. Multiple messages may be sent during either phase. The first byte transferred in either of these phases shall be either a single-byte message or the first byte of a multiple-byte message. Multiple-byte messages shall be wholly contained within a single message phase.

4.1.9.1 MESSAGE IN Phase

The MESSAGE IN phase allows the target to request that message(s) be sent to the initiator from the target.

The target shall assert the C/D, I/O, and MSG signals during the REQ/ACK handshake(s) of this phase.

4.1.9.2 MESSAGE OUT Phase

The MESSAGE OUT phase allows the target to request that message(s) be sent from the initiator to the target. The target invokes this phase in response to the attention condition created by the initiator.

The target shall assert the C/D and MSG signals and negate the I/O signal during the REQ/ACK handshake(s) of this phase. The target shall handshake byte(s) in this phase until the ATN signal is negated, except when rejecting a message.

If the target detects one or more parity error(s) on the message byte(s) received, it may indicate its desire to retry the message(s) by asserting the REQ signal after detecting the ATN signal has gone false and prior to changing to any other phase. The

initiator, upon detecting this condition, shall re-send all of the previous message byte(s) in the same order as previously sent during this phase. When re-sending more than one message byte, the initiator shall assert the ATN signal at least two deskew delays prior to asserting the ACK signal on the first byte and shall maintain the ATN signal asserted until the last byte is sent.

If the target does not retry the MESSAGE OUT phase or it exhausts its retry limit it may

- a) return CHECK CONDITION status and set the sense key to ABORTED COMMAND and the additional sense code to MESSAGE ERROR.
- b) indicate an exception condition by performing an unexpected disconnect.

The target may act on messages as received as long as no parity error is detected and may ignore all remaining messages sent under one ATN condition after a parity error is detected. When a sequence of messages is re-sent by an initiator because of a target detected parity error, the target shall not act on any message which it acted on the first time received.

If the target receives all of the message byte(s) successfully (i.e., no parity errors), it shall indicate that it does not wish to retry by changing to any information transfer phase other than the MESSAGE OUT phase and transfer at least one byte. The target may also indicate that it has successfully received the message byte(s) by changing to the BUS FREE phase (e.g., ABORT or BUS DEVICE RESET messages).

4.2 SCSI Bus Conditions

The SCSI bus has two asynchronous conditions; the attention condition and the reset condition. These conditions cause the SCSI device to perform certain actions and can alter the phase sequence.

4.2.1 Attention Condition

The attention condition allows an initiator to inform a target that the initiator has a message ready. The target may get this message by performing a MESSAGE OUT phase.

The initiator creates the attention condition by asserting ATN at any time except during the ARBITRATION or BUS FREE phases.

The initiator shall negate the ATN signal at least two deskew delays before asserting the ACK signal while transferring the last byte of the messages indicated with a "Yes" in Table 5-2. If the target detects that the initiator failed to meet this requirement, then the target shall go to BUS FREE phase (see unexpected disconnect, 5.1.1).

The initiator shall assert the ATN signal at least two deskew delays before negating the ACK signal for the last byte transferred in a bus phase for the attention condition to be honored before transition to a new bus phase. Asserting the ATN signal later might not be honored until a later bus phase and then may not result in the expected action.

A target shall respond with MESSAGE OUT phase as follows:

- a) If the ATN signal becomes true during a COMMAND phase, the target shall enter MESSAGE OUT phase after transferring part or all of the command descriptor block bytes.
- b) If the ATN signal becomes true during a DATA phase, the target shall enter MESSAGE OUT phase at the target's earliest convenience (often, but not

necessarily on a logical block boundary). The initiator shall continue REQ/ACK handshakes until it detects the phase change.

- c) If the ATN signal becomes true during a STATUS phase, the target shall enter MESSAGE OUT phase after the status byte has been acknowledged by the initiator.
- d) If the ATN signal becomes true during a MESSAGE IN phase, the target shall enter MESSAGE OUT phase before it sends another message. This permits a MESSAGE PARITY ERROR message from the initiator to be associated with the appropriate message.
- e) If the ATN signal becomes true during a SELECTION phase and before the initiator releases the BSY signal, the target shall enter MESSAGE OUT phase immediately after that SELECTION phase.
- f) If the ATN signal becomes true during a RESELECTION phase, the target shall enter MESSAGE OUT phase after the target has sent its IDENTIFY message for that RESELECTION phase.

The initiator shall keep the ATN signal asserted if more than one byte is to be transferred. The initiator may negate the ATN signal at any time except it shall not negate the ATN signal while the ACK signal is asserted during a MESSAGE OUT phase. Normally, the initiator negates the ATN signal while the REQ signal is true and the ACK signal is false during the last REQ/ACK handshake of the MESSAGE OUT phase.

4.2.2 Reset Condition

The reset condition is used to immediately clear all SCSI devices from the bus. This condition shall take precedence over all other phases and conditions. Any SCSI device may create the reset condition by asserting the RST signal for a minimum of a reset hold time.

All SCSI devices shall release all SCSI bus signals (except the RST signal) within a bus clear delay of the transition of the RST signal to true. The BUS FREE phase always follows the reset condition.

The ECHO, upon detection of the reset condition, shall:

- 1) Clear all I/O processes including queued I/O processes.
- 2) Release all SCSI device reservations.
- 3) Return any SCSI device operating modes to their appropriate initial conditions, similar to those conditions that would be found after a normal power-on reset. MODE SELECT conditions shall be restored to their last saved values if saved values have been established. MODE SELECT conditions for which no values have been saved shall be returned to their default values.
- 4) Unit attention condition shall be set (See 6.9).

It is recommended that following a reset to selection time after a hard reset condition ends, SCSI targets be able to respond with appropriate status and sense data to the TEST UNIT READY, INQUIRY, and REQUEST SENSE commands.

4.3 SCSI Bus Phase Sequences

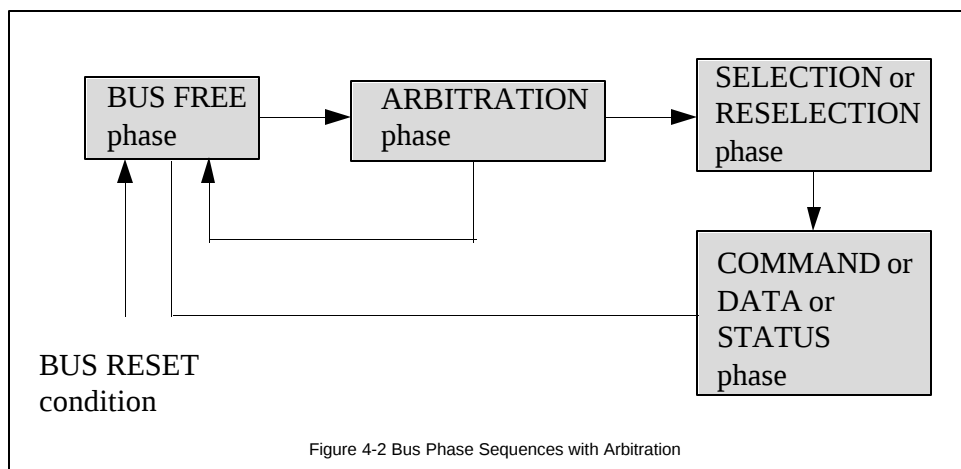
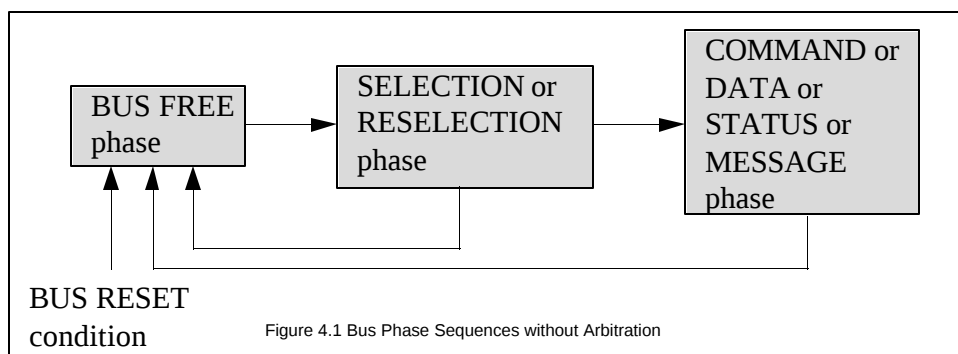
The order in which phases are used on the SCSI bus follows a prescribed sequence.

The reset condition can abort any phase and is always followed by the BUS FREE phase. Also any other phase can be followed by the BUS FREE phase but many such instances are error conditions (see unexpected disconnect, 4.1.1).

The additional allowable sequences shall be as shown in Figures 4.1 & 4.2. The normal progression is from the BUS FREE phase to ARBITRATION (if so configured), from ARBITRATION to SELECTION or RESELECTION, and from SELECTION or RESELECTION to one or more of the information transfer phases (COMMAND, DATA, STATUS, or MESSAGE). The final information transfer phase is normally the MESSAGE IN phase where a DISCONNECT, or COMMAND COMPLETE message is transferred, followed by the BUS FREE phase.

4.4 SCSI Pointers

The SCSI architecture provides for a set of three pointers for each I/O process, called the saved pointers. The set of three pointers consist of one for the command, one for the data, and one for the status. When an I/O process becomes active, its three saved pointers are copied into the initiator's set of three current pointers.



There is only one set of current pointers in each initiator. The current pointers point to the next command, data, or status byte to be transferred between the initiator's memory and the target. The saved and current pointers reside in the initiator.

The saved command pointer always points to the start of the command descriptor block (see 6.2) for the I/O process. The saved status pointer always points to the start of the status area for the I/O process. The saved data pointer points to the start of the data area until the target sends a SAVE DATA POINTER message (see 4.6.20) for the I/O process.

In response to the SAVE DATA POINTER message, the initiator stores the value of the current data pointer into the saved data pointer for that I/O process. The target may restore the current pointers to the saved pointer values for the active I/O process by sending a RESTORE POINTERS message (see 5.6.19) to the initiator. The initiator then copies the set of saved pointers into the set of current pointers. Whenever a target disconnects from the bus, only the set of saved pointers are retained. The set of current pointers is restored from the set of saved pointers upon reconnection of the I/O process.

4.5 Message System Description

The message system allows communication between an initiator and target for the purpose of interface management. A message may be one, two, or multiple bytes in length. One or more messages may be sent during a single MESSAGE phase, but a message may not be split over MESSAGE phases.

One-byte messages consist of a single byte transferred during a MESSAGE phase. The value of the byte determines which message is to be performed as defined in Table 4-2.

Two-byte messages consist of two consecutive bytes transferred during a MESSAGE phase. The value of the first byte determines which message is to be performed as defined in Table 4-2. The second byte is a parameter byte which is used as defined in the message description.

A value of one in the first byte of a message indicates the beginning of a multiple-byte extended message codes used by ECHO are shown in Table 4-3.

The extended message length specifies the length in bytes of the extended message code plus the extended message arguments to follow. Therefore, the total length of the message is equal to the extended message length plus two.

Code	Message Name	Direction	Negate ATN Before last ACK
06h	ABORT	Out	Yes
0Ch	BUS DEVICE RESET	Out	Yes
00h	COMMAND COMPLETE	In	---
04h	DISCONNECT	In	---
80h+	IDENTIFY	Out	No
23h	IGNORE WIDE RESIDUE (Two Bytes)	In	
05h	INITIATOR DETECTED ERROR	Out	Yes
0Ah	LINKED COMMAND COMPLETE	In	---
0Bh	LINKED COMMAND COMPLETE (WITH FLAG)	In	---
09h	MESSAGE PARITY ERROR	Out	Yes
07h	MESSAGE REJECT	In Out	Yes
08h	NO OPERATION	Out	Yes
03h	RESTORE POINTERS	In	---
02h	SAVE DATA POINTER	In	---
***	SYNCHRONOUS DATA TRANSFER REQUEST	In Out	Yes
***	WIDE DATA TRANSFER REQUEST	In Out	
11h	TERMINATE I/O PROCESS	Out	Yes
***	BLOCK DESCRIPTOR MESSAGE	In	

Key:
M = Mandatory support , 0 = Optional support.
In = Target to initiator, Out = Initiator to target
Yes = Initiator shall negate ATN before last ACK of message.
No = Initiator may or may not negate ATN before last ACK of message. (attention condition, 4.2.1)
--- = Not applicable
*** = Extended message (see Tables 4-4 and 4-5)
**** = Extended message (see Appendix A).
80h+ = Codes 80h through Ffh are used for IDENTIFY messages (see Table 4-6).

Table 4-2: Messages Supported by ECHO

Code	Description
01h	SYNCHRONOUS DATA TRANSFER REQUEST
03h	WIDE DATA TRANSFER REQUEST
81h	BLOCK DESCRIPTOR MESSAGE (Vendor Specific)

Table 4-3: Extended Messages Supported by ECHO

The first message sent by the initiator after the SELECTION phase shall be an IDENTIFY, ABORT, or BUS DEVICE RESET message. If a target receives any other message it shall go to BUS FREE phase (see unexpected disconnect, 4.1.1).

If the first message is an IDENTIFY message, then it may be immediately followed by other messages, such as the first of a pair of SYNCHRONOUS DATA TRANSFER REQUEST messages. The IDENTIFY message establishes a logical connection between the initiator and the specified logical unit or target routine within the target known as an I_T_L nexus or I_T_R nexus. After the RESELECTION phase, the target's first message shall be IDENTIFY. This allows the I_T_L nexus or I_T_R nexus to be re-established. Only one logical unit or target routine shall be identified for any

connection; if a target receives a second IDENTIFY message with a different logical unit number or target routine number during a connection, it shall go to BUS FREE phase (see unexpected disconnect, 4.1.1).

Whenever an I_T_L nexus or I_T_R nexus is established by an initiator that is allowing disconnection, the initiator shall ensure that the current pointers are equal to the saved pointers for that particular logical unit or target routine. An implied restore pointers operation shall occur as a result of a reconnection.

4.6 Messages

The SCSI messages are defined in this section.

4.6.1 ABORT

The ABORT message is sent from the initiator to the target to clear any I/O process for the I_T_x nexus. The target shall go to the BUS FREE phase following successful receipt of this message. The pending data, status, and I/O processes for any other nexus shall not be cleared.

If only an I_T nexus has been established, the target shall go to the BUS FREE phase. No status or message shall be sent for the current I/O process and no other I/O process shall be affected.

It is not an error to issue this message to an I_T_x nexus that does not have an active or queued I/O process.

Previously established conditions, including MODE SELECT parameters, reservations, are not be changed by the ABORT message.

4.6.2 BUS DEVICE RESET

The BUS DEVICE RESET message is sent from an initiator to direct a target to clear all I/O processes on that SCSI device. This message forces a hard reset condition to the selected SCSI device. The target shall go to the BUS FREE phase following successful receipt of this message. The ECHO will create a unit attention condition for all initiators if so enabled by the setup configuration.

4.6.3 COMMAND COMPLETE

The COMMAND COMPLETE message is sent from a target to an initiator to indicate that the execution of an I/O process has completed and that valid status has been sent to the initiator. After successfully sending this message, the target shall go to the BUS FREE phase by releasing the BSY signal. The target shall consider the message transmission to be successful when it detects the negation of ACK for the COMMAND COMPLETE message with the ATN signal false.

The I/O process may have completed successfully or unsuccessfully as indicated in the status.

4.6.4 DISCONNECT

The DISCONNECT message is sent from a target to inform an initiator that the present connection is going to be broken (the target plans to disconnect by releasing the BSY signal), but that a later reconnect will be required in order to complete the current I/O process. This message shall not cause the initiator to save the data pointer. After successfully sending this message, the target shall go to the BUS FREE phase by

releasing the BSY signal. The target shall consider the message transmission to be successful when it detects the negation of the ACK signal for the DISCONNECT message with the ATN signal false.

Targets which break data transfers into multiple connections shall end each successful connection (except possibly the last) with a SAVE DATA POINTER - DISCONNECT message sequence.

This message may also be sent from an initiator to a target to instruct the target to disconnect from the SCSI bus. If this option is supported, and after the DISCONNECT message is received, the target shall switch to MESSAGE IN phase, send the DISCONNECT message to the initiator (possibly preceded by SAVE DATA POINTER message), and then disconnect by releasing BSY. After releasing the BSY signal, the target shall not participate in another ARBITRATION phase for at least a disconnection delay or the time limit specified in the disconnect time limit mode parameter whichever is greater. If this option is not supported or the target cannot disconnect at the time when it receives the DISCONNECT message from the initiator, the target shall respond by sending a MESSAGE REJECT message to the initiator.

4.6.5 IDENTIFY

The IDENTIFY message (Table 46) is sent by either the initiator or the target to establish an I_T_L nexus or an I_T_R nexus.

Bit	7	6	5	4	3	2	1
	1	DiscPriv	0	0	0	0	0

Table 4-6 IDENTIFY Message Format

A disconnect privilege (DiscPriv) bit of one specifies that the initiator has granted the target the privilege of disconnecting.

A DiscPriv bit of zero specifies that the target shall not disconnect. This bit is not defined and shall be set to zero when an IDENTIFY message is sent by a target.

An implied RESTORE POINTERS message shall be performed by the initiator prior to the assertion of the ACK signal on the next phase for an inbound IDENTIFY message sent during reconnection.

An implied RESTORE POINTERS message shall be performed by the initiator following successful identification of the nexus during the MESSAGE IN phase of a reconnection and before the negation of the ACK signal for the next transfer following the successful identification.

Identification is considered successful during an initial connection or an initiator reconnect when the target detects no error during the transfer of the IDENTIFY message in the MESSAGE OUT phase immediately following the SELECTION phase.

Identification is considered successful during a target reconnect when the ATN signal is not asserted during the transfer of the IDENTIFY message for an I_T_L_Q nexus in the MESSAGE IN phase immediately following the RESELECTION phase.

4.6.6 IGNORE WIDE RESIDUE

The IGNORE WIDE RESIDUE message shall be sent from a target to indicate that the number of valid bytes sent during the last REQ/ACK handshake of a DATA IN phase is less than the negotiated transfer width. The ignore field set to 01h indicates that the bytes sent on DB15-DB8 are invalid and should be ignored. This message shall be sent immediately following that DATA IN phase and prior to any other messages.

Bit Byte	7	6	5	4	3	2	1	0
0	Message Code (23h)							
1	Ignore (01h)							

Table 4-7 IGNORE WIDE RESIDUE MESSAGE

4.6.7 INITIATOR DETECTED ERROR

The INITIATOR DETECTED ERROR message is sent from an initiator to inform a target that an error has occurred that does not preclude the target from retrying the operation. The source of the error may either be related to previous activities on the SCSI bus or may be internal to the initiator and unrelated to any previous SCSI bus activity. Although present pointer integrity is not assured, a RESTORE POINTERS message or a disconnect followed by a reconnect, shall cause the pointers to be restored to their defined prior state.

4.6.8 LINKED COMMAND COMPLETE

The LINKED COMMAND COMPLETE message is sent from a target to an initiator to indicate that the execution of a linked command has completed and that status has been sent. The initiator shall then set the pointers to the initial state for the next linked command.

4.6.9 LINKED COMMAND COMPLETE (WITH FLAG)

The LINKED COMMAND COMPLETE (WITH FLAG) message is sent from a target to an 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. The initiator shall then set the pointers to the initial state of the next linked command. Typically this message would be used to cause an interrupt in the initiator between two linked commands.

4.6.10 MESSAGE PARITY ERROR

The MESSAGE PARITY ERROR message is sent from the initiator to the target to indicate that it received a message byte with a parity error (see 4.2.1).

In order to indicate its intentions of sending this message, the initiator shall assert the ATN signal prior to its release of the ACK signal for the REQ/ACK handshake of the message byte that has the parity error. This provides an interlock so that the target can determine which message byte has the parity error. If the target receives this message under any other circumstance, it shall signal a catastrophic error condition by releasing the BSY signal without any further information transfer attempt.

If after receiving the MESSAGE PARITY ERROR message the target returns to the MESSAGE IN phase before switching to some other phase, the target shall re-send the entire message that had the parity error.

4.6.11 MESSAGE REJECT

The MESSAGE REJECT message is sent from either the initiator or target to indicate that the last message or message byte it received was inappropriate or has not been implemented.

In order to indicate its intentions of sending this message, the initiator shall assert the ATN signal prior to its release of the ACK signal for the REQ/ACK handshake of the message byte that is to be rejected. If the target receives this message under any other circumstance, it shall reject this message.

When a target sends this message, it shall change to MESSAGE IN phase and send this message prior to requesting additional message bytes from the initiator. This provides an interlock so that the initiator can determine which message byte is rejected.

After a target sends a MESSAGE REJECT message and if the ATN signal is still asserted, then it shall return to the MESSAGE OUT phase. The subsequent MESSAGE OUT phase shall begin with the first byte of a message.

4.6.12 NO OPERATION

The NO OPERATION message is sent from an initiator in response to a target's request for a message when the initiator does not currently have any other valid message to send.

For example, if the target does not respond to the attention condition until a later phase and at that time the original message is no longer valid the initiator may send the NO OPERATION message when the target enters the MESSAGE OUT phase.

4.6.13 RESTORE POINTERS

The RESTORE POINTERS message is sent from a target to direct the initiator to copy the most recently saved command, data, and status pointers for the I/O process to the corresponding current pointers. The command and status pointers shall be restored to the beginning of the present command and status areas. The data pointer shall be restored to the value at the beginning of the data area in the absence of a SAVE DATA POINTER message or to the value at the point at which the last SAVE DATA POINTER message occurred for that nexus.

4.6.14 SAVE DATA POINTER

The SAVE DATA POINTER message is sent from a target to direct the initiator to copy the current data pointer to the saved data pointer for the current I/O process.

4.6.15 SYNCHRONOUS DATA TRANSFER REQUEST

Bit	7	6	5	4	3	2	1	0
Byte								

0	Extended Message (01h)
1	Extended Message Length (03h)
2	Synchronous Data Transfer Request (01h)
3	Transfer Period Factor
4	REQ / ACK Offset

Table 4-9: SYNCHRONOUS DATA TRANSFER REQUEST

A SYNCHRONOUS DATA TRANSFER REQUEST (SDTR) message (Table 4-9) exchange shall be initiated by an SCSI device whenever a previously-arranged data transfer agreement may have become invalid. The agreement becomes invalid after any condition which may leave the data transfer agreement in an indeterminate state such as:

- a) after a hard reset condition;
- b) after a BUS DEVICE RESET message and;
- c) after a power cycle.

In addition, an SCSI device may initiate an SDTR message exchange whenever it is appropriate to negotiate a new data transfer agreement (either synchronous or asynchronous). SCSI devices that are capable of synchronous data transfers shall not respond to an SDTR message with a MESSAGE REJECT message.

The SDTR message exchange establishes the permissible transfer periods and the REQ/ACK offsets for all logical units and target routines on the two devices. This agreement only applies to data phases.

The transfer period factor times four is the value of the transfer period. The transfer period is the minimum time allowed between leading edges of successive REQ pulses and of successive ACK pulses to meet the device requirements for successful reception of data.

The REQ/ACK offset is the maximum number of REQ pulses allowed to be outstanding before the leading edge of its corresponding ACK pulse is received at the target. This value is chosen to prevent overflow conditions in the device's reception buffer and offset counter. A REQ/ACK offset value of zero shall indicate asynchronous data transfer mode; a value of FFh shall indicate unlimited REQ/ACK offset.

The originating device (the device that sends the first of the pair of SDTR messages) sets its values according to the rules above to permit it to receive data successfully. If the responding device can also receive data successfully with these values (or smaller transfer periods or larger REQ/ACK offsets or both), it returns the same values in its SDTR message. If it requires a larger transfer period, a smaller REQ/ACK offset, or both in order to receive data successfully, it substitutes values in its SDTR message as required, returning unchanged any value not required to be changed. Each device when transmitting data shall respect the limits set by the other's SDTR message, but it is permitted to transfer data with larger transfer periods, smaller REQ/ACK offsets, or both than specified in the other's SDTR message. The successful completion of an exchange of SDTR messages implies an agreement as follows:

Responding Device SDTR response

- 1) Non-zero REQ/ACK offset
 - a greater

Implied Agreement

Each device transmits data with transfer period equal to or than and a REQ/ACK

offset

equal to or less than the values received in the other device's SDTR message.

2) REQ/ACK offset equal to zero

Asynchronous transfer

3) MESSAGE REJECT message

Asynchronous transfer

If the initiator recognizes that negotiation is required, it asserts the ATN signal and sends a SDTR message to begin the negotiating process. After successfully completing the MESSAGE OUT phase, the target shall respond with the proper SDTR message. If an abnormal condition prevents the target from returning an appropriate response, both devices shall go to asynchronous data transfer mode for data transfers between the two devices.

Following target response (1) above, the implied agreement for synchronous operation shall be considered to be negated by both the initiator and the target if the initiator asserts the ATN signal and the first message out is either MESSAGE PARITY ERROR or MESSAGE REJECT. In this case, both devices shall go to asynchronous data transfer mode for data transfers between the two devices. For the MESSAGE PARITY ERROR case, the implied agreement shall be reinstated if a re-transmittal of the second of the pair of messages is successfully accomplished. After a vendor-specific number of retry attempts (greater than zero), if the target receives a MESSAGE PARITY ERROR message, it shall terminate the retry activity. This may be done either by changing to any other information transfer phase and transferring at least one byte of information or by going to the BUS FREE phase (see 5.1.1). The initiator shall accept such action as aborting the negotiation, and both devices shall go to asynchronous data transfer mode for data transfers between the two devices.

If the target recognizes that negotiation is required, it sends an SDTR message to the initiator. Prior to releasing the ACK signal on the last byte of the SDTR message from the target, the initiator shall assert the ATN signal and respond with its SDTR message or with a MESSAGE REJECT message. If an abnormal condition prevents the initiator from returning an appropriate response, both devices shall go to asynchronous data transfer mode for data transfers between the two devices.

Following an initiator's responding SDTR message, an implied agreement for synchronous operation shall not be considered to exist until the target leaves the MESSAGE OUT phase, indicating that the target has accepted the negotiation. After a vendor-specific number of retry attempts (greater than zero), if the target has not received the initiator's responding SDTR message, it shall go to the BUS FREE phase without any further information transfer attempt (see 5.1.1). This indicates that a catastrophic error condition has occurred. Both devices shall go to asynchronous data transfer mode for data transfers between the two devices.

If, following an initiator's responding SDTR message, the target shifts to MESSAGE IN phase and the first message in is MESSAGE REJECT, the implied agreement shall be considered to be negated and both devices shall go to asynchronous data transfer mode for data transfers between the two devices.

The implied synchronous agreement shall remain in effect until a BUS DEVICE RESET message is received, until a hard reset condition occurs, or until one of the two SCSI devices elects to modify the agreement. The default data transfer mode is asynchronous data transfer mode. The default data transfer mode is entered at power on, after a BUS DEVICE RESET message, or after a hard reset condition.

4.6.17 TERMINATE I/O PROCESS

The TERMINATE I/O PROCESS message is sent from the initiator to the target to terminate the current I/O process without corrupting the medium.

With the following exceptions, the target shall terminate the current I/O process and return COMMAND TERMINATED status. The sense key shall be set to NO SENSE. The additional sense code and qualifier are set to I/O PROCESS TERMINATED.

If the associated I/O process involves a data phase, the target shall set the valid bit in the sense data to one and set the information field as follows:

- 1) If the command descriptor block specifies an allocation length or parameter list length, the information field shall be set to the difference (residue) between the number of bytes successfully transferred and the requested length.
- 2) If the command descriptor block specifies a transfer length field, the information field shall be set as defined in the REQUEST SENSE command.

If an error is detected for the associated I/O process the target shall ignore the TERMINATE I/O PROCESS message.

If the operation requested for the associated I/O process has been completed but status has not been returned, the target shall ignore the TERMINATE I/O PROCESS message.

If the target does not support this message or is unable to stop the current I/O process, it shall send a MESSAGE REJECT message to the initiator and continue the I/O process in a normal manner.

4.6.18 Wide Data Transfer Request Message

Bit Byte	7	6	5	4	3	2	1	0
0	Extended Message (01h)							
1	Extended Message Length (02h)							
2	Wide Data Transfer Request (03h)							
3	Transfer Width Exponent (01h)							

Table 4-10 WIDE DATA TRANSFER REQUEST MESSAGE

A WIDE DATA TRANSFER REQUEST (WDTR) message (Table 4-10) exchange shall be initiated by an SCSI device whenever a previously-arranged transfer width agreement may have become invalid. These reasons are identical to the reasons for negotiating a new SYNCHRONOUS mode (See 4.x.15). In addition, an SCSI device may initiate an WDTR message exchange whenever it is appropriate to negotiate a new transfer width agreement.

NOTE: Re-negotiation at every selection is not recommended, since a significant performance impact is likely.

The WDTR message exchange establishes an agreement between two SCSI devices on the width of the data path to be used for DATA phase transfers between the two devices. This agreement applies to DATA IN and DATA OUT phases only. All other

information transfer phases shall use an eight-bit data path. A wide data transfer agreement shall be negotiated prior to negotiating the synchronous data transfer agreement. If a synchronous data transfer agreement is in effect, then a WDTR message shall reset the synchronous agreement to asynchronous mode.

The transfer width is two to the transfer width exponent bytes wide. The transfer width that is established applies to all logical units on both SCSI devices. Valid transfer widths are 8 bits (m = 00h) and 16 bits (m = 01h).

The originating SCSI device (the SCSI device that sends the first of the pair of WDTR messages) sets its transfer width value to the maximum data path width it elects to accommodate. If the responding SCSI device can also accommodate this transfer width, it returns the same value in its WDTR message. If it requires a smaller transfer width, it substitutes the smaller value in its WDTR message.

The successful completion of an exchange of WDTR messages implies an agreement as follows:

<u>Responding Device WDTR Response</u>	<u>Implied Agreement</u>
1) Non-zero transfer width	Each device transmits and receives data with a transfer width equal to the responding SCSI device's transfer width.
2) Transfer width equal to zero	Eight-bit Data Transfer
3) MESSAGE REJECT message	Eight-bit Data Transfer

If the initiator recognizes that negotiation is required, it asserts the ATN signal and sends a WDTR message to begin the negotiating process. After successfully completing the MESSAGE OUT phase, the ECHO will respond with the proper WDTR message. If the ECHO is not configured with the 16 bit WIDE option, it will respond with response (2) above. Otherwise, it will respond with response (1) with TRANSFER WIDTH EXPONENT set to 01h. The ECHO will respond to an initiator's WDTR message with a proper WDTR message regardless of the setting of the WIDE NEGO parameter in the configuration setup.

If an abnormal condition exists, both devices shall go to eight-bit data transfer mode for data transfers between the two devices. Following target response (1) above, the implied agreement for wide data transfers shall be considered to be negated by both the initiator and the target if the initiator asserts ATN and the first message out is either MESSAGE PARITY ERROR or MESSAGE REJECT. In this case, both devices shall go to eight-bit data transfer mode for data transfers between the two devices. For the MESSAGE PARITY ERROR case, the implied agreement shall be reinstated if a re-transmittal of the second of the pair of messages is successfully accomplished. After two retry attempts, if the target receives a MESSAGE PARITY ERROR message, it shall terminate the retry activity. This may be done either by changing to any other information transfer phase and transferring at least one byte of information or by going to the BUS FREE phase. The initiator shall accept such action as aborting the negotiation, and both devices shall go to eight-bit data transfer mode for data transfers between the two devices.

The ECHO recognizes that negotiation is required when first selected after a power on, or BUS RESET condition. If it is configured with the 16 bit WIDE option, and the setup configuration permits WIDE negotiation, it sends a WDTR message to the initiator. Prior to releasing the ACK signal on the last byte of the WDTR message from the target, the initiator shall assert the ATN signal and respond with its WDTR message or with a MESSAGE REJECT message. If an abnormal condition prevents the initiator

from returning an appropriate response, both devices shall go to eight-bit data transfer mode for data transfers between the two devices. Following an initiator's responding WDTR message, an implied agreement for wide data transfer operation shall not be considered to exist until the target leaves the MESSAGE OUT phase, indicating that the target has accepted the negotiation. (greater than zero), If the ECHO has not received the initiator's responding WDTR message after two retry attempts it shall go to the BUS FREE phase without any further information transfer attempt.

This indicates that a catastrophic error condition has occurred. Both devices shall go to eight-bit data transfer mode for data transfers between the two devices. If, following an initiator's responding WDTR message, the target shifts to MESSAGE IN phase and the first message in is MESSAGE REJECT, the implied agreement shall be considered to be negated and both devices shall go to eight-bit data transfer mode for data transfers between the two devices. The implied transfer width agreement shall remain in effect until a BUS DEVICE RESET message is received, until a hard reset condition occurs, or until one of the two SCSI devices elects to modify the agreement.

The default data transfer width is eight-bit data transfer mode. The default data transfer mode is entered at power on, after a BUS DEVICE RESET message, or after a hard reset condition.

4.6.19 Block Descriptor Message

Bit Byte	7	6	5	4	3	2	1	0
0	Extended Message Indicator (01h)							
1	Message Length (08)							
2	Vendor Unique Message Code (81h)							
3	MSB							
4	Block Number							
5	LSB							
6	MSB							
7	Block							
8	Size							
9	LSB							

Table 4-10: BLOCK DESCRIPTOR MESSAGE

The Block Descriptor Message (BDM) is sent by the target to communicate the size of physical data blocks. BDMs are sent only when the target is set to buffer mode 3h (Special Buffer Mode) A Block Descriptor Message is sent by the target in Buffer Mode 3h following the Data Out phase of a variable READ Command whenever that command causes data to be passed over the SCSI bus from a new physical block. Subsequent reads of data from a block for which a Block Descriptor Message has already been sent do not cause a BDM to be transmitted. See Appendix A.



SCSI

Block Number

The Block number indicates the position of the current block. This is the same quantity as would be returned by the READ POSITION Command in the FIRST BLOCK POSITION field.

Block Size

Size in bytes of the current block

5. SCSI Commands and Status

This section defines the SCSI command and status structures. Status data is also described.

By keeping to a minimum the functions essential to communicate via this protocol, a wide range of peripheral devices of varying capability can operate in the same environment.

5.1 Command Implementation Requirements

The first byte of all SCSI commands shall contain an operation code as defined in the ANSI SCSI standard. The commands supported by the ECHO are listed and described in detail in Section 6.

5.2 Command Descriptor Block

A command is communicated by sending a command descriptor block (CDB) to the target. For several commands, the command descriptor block is accompanied by a list of parameters sent during the DATA OUT phase. See the specific commands for detailed information.

The command descriptor block always has an operation code as its first byte and a control byte as its last byte. SCSI command descriptor blocks are either six or ten bytes in length.

For all commands, if there is an invalid parameter in the command descriptor block, then the ECHO will terminate the command without altering the medium, and issuing appropriate status, usually CHECK CONDITION.

Bit Byte	7	6	5	4	3	2	1	0
0	Group Code			Command Code				
1	LUN			Depends on command				
2	Command Dependant Parameter							
3	Command Dependant Parameter							
4	Command Dependant Parameter							
5	Control Field						Flag	Lin k

Table 5-1: Typical Command Descriptor Block for Six-byte Commands

5.2.1 Logical Unit Number (LUN)

Manually loaded ECHO drives contain an embedded SCSI controller which supports only a single Logical Unit (LUN 0). If the LUN is non-zero, ECHO will return CHECK



SCSI

CONDITION with ILLEGAL REQUEST, LOGICAL UNIT NOT SUPPORTED in the Sense data.

5.2.3 Logical Block Address

The logical block address on logical units or within a partition on device volumes shall begin with block zero and be contiguous up to the last logical block on that logical unit or within that partition.

Bit Byte	7	6	5	4	3	2	1	0
0	Group Code			Command Code				
1	LUN			Depends on command				
2	(MSB) Logical							
3	Block							
4	Address							
5	(LSB)							
6	Reserved							
7	(MSB) Transfer / Parameter List / Allocation							
8	(LSB) Length (dependent on command)							
9	Control Field						Flag	Link

Table 5-2: Typical Command Descriptor Block for Ten-byte Commands

A six-byte command descriptor block contains a 21-bit logical block address. Ten-byte command descriptor blocks contain 32-bit logical block addresses. Logical block addresses in additional parameter data have their length specified for each occurrence. See the specific command descriptions for more information.

5.2.4 Transfer Length

The transfer length field specifies the amount of data to be transferred, usually the number of blocks. For several commands the transfer length indicates the requested number of bytes to be sent as defined in the command description. For these commands the transfer length field may be identified by a different name. See the following descriptions and the individual command descriptions for further information.

5.2.5 Parameter List Length

The parameter list length is used to specify the number of bytes sent during the DATA OUT phase. This field is typically used in command descriptor blocks for parameters that are sent to a target (e.g., mode parameters, diagnostic parameters, log

parameters, etc.). A parameter length of zero indicates that no data shall be transferred.

5.2.6 Allocation Length

The allocation length field specifies the maximum number of bytes that an initiator has allocated for returned data. An allocation length of zero indicates that no data shall be transferred. This condition shall not be considered as an error. The target shall terminate the DATA IN phase when allocation length bytes have been transferred or when all available data have been transferred to the initiator, whichever is less.

The allocation length is used to limit the maximum amount of data (e.g., sense data, mode data, log data, diagnostic data, etc.) returned to an initiator.

5.2.7 Control Field

The control field is the last byte of every command descriptor block. The control field is defined in Table 5-5.

Bit Byte	7	6	5	4	3	2	1	0
5 or 9	Vendor Specific		Reserved				Flag	Link

Table 5-3 Control Field

The flag bit specifies which message the target shall return to the initiator if the link bit is one and the command completes without error.

The flag bit should be set to zero if the link bit is zero. If link bit is zero and the flag bit is one, the target shall return CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST.

If the flag bit is zero and the link bit is one, and if the command completes successfully, the target shall send the LINKED COMMAND COMPLETE message. If the flag bit is one and the link bit is one, and if the command completes successfully, the target shall send the LINKED COMMAND COMPLETE (WITH FLAG) message. The flag bit is typically used to cause an interrupt in the initiator between linked commands.

The link bit is used to continue the I/O process across multiple commands.

A link bit of one indicates that the initiator requests a continuation of the I/O process and that the target should enter the command phase upon successful completion of the current command.

If the link bit is one, and if the command completes successfully, the target shall return INTERMEDIATE or INTERMEDIATE-CONDITION MET status and shall then send one of the two messages defined by the flag bit.

5.3 Status

The status byte and status byte code are specified in Tables 5-4 and 5-5. A status byte shall be sent from the target to the initiator during the STATUS phase at the

completion of each command unless the command is terminated by one of the following events:

- a) an ABORT message;
- b) a BUS DEVICE RESET message;
- c) a hard reset condition;
- d) an unexpected disconnect.

The STATUS phase normally occurs at the end of a command but in some case may occur prior to transferring the command descriptor block.

Bit	7	6	5	4	3	2	1	0
	0	0	Status Byte Code					0

Table 5-4: Status Byte

Bits of Status Byte								Status
7	6	5	4	3	2	1	0	
0	0	0	0	0	0	0	0	GOOD
0	0	0	0	0	0	1	0	CHECK CONDITION
0	0	0	0	1	0	0	0	BUSY
0	0	0	1	0	0	0	0	INTERMEDIATE
0	0	0	1	1	0	0	0	RESERVATION CONFLICT
0	0	1	0	0	0	1	0	COMMAND TERMINATED

Table 5-5 Status Byte Codes

A definition of the status byte codes is given below.

GOOD. This status indicates that the target has successfully completed the command.

CHECK CONDITION. This status indicates that some error or warning condition exists. More information about the type of error or unexpected condition and about possible recovery procedures can be obtained by issuing the REQUEST SENSE command. REQUEST SENSE *must* be issued immediately following the return of CHECK CONDITION status or the information may be lost.

BUSY. This status indicates that the target is busy. This status shall be returned whenever a target is unable to accept a command from an otherwise acceptable initiator (i.e., no reservation conflicts). The recommended initiator recovery action is to issue the command again at a later time.

INTERMEDIATE. This status shall be returned for every successfully completed command in a series of linked commands (except the last command), unless the command is terminated with CHECK CONDITION, RESERVATION CONFLICT, or COMMAND TERMINATED status. If INTERMEDIATE status is not returned, the series of linked commands is terminated and the I/O process is ended.



SCSI

RESERVATION CONFLICT. This status shall be returned whenever an initiator attempts to access a logical unit or an extent within a logical unit that is reserved with a conflicting reservation type for another SCSI device (see the RESERVE and RESERVE UNIT commands). The recommended initiator recovery action is to issue the command again at a later time.

6. SCSI COMMANDS

Table 6-1 Lists the available SCSI Commands.

Command Name	Operation Code	Implementation	Section Number
ERASE	19h	I	6.1
INQUIRY	12h	I	6.2
LOAD DISPLAY	06h	*	6.3
LOAD UNLOAD	1Bh	I	6.4
LOCATE	2Bh	I	6.5
LOG SENSE	4Dh	I	6.6
LOOP WRITE TO READ		*	6.7
MODE SELECT(6)	15h	I	6.8
MODE SENSE(6)	1Ah	I	6.9
POSITION LOADER	02h	*	6.10
PREVENT / ALLOW MEDIUM REMOVAL	1Eh	I	6.11
READ	08h	I	6.12
READ BLOCK LIMITS	05h	I	6.13
READ BUFFER	3Ch	*	6.14
READ POSITION	34h	I	6.15
READ REVERSE	0Fh	I	6.16
RECEIVE DIAGNOSTIC RESULTS	1Ch	*	6.17
RECOVER BUFFERED DATA	14h	I	6.18
RELEASE UNIT	17h	I	6.19
REQUEST SENSE	03h	I	6.20
RESERVE UNIT	16h	I	6.21
REWIND	01h	I	6.22
SEND DIAGNOSTIC	1Dh	*	6.23
SPACE	11h	I	6.24
SYNCHRONIZE	C3h	*	6.25
TEST UNIT READY	00h	I	6.26
WRITE	0Ah	I	6.27
WRITE BUFFER	3Bh	*	6.28
WRITE FILEMARKS	10h	I	6.29
Implementation Key I = Implemented according to SCSI SPEC ? = Implementation TBD * = Implemented in a vendor specific manner			

TABLE 6-1: SCSI Command List

6.1 ERASE Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (19h)							
1	LUN			0			Immed	Long
2	0							
3	0							
4	0							
5	Control Byte						Flag	Link

Table 6-2: ERASE Command

The ERASE command causes part or all of the medium to be erased beginning at the current position on the logical unit. As used here, "erased" means a pattern shall be written on the medium that appears as a gap to the target.

Immed

An immediate bit of zero indicates that the target shall not return status until the erase operation has completed. An Immed bit of one indicates that the target shall return status as soon as the command has been validated. If CHECK CONDITION status is returned for an ERASE command with an Immed bit of one, the erase operation was not performed.

Long

A long bit of one indicates that all remaining medium shall be erased beginning at the current position. The special Data Security Erase pattern is used. If the Immed bit is one, the target shall return status as soon as all buffered commands have completed execution and the command descriptor block of the ERASE command has been validated. The logical position following an ERASE command with a long bit of one is physical EOM.

A long bit of zero specifies the write of an Erase Gap Mark followed by an IBG. If the Immed bit is one, the target shall return status as soon as the command descriptor block has been validated.

If the logical unit encounters early-warning, Logical End of Tape (LEOT), during an ERASE command, and any buffered data, or filemarks remain to be written, the target action shall be as defined for the early-warning condition of the WRITE command. If the long bit is zero, the erase operation shall terminate with CHECK CONDITION status and return sense data as defined for the WRITE command.

6.2 INQUIRY Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (12h)							
1	LUN			0				
2	0							
3	0							
4	Allocation Length							
5	Control Byte						Flag	Link

Table 6-3: INQUIRY Command

The INQUIRY command requests that information regarding parameters of the target and its attached peripheral device(s) be sent to the initiator. An option allows the initiator to request additional information about the target or logical unit.

The INQUIRY command shall return CHECK CONDITION status only when the target cannot return the requested INQUIRY data.

The INQUIRY data will be returned even though the target may not be ready for other commands.

If an INQUIRY command is received from an initiator with a pending unit attention condition (i.e., before CHECK CONDITION status), the target will perform the INQUIRY command and shall not clear the unit attention condition.

The INQUIRY command is typically used by the initiator after a reset or power-up condition to determine the device types for system configuration.

6.2.1 Standard INQUIRY Data

Standard INQUIRY data (shown on the next page in Table 6-4) contains 36 bytes.

INQUIRY data may change based on installed options, and EMULATION setups. Table 6-4 shows the standard format for INQUIRY data. See Appendix B for differing INQUIRY data sets.

Bit Byte	7	6	5	4	3	2	1	0
0	Peripheral Qualifier			Device Type (01h)				
1	1	0						
2	0			0		0 1 0		
3	0	0	0		Res. Data Fmt (02h)			
4	Additional Length (n-4)							
5	0							
6	0							
7	0	0	1	1	0	0	0	0
8 -	(MSB) Vendor							
15	(LSB) Identification*							
16 -	(MSB) Device							
31	(LSB) Identification*							
32 -	Product				Revision			
35	Level							
36	0	0	0	0	36tr k	18tr k	Comp	Atl

Table 6-4: Standard INQUIRY Data Format

Note: * Indicates that these parameters are variable in the SETUP mode.

Peripheral Qualifier / Device Type 01 if LUN installed, 7Fh if not installed

18trk - Set to 1 if drive capable of 18 track writes.

36trk - Set to 1 if drive capable of 36 track read/writes.

Comp - Set to 1 if drive capable of IDRC compression/compaction.

ATL - Set to 1 if autoloader installed.

6.3 LOAD DISPLAY Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (06h)							
1	LUN			0				
2	0							
3	0							
4	Transfer Length (11h)							
5	Control Byte						Flag	Link

Table 6-5: LOAD DISPLAY Command

The Load Display Command is used to allow text to be displayed on the Operator Control Panel LCD Display. The upper right eight bytes of this display are modifiable by this command. LOAD DISPLAY transfers 17 bytes of data from the host to the target. This data represents two 8 byte messages with a control byte indicating how the messages are to be displayed.

Transfer Length - Must be 17d (11h).

The 17 bytes of data are formatted as follows:

Bit Byte	7	6	5	4	3	2	1	0
0	Overlay			Alt	Blnk	L/H	0	0
1 - 8	ASCII Message 1							
9 - 16	ASCII Message 2							

Table 6-6 Load Display Data Format

Overlay

000b - Display Message1 or Message2 (as per L/H bit (2)) until the next command that causes tape motion, or the next Load Display command. ALT (bit 4) ignored.

001b - Maintain the Message1 until the cartridge is unloaded, or a new cartridge is loaded. ALT and L/H ignored.

010b - Load two messages to be displayed according to bits 2 and 4

011b - Load Message1. Message 2 is defined as the default eight byte string which would be displayed by the ECHO if LOAD DISPLAY were not used. This corresponds to the write enable state and density of the cartridge. Display the two messages according to ALT and L/H.

111b - Display Message1 whenever the drive is unloaded and Message2 whenever the drive is loaded. ALT and L/H ignored.

ALT

- 0 - Display message indicated by bit 2 only.
- 1 - Alternate Messages 1 and 2 at intervals of 2 seconds. Bit 2 ignored.

BLNK

- 0 - Message display constant
- 1 - Messages display in blinking fashion with a period of about 1 sec.

L /H

- 0 - Display Message1 (if not ignored by other bit settings).
- 1 - Display Message2 (if not ignored by other bit settings).

6.4 LOAD / UNLOAD Command

Bit Byt e	7	6	5	4	3	2	1	0
0	Operation Code (1Bh)							
1	LUN			0				Immed
2	0							
3	0							
4	0						Load	
5	Control Byte						Flag	Link

Table 6-7: LOAD UNLOAD Command

The LOAD/ UNLOAD command requests the cartridge to be loaded or unloaded. Prior to performing the load or unload operation, the target shall ensure that all buffered data, filemarks, and setmarks have been transferred to the medium.

Immed

An immediate bit of zero indicates that the target shall not return status until the load or unload operation has completed. An Immed bit of one indicates that the target shall return status as soon as all buffered commands have completed execution and the command descriptor block of the LOAD UNLOAD command has been validated. If CHECK CONDITION status is returned for a LOAD UNLOAD command with an Immed bit of one, the load or unload operation shall not be performed.

Load

The load bit is enabled only for logical units having a loader option installed. If the load bit is set to one, the cartridge currently positioned in the autoloader shall be loaded and positioned to the beginning-of-tape. The autoloader is positioned from the front panel, or by issuing the POSITION LOADER command.

If the load bit is zero, the cartridge in the logical unit shall be rewound and unloaded. If an autoloader is installed, the logical unit will return the cartridge to the magazine

position it originally came from. Following successful completion of an unload operation, the logical unit shall return CHECK CONDITION status with the sense key set to NOT READY for all subsequent medium-access commands until a new volume is mounted or a load operation is successfully completed.

When operating in buffered mode, the target shall discard any unwritten buffered data after the LOAD UNLOAD command is validated if the previous command was terminated with CHECK CONDITION status and the device is unable to continue successfully writing.

6.5 LOCATE Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Bh)							
1	L U N			0		BT	0	Immed
2	0							
3	Wrap	Sector Address or Block Address MSB						
4	MSB							
5	Block Address							
6	LSB							
7	0							
8	0							
9	Control Byte						Flag	Link

Table 6-8: LOCATE Command

LOCATE command causes the target to position the logical unit to the specified block address in a specified wrap. LOCATE moves to wrap and sector addresses at twice the normal tape speed. Upon completion, the logical position shall be before the specified location. Prior to performing the locate operation, all buffered data, filemarks, will be transferred to the medium. Valid block addresses for this command can be recovered by performing the READ POSITION Command.

BT

A block address type (BT) bit of one indicates the value in the block address field shall be interpreted as follows:

Byte 3 bits 6-0 Sector Number used in high speed search;

Byte 4-6 Sequential block count from BOT.

A BT bit of zero indicates the value in the sector and block address fields shall be interpreted as a four byte physical sequential block number.

Wrap

Used only on 36 track drives having a 36 track medium loaded, and only when BT is set to one. When wrap is set to zero, drive will access blocks on wrap zero (from PBOT to PEOT), when one, drive will access blocks on wrap 1 (from PEOT to PBOT). On eighteen track media, this bit becomes the MSB of the sector address if BT is set to one. On all media, when BT is set to zero, this bit becomes the MSB of the Block Address field.

Immed

An immediate bit of zero indicates that the target shall not return status until the locate operation has completed. An Immed bit of one indicates that the target shall return status as soon as all buffered commands have completed execution and the command descriptor block of the LOCATE command has been validated. If CHECK CONDITION status is returned for a LOCATE command with an Immed bit of one, the locate operation shall not be performed.

6.6 LOG SENSE Command

Bit	7	6	5	4	3	2	1	0
Byte 0	Operation Code (4Dh)							
1	LUN			0				
2	0				PAGE CODE			
3	0							
4	0							
5	0							
6	0							
7	0							
8	Transfer Length							
9	RST	Control Byte					Flag	Link

Table 6-9 LOG SENSE Command

The LOG SENSE command provides a means for the initiator to retrieve statistical error information maintained by the drive. See **Appendix A** (p. 89) for error information.

The ECHO maintains two lists of block and track error counts. The first list is accumulated for the currently mounted cartridge. The values stored in this list are automatically added to a second list stored in nonvolatile RAM when the cartridge is unloaded. The lists may be used to determine the error counts on a particular cartridge, and if the drive is performing to manufacturer's specifications, and to determine if maintenance is required.

PC

Page Code If zero, the volatile list will be returned (List 0), if one the stored list (List 1).

RST

This bit may be used to reset List 0. If set, List 0 will be reset *after* command completes. If zero, list zero will not be cleared.

1. Total block read Count 4 bytes.
2. Total recovered read error count 3 bytes.
3. Total unrecovered read error count 3 bytes.
4. Total blocks written Count 4 bytes.
5. Total recovered write error count 3 bytes.
6. Total unrecovered write error count 3 bytes.
- 7-53. Total Track error counts for tracks 1-36 3 bytes each.
54. Total tape motion hours since last cleaning (reset to zero automatically when cleaning cycle is performed) 2 bytes.
55. Total IDRC errors.
56. ???

6.7 LOOP WRITE TO READ Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code(C1h)							
1	L U N			Comp 0				Fixed
2	MSB Transfer							
3	Length							
4	LSB							
5	0							
6	0							
7	0							
8	0							
9	Control Byte						0	Link

Table 6-10 LOOP WRITE TO READ Command

LOOP WRITE TO READ (LWR) is a diagnostic command which operates in a manner similar to a WRITE command. It causes write data to be passed through the buffer, compression hardware (if enabled), write formatter and write amplifiers, and be returned directly to the read amplifiers, read formatter, compression hardware and buffer. In this manner, it permits a test of the complete internal data path without moving or altering

media. It is operable only without tape loaded. I.e. ECHO will return CHECK CONDITION with ILLEGAL REQUEST if the drive is loaded when this command is issued.

If the ECHO successfully performs the simulated write (no errors returned from write or read formatter, compression hardware, buffer or controller), returned status will be GOOD with NO ADDITIONAL SENSE.

If errors are indicated from any internal subsystem, status will be CHECK CONDITION with HARDWARE ERROR, WRITE ERROR in the sense data. In this case, further diagnostic results can be obtained by issuing REQUEST SENSE and LOG SENSE commands.

Fixed

See the WRITE Command for definition of this bit.

Comp

If Comp is zero, the compression hardware will be disabled during the simulated write. If Comp is one, compression hardware will be enabled.

6.8 Mode Select Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (15h)							
1	LUN			PF	0			SP
2	0							
3	0							
4	Parameter List Length							
5	Control Byte						Flag	Link

Table 6-11 MODE SELECT Command

The Mode Select command is used to specify specific device parameters and options for a particular logical unit. Mode Select data consists of a header, an optional block descriptor, and, optionally, one or more pages of mode select data.

PF (Page Format)

0 = SCSI-1 type mode select data

1 = SCSI-2 type page formatted mode select data

SP (Save Parameters)

0 = Mode select data changed, but not saved in Nonvolatile memory.

1 = Mode select data changed and saved in Nonvolatile memory.

Parameter List Length

Total number of bytes of all header, block descriptor, and mode pages sent with command.



SCSI

Three types of mode select data are defined:

1. HeaderData
2. Block descriptor Data
3. Paged data

The three Mode select data types may be sent to the drive in the following order:

Header [Block Descriptor] [Paged Data] (data types contained in [] are optional)

Bit Byte	7	6	5	4	3	2	1	0
0	0							
1	0							
2	0	Buffered Mode			Speed Code			
3	Block Descriptor Length							

Table 6-12 MODE SELECT HEADER DATA

Buffered Mode

000b = Write commands return status after data is on tape.

001b = Write commands return status after data from any Initiator is in buffer.

010b = Write command return status after data from current initiator is in buffer.

011b = Special Buffer Mode (See Appendix)

Speed Code

Must be 0

Block Descriptor Length

08 = Block Descriptor Follows Header

00 = Block Descriptor Not sent

Mode Select Block Descriptor Data

Bit Byte	7	6	5	4	3	2	1	0
0	Density Code							
1	MSB							
2	Block							
3	Count							
	LSB							
4	MSB							
5	Block							
6	Length							
7								

	LSB
--	-----

Table 6-13: Block Descriptor Data

Density Code

00 = Default set in SETUP parameters (MODE SELECT ONLY)

09 = Eighteen Track (3480)

?18 = Thirty-six track ?

7Fh = No Change (MODE SELECT ONLY)

Attempts to change this field at tape positions other than BOT (or during rewind operations) will result in CHECK CONDITION and ILLEGAL REQUEST status. This field may change based on the density of the currently mounted cartridge during read and may be used with MODE SELECT to determine the density of a cartridge.

Block Count

Must be 0

Block Length

0 = Variable Mode (Block length defined by individual write commands in buffer modes 000 and 001).

1 - MAXIMUM = Fixed Mode (in Buffered Modes 000 and 001). If set, fixed bit must be used in all READ / WRITE commands. In Buffered Mode 011, this parameter will be used to set write block size for all subsequent writes (fixed bit need not be set.)

Read Write Error Recovery Page

Bit Byte	7	6	5	4	3	2	1	0
0	Page Code (01h)							
1	Page Length (0Ah)							
2	0	0	TB	0	EER	PER	DTE	DCR
3	Read Retry Count							
4	0							
5	0							
6	0							
7	0							
8	Write Retry Count							
9 - 11	0							

Table 6-14 Read Write Error Recovery Page Data (Page 01)

TB

Must be = 0. Transfer block, no data from an unrecoverable data block shall be transferred to the initiator.

PER

Must be = 0, GOOD status reported for recovered errors

EER

Must be = 1. Echo always uses the most expedient error recovery technique.

DTE

Must be = 0. Recoverable read/write errors do not cause termination of data transfer.

DCR

Must be = 0. Echo's error correction is always enabled.

Read Retry Count

The read retry count specifies the number of times that the target should attempt its recovery algorithm during a read operation before an unrecoverable error is reported. A read retry count of zero indicates that the target shall not use its recovery algorithm during read operations. This parameter is alterable from the operator control panel (OCP). The recommended and default value is 10.

Write Retry Count

The write retry count specifies the number of times that the target should attempt its recovery algorithm during a write operation before an unrecoverable error is reported. A write retry count of zero indicates that the target shall not use its recovery algorithm during write operations. This parameter is alterable from the Operator Control Panel (OCP). The recommended and default value is 10.

Control Mode Parameters Page 0Ah

Bit Byte	7	6	5	4	3	2	1	0
0	PS	0	0	0	1	0	1	0
1	Page Length							
2	0							RLEC
3	Que Algorithm (0)						Qerr	DisQ
4	EECA	0				RAEN P	UAENP	EAENP
5	0							
6	MSB Asynchronous Event							
7	Notification Holdoff LSB							

Table 6-15 Control Mode Parameters Page (Page 0A)

PS

Page Save must be 0

RLEC



SCSI

Report Log Exception Condition may be set to zero or one. If set to one, the target will report Log overflow conditions, zero indicated that log overflow conditions will not be reported. Defaults to 0.

Que Algorithm, Qerr

Qued commands are not supported by ECHO, these fields must be 0.

DisQ

Disable Queing Must be 1

EECA

An enable extended contingent allegiance (EECA) bit of one specifies that extended contingent allegiance is enabled. An EECA bit of zero specifies that extended contingent allegiance is disabled.

Asynchronous Event Notification Protocol Control Bits

The RAENP, UAAENP, and EAENP bits enable specific events to be reported via the asynchronous event notification protocol. When all three bits are zero, the target shall not create asynchronous event notifications. AEN is not supported by Echo, all must be zero.

Device Configuration Page (10h)

Bit	7	6	5	4	3	2	1	0
Byte								
0	Page Code (10h)							
1	Page Length (0Eh)							
2 - 3	0							
4	Write Buffer Full Ratio (0)							
5	Read Buffer Empty Ratio (0)							
6	MSB Write Delay							
7	Time LSB							
8	DBR(1)	BIS(1)	0	0	SOCF(00)		RBO(1)	REW0
9	Gap Size (0)							
10	EOD Def.(000)			EEG	SEW(1)	0		
11	MSB							
12	Buffer Size At Early Warning (0)							
13	LSB							
14	Select Data Compression Algorithm							

15	0
----	---

Table 6-16 Device Configuration Page Data (Page 10)

Write Buffer Full Ratio

This value is ignored by the Echo.

Read Buffer Empty Ratio

This value is ignored by the Echo.

Write Delay Time

The write delay time indicates the maximum time, in 100 millisecond increments, that the target should wait before any buffered data that is to be written, is forced to the medium after the last buffered WRITE command that did not cause the buffer to exceed the buffer full ratio. A value of zero indicates that the target shall never force buffered data to the medium under these conditions. Defaults to 50h (eight seconds).

DBR

Set to one, indicating that Echo supports data buffer recovery using the RECOVER BUFFERED DATA command. Not alterable by MODE SELECT command.

BIS

Set to one indicating that the ECHO has format specific block ID data recorded on the medium. Not alterable in MODE SELECT.

SOCF Field

A stop on consecutive filemarks (SOCF) indicates after how many filemarks shall the ECHO write all buffered data to the medium. If the SOCF is set to 00b the Echo will buffer all filemarks; synchronize on none. If the SOCF is set to 01b the Echo shall write all buffered data after receiving a write filemark command; synchronize on one. If the SOCF is set to 10b the Echo will write all buffered data after receiving 2 consecutive filemarks; synchronize on two consecutive filemarks. A SOCF of 11b is not supported.

RBO

Must be set to one. Indicates that data blocks shall be returned from the target's buffer on a RECOVERED BUFFERED DATA command in LIFO order (last-in-first-out) from which they were written to the buffer.

REW

Must be set to zero indicating that the ECHO will not report the early-warning condition for read operations and it shall report early-warning before any medium-defined early-warning position during write operations.

EOD Format Field

Must be set to 000b indicating that the ECHO supports only the default EOD definition

EEG

An enable EOD generation (EEG) bit set to one indicates that the logical unit shall generate the appropriate EOD area, as determined by the EOD defined field. A value of zero indicates that EOD generation is disabled. Set to one on 36 track drives loaded with 36 track media, zero in other cases.

SEW

Must be set to one indicating that the ECHO will Synchronize at Early Warning. Meaning that arrival at Early Warning will force the target to write all buffered data to the medium when the early warning point is reached. Succeeding writes will return CHECK CONDITION status and EOM set in the sense data.

Buffer Size at Early Warning

The buffer size at early-warning field indicates the value, in bytes, to which the target shall reduce its logical buffer size when writing. ECHO disables buffering when Early Warning is reached. Must be 0.

Select Data Compression Algorithm

0 = No data compression used

1 = Enable ICRC Compression

This field corresponds to the "COMP" setting in the OCP configuration. Setting this byte to one will cause SCSI disconnect during the data out phase if it is determined that the data cannot be compressed by the algorithm. ECHO will then arbitrate and reconnect and send a RESTORE DATA POINTERS message. If the message is received, ECHO will enter DATA OUT, expecting the entire block to be sent again and write it to the tape uncompressed. The setting of this field is not changed by this action, and data will be tested for actual compression on a block by block basis.

If this field is set to two, compressed tape will be written, regardless of whether the "compressed" data is actually larger than the original "uncompressed" data. This *may* cause tapes to be written which cannot be read on other vendor's drives.

This field may be overridden by the drive when reading. It may be used in MODE SENSE to determine current operating mode in the case of auto compression selection on reads.

18/36 track drives fill this field according to the above rules and the current density selection.

VOLID Page 21h

The VOLID page is used to support the VOLID mark on 3490E tapes. This mark may be generated using data contained on this page through a special condition of the WRITE FILEMARKS command. If read using MODE SENSE, this page will indicate the VOLID data contained on the currently mounted cartridge.

Bit Byte	7	6	5	4	3	2	1	0
0	Page Code (21h)							
1	Page Length(08h)							
2	0					Err	ASCI I	Vali d
3 - 8	VOLID							
9	Accessibility Byte							

Table 6-17 VOLID Page 21h

Valid

If zero, tape does not contain VALID mark, recovered VALID data is erroneous, or do not write VALID mark when initializing tape with WRITE FILEMARKS Command. Always zero for 18 track tapes. Zero by default.

ASCII

A one indicates the page and/or VALID mark is encoded using ASCII coding, a zero indicates the VALID is encoded using EBCDIC coding.

Err

A one indicates that the VALID exists on the tape, but cannot be read correctly. This bit may be one only when the page is returned as a result of MODE SENSE.

VALID

The six byte ASCII representation of the VALID mark. A one to six character alphanumeric field left justified with blanks (ASCII spaces).

Accessibility Byte

Represents the value of the VOLUME ACCESSIBILITY byte (byte 11 of the ANSI VOL1 Label).

If ASCII bit is zero, this byte will/must contain zero. If ASCII bit is one, this byte may contain an ASCII space (20h) or ASCII uppercase letters A-Z. (See ANSI X3.27-1987 or ISO 1001-1979) for more information).

6.9 MODE SENSE Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Ah)							
1	LUN			0	DBD	0		
2	PC		Page Code					
3	0							
4	Allocation Length							
5	Control Byte						Flag	Link

Table 6-18: MODE SENSE Command

The MODE SENSE command provides a means for a target to report parameters to the initiator. It is a complementary command to the MODE SELECT(6) command.

DBD

A disable block descriptors (DBD) bit of zero indicates that the target may return zero or more block descriptors in the returned MODE SENSE data at the target's discretion. A DBD bit of one specifies that the target shall not return any block descriptors in the returned MODE SENSE data.

PC



SCSI

The page control (PC) field defines the type of mode parameter values to be returned in the mode pages. The page control field is defined in below.

00b	Current Values
01b	Changeable Values
10b	Default Values
11b	Saved Values

The page code specifies which mode page(s) to return. Mode page code usage is the same as that defined under the MODE SELECT command.

Current Values are those currently in use by the system which are stored in volatile RAM. These may be identical to the SAVED values if no changes have occurred since power-on.

Changeable Values (01b) returns a mask of selected pages with changeable fields set to one, and non-changeable fields set to zero.

Default Values (10b) returns pages stored in a section of PROM which is not alterable by MODE SELECT or front panel operations. These represent the most basic default values, and are used in case of FROM checksum error upon power-on.

Saved Values (11b) returns pages stored in a user alterable portion of the system FROM. These may be altered by the MODE SELECT command, and from the front panel. These values are loaded to the operational section of RAM upon power-on.

6.10 Prevent / Allow Medium Removal Command

Bit Byte	7	6	5	4	3	2	1	0					
0	Operation Code (1Eh)												
1	LUN												
2	0												
3	0												
4	0							Prev					
5	Control Byte						Flag	Link					

Table 6-19: PREVENT ALLOW MEDIUM REMOVAL Command

The PREVENT ALLOW MEDIUM REMOVAL command requests that the target drive enable or disable the front panel UNLOAD switch. This command is useful in a computer room setting to assure that an operator does not inadvertently unload a cartridge in use by the system.

If, after this command is issued with the PREV bit set to one, an operator attempts to set drive OFFLINE from the OCP, the LCD will display "CARTRIDGE LOCKED"

Prev

- 0 - Enable front panel OFFLINE switch.
- 1 - Disable front panel switch OFFLINE switch.

6.11 READ Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (08h)							
1	LUN			0			SILI	Fixed
2	MSB							
3	Transfer Length							
4	LSB							
5	Control Byte						Flag	Link

Table 6-20 READ Command

Read Operation in Buffer Modes 0, 1 & 2

The READ command requests that the target transfer one or more block(s) of data to the initiator beginning with the next block on the logical unit.

Fixed

The fixed bit specifies whether fixed-length or variable-length blocks are to be transferred. If the fixed bit is one, the transfer length specifies the number of fixed-length blocks to be transferred, using the current block length reported in the mode parameters block descriptor (see MODE SELECT). If the fixed bit is zero, a variable-length block is requested with the transfer length specifying the maximum number of bytes allocated for the returned data. A successful READ command with a fixed bit of one shall transfer the requested transfer length times the current block length in bytes to the initiator. A successful READ command with a fixed bit of zero shall transfer the requested transfer length in bytes to the initiator. Upon completion, the logical position shall be after the last block transferred (end-of-partition side).

SILI

If the suppress incorrect length indicator (SILI) bit is one and the fixed bit is zero, the target shall:

- 1) report CHECK CONDITION status for an incorrect length condition only if the overlength condition exists and the block length field in the mode parameter block descriptor is nonzero.
- 2) not report CHECK CONDITION status if the only error is the underlength condition, or if the only error is the overlength condition and the block length field of the mode parameters block descriptor is zero.

If the SILI bit is one and the fixed bit is one, the target shall terminate the command with CHECK CONDITION status and the sense key shall be set to ILLEGAL REQUEST with an additional sense code of INVALID FIELD IN CDB.

If the SILI bit is zero and an incorrect length block is read, CHECK CONDITION status shall be returned and the ILI and VALID bits shall be set to one in the sense data. Upon termination, the logical position shall be after the incorrect length block (end-of-partition side). If the fixed bit is one, the information field shall be set to the requested transfer length minus the actual number of blocks read (not including the incorrect length block). If the fixed bit is zero, the information field shall be set to the requested transfer length minus the actual block length.

If a filemark is read, the command will return CHECK CONDITION status. FILEMARK and VALID bits are set in the sense data and the tape is positioned after the filemark. In variable block mode, the INFORMATION BYTES are set to the TRANSFER LENGTH. In fixed block mode, INFORMATION BYTES are set to the TRANSFER LENGTH minus the actual number of blocks read (not including the filemark).

If a read error is encountered, READ will respond according to the state of the TB, PER and DTE bits found on MODE SELECT page 01h.

If an unrecoverable data block is reached, READ will return CHECK CONDITION with MEDIUM ERROR and READ RETRIES EXHAUSTED.

If unrecorded tape is reached as a result of READ, it will terminate with CHECK CONDITION with BLANK CHECK in the sense.

If EOD (36 trk) is encountered, CHECK CONDITION status is returned. BLANK CHECK, END OF DATA DETECTED and the Valid bit is set in the sense key and the tape is positioned after the last valid block. INFORMATION BYTES are calculated as in the case of a filemark.

If PEOT (PBOT on 36 track wrap 1) is encountered, CHECK CONDITION status with MEDIUM ERROR, END-OF-MEDIUM sense key.

Reading past EOT (early warning) does not by itself generate CHECK CONDITION unless one of the above conditions is true.

READ operation in Buffer Mode 03h (Special Buffer Mode)

See Appendix A for a description of Special Buffer Mode.



SCSI

6.12 READ BLOCK LIMITS Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (05h)							
1	LUN			Reserved(0)				
2	0							
3	0							
4	0							
5	Control Byte						Flag	Link

Table 6-21: READ BLOCK LIMITS Command

The READ BLOCK LIMITS command requests that the logical unit's block length limits capability be returned. The READ BLOCK LIMITS data shown in Table 6-26 shall be returned during the DATA IN phase of the command.

Bit Byte	7	6	5	4	3	2	1	0
0	0							
1	MSBMaximum							
2	Block Length							
3	Limit							
	LSB							
4	MSBMinimum							
5	Block LengthLimit							
	LSB							

Table 6-22: READ BLOCK LIMITS Data

The default values for these datum are:

Maximum Block Length Limit

36 track drives in 36 track mode = 40,000h bytes (256K)

18 track drives or 36 track drives in 18 track mode = 40,000 bytes (256K)

Minimum Block Length Limit

1 byte

6.13 READ BUFFER Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (3Ch)							
1	L U N			0				1
2								Comp
3	MSB							
4	Buffer Offset							
5	LSB							
6	MSB							
7	Allocation Length							
8	LSB							
9	Control Byte						Flag	Link

Table 6-23: READ BUFFER Command

The READ BUFFER command is used in conjunction with the WRITE BUFFER command as a diagnostic function for testing buffer memory, compression hardware and SCSI bus integrity. This command will not alter the medium.

Manipulation of the COMP bit allows data written in compressed form during WRITE BUFFER to be read back with compression hardware disabled, thereby allowing readout of the compressed form of the data.

Comp

0 = IDRC Compression hardware Disabled

1 = IDRC Compression hardware Enabled

Buffer Offset

Must be 0

Allocation Length

Length of data to be returned in bytes.

6.14 READ POSITION Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (34h)							
1	L U N			0				BT
2	0							
3	0							
4	0							
5	0							
6	0							
7	0							
8	0							
9	Control Byte						Flag	Link

Table 6-24: READ POSITION Command

The READ POSITION command reports the current position of the logical unit and any data blocks in the buffer. No medium movement shall occur as a result of the command. The 20 bytes of READ POSITION data shown in Table 629 shall be returned during the DATA IN phase of the command.

BT Block Address Type

0 = Positions returned denote sequential block counts on tape.

1 = Positions returned denote positions referenced to a sector address.

With BT set to one, READ POSITION returns location formats compatible to the sector addressing format of the high speed search mode of the LOCATE command.

Bit Byte	7	6	5	4	3	2	1	0
0	BOP	EOP	0			BPU	0	
1 - 3	0							
4 - 7	First Block Location							
8 - 11	Last Block Location							
12	0							
13 - 15	Number of Blocks In Buffer							
16 - 19	Number of Bytes In Buffer							

Table 6-25 Read Position Data Format

BOP

Beginning of Partition. If BT bit set to one, this is interpreted as BOT (Beginning of Tape). If BT set to zero, tape position is Beginning of Partition.

EOP

End Of Partition. If BT bit set to one, this is interpreted as EOT (End Of Tape) meaning that the current position of the tape is between the physical end of tape and early warning marker. In 36 track modes this indicates that actual physical position is nearing puck end of tape AFTER it has returned from hub end. If BT zero, tape is at end of logical partition.

BPU

Block Position Unknown. If set, block and byte data returned may be invalid.

First Block Location

Block address of the next buffered block (assuming forward tape motion).

Last Block Location

Block address of the next block on tape (assuming forward tape motion).

Number of Blocks In Buffer

Number of blocks which separate buffered logical position from actual tape location. If zero, tape and buffer are synchronized.

Number of Bytes In Buffer

Number of bytes remaining to be written to tape.

6.15 READ REVERSE Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (0Fh)							
1	LUN			0			SILI	Fixed
2	MSB							
3	Transfer Length							
4	LSB							
5	Control Byte						Flag	Link

Table 6-26: READ REVERSE Command

The READ REVERSE command requests that the target transfer one or more block(s) of data to the initiator beginning at the current position on the logical unit. The execution of this command is similar to the READ command except that medium motion is in the reverse direction. All block(s), and the byte(s) within the block(s), are transferred in the reverse order. The order of bits within each byte shall not be changed. Data may be transferred only from uncompressed data blocks.

Upon completion of a READ REVERSE command, the logical position shall be before the last block transferred (beginning-of-partition side).

Refer to the READ command (6.xx) for a description of the fixed bit, the SILI bit, the transfer length field, and any associated error conditions. Filemarks, setmarks, incorrect length blocks, and unrecovered read errors are handled the same as in the READ command, except that upon termination the logical position shall be *before* the filemark, setmark, incorrect length block, or unrecovered block (beginning-of-partition side).

If the logical unit encounters beginning-of-partition during a READ REVERSE command, CHECK CONDITION status shall be returned and the EOM and valid bits shall be set to one in the sense data. The sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate. If the fixed bit is one, the information field shall be set to the requested transfer length minus the actual number of blocks transferred. If the fixed bit is zero, the information field shall be set to the requested transfer length.

If attempted on a compressed format tape, READ REVERSE will return CHECK CONDITION with MEDIUM ERROR in the sense. The tape position will not be changed.

6.16 RECEIVE DIAGNOSTIC RESULTS Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Ch)							
1	LUN			0				
2	0							
3	MSB							
4	Allocation Length (0Ah)							
	LSB							
5	Control Byte						Flag	Link

Table 6-27: RECEIVE DIAGNOSTIC RESULTS Command

The RECEIVE DIAGNOSTIC RESULTS command requests analysis data be sent to the initiator after completion of a SEND DIAGNOSTIC command.

The format of the data returned is shown below.

Bit Byte	7	6	5	4	3	2	1	0
0	Routine in Error (00h, 50h - 57h)							
1	Pass Count							
2	0							
3	0							
4	MSB First Symptom							
5	Code LSB							
6	MSB Second Symptom							
7	Code LSB							
8	MSB Third Symptom							
9	Code LSB							

Table 6-28: RECEIVE DIAGNOSTIC RESULTS data format

Routine In Error

Test routine in which error was discovered. If 00h, no error discovered

Pass Count

Number of test pass in which error was discovered

Symptom Codes

6.17 RECOVER BUFFERED DATA Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (14h)							
1	LUN			0			SILI	Fixed
2	MSB							
3	Transfer Length							
4	LSB							
5	Control Byte						Flag	Link

Table 6-29: RECOVER BUFFERED DATA Command

The RECOVER BUFFERED DATA command is used to recover data that has been transferred to the target's buffer but has not been successfully written to the medium. It is normally used to recover from error or exception conditions that make it impossible to write the buffered data to the medium. One or more RECOVER BUFFERED DATA commands may be required to recover all unwritten buffered data.

The execution of this command is similar to the READ command except that the data is transferred from the target's buffer instead of the medium. Data from the buffer will be returned in last-in-first-out (LIFO) order.

Refer to the READ command (6.x.x) for a description of the fixed bit, the SILI bit, the transfer length field, and any associated error conditions. If the fixed bit is zero, no more than the requested transfer length shall be transferred to the initiator. If the requested transfer length is smaller than the actual length of the logical block to be recovered, only the requested transfer length shall be transferred to the initiator and the remaining data for the current logical block shall be discarded.

If a buffered filemark is encountered during a RECOVER BUFFERED DATA command, CHECK CONDITION status shall be returned, the sense key shall be set to NO SENSE, and the filemark and valid bits shall be set to one in the sense data. Upon termination, the logical position shall be after the filemark.

If the fixed bit is one, the information field shall be set to the requested transfer length minus the actual number of blocks transferred (not including the filemark). If the fixed bit is zero, the information field shall be set to the requested transfer length.

If an attempt is made to recover more logical blocks of data than are contained in the target's buffer, CHECK CONDITION status shall be returned, the sense key shall be set to NO SENSE, and the EOM and valid bits shall be set to one in the sense data. If the fixed bit is one, the information field shall be set to the requested transfer length minus the actual number of blocks transferred. If the fixed bit is zero, the information field shall be set to the requested transfer length.

6.18 RELEASE UNIT Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (17h)							
1	LUN			3rdP	3rd Party ID			0
2	0							
3	0							
4	0							
5	Control Byte						Flag	Link

Table 6-30: RELEASE UNIT Command

The RESERVE UNIT and RELEASE UNIT commands provide the basic mechanism for contention resolution in multiple-initiator systems. The RELEASE UNIT command is used to release previously reserved logical units for the requesting initiator, or if it is a third-party release, to another specified SCSI device. If a valid reservation exists, the target shall release the reservation and return GOOD status. A reservation may only be released by the initiator that made it. It is not an error to attempt to release a reservation that is not currently valid or is held by another initiator. In this case, the target shall return GOOD status without altering any other reservation.

Third-party release allows an initiator to release a logical unit that was previously reserved using a third-party reservation (see RESERVE UNIT).

3rdP

0 - Single Party release, 3rd PARTY ID ignored

1 - Third party release of reservation made with 3rd Party ID

3rd Party ID

SCSI ID of 3rd Party denoted by RESERVE UNIT command which originally reserved the device.

6.19 REQUEST SENSE Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (03h)							
1	LUN			0				
2	0							
3	0							
4	Allocation Length							
5	Control Byte						Flag	Link

Table 6-31 REQUEST SENSE Command

The REQUEST SENSE command requests that the target transfer sense data to the initiator. REQUEST SENSE is the primary means of returning situational status and error data from the drive. It should be issued whenever CHECK CONDITION status is returned from the drive.

Allocation Length

Maximum length of sense data to return during DATA IN phase. A maximum of 32 bytes are supported by the ECHO.

Sense data is a string of up to XX bytes formatted according to the table on the following page. If fewer bytes are returned, than specified in the ALLOCATION LENGTH parameter, initiators can assume that the byte omitted would be invalid or zero.

Bit Byte	7	6	5	4	3	2	1	0
0	VALID	Error Code (70h or 71h)						
1	Segment Number							
2	FMK	EOM	ILI	0	Sense Key			
3	MSB Information Bytes							
6	LSB							
7	Additional Sense Length (n-7)							
8 - 9								
10	Command Specific Bytes							
11								
12	Additional Sense Code (ASC)							
13	Additional Sense Code Qualifer (ASCQ)							
14	Field Replaceable Unit Code							
15	SKSV Bytes	Sense Key Specific						

Table 6-32: Standard Sense Data Format

Valid

0 - Sense information bytes is undetermined or invalid

1 - Sense information bytes is valid

Error Code

70h Current Error. Sense data reflects errors which occurred on last issued command.

71h Deferred Error. Sense data reflects errors which occurred on a previous command and not detected due to buffering of commands or data

FMK

If set, a filemark was detected.

EOM

If set the end of medium early warning marker has been reached on WRITE, or end of medium condition has been reached during READ forward, or BOT encountered during READ REVERSE.

ILI

Illegal Length Indicator. Requested block length did not match the logical block length of the data on the medium, and the SILI bit was not set in the CDB.

Sense Key

- 0 NO SENSE. No specific sense data to be reported for logical unit.
- 1 RECOVERED ERROR. Command completed successfully only through some remedial action taken by the drive.
- 2 NOT READY. Drive not ready for tape motion commands. (off line, or cartridge missing).
- 3 MEDIUM ERROR. Command terminated in error due to flawed media, or unreadable data blocks. Retries exhausted.
- 4 HARDWARE ERROR. Controller detected failure of subsystem, or parity error.
- 5 ILLEGAL REQUEST. Illegal parameter contained in CDB (see sense bytes 15 & 16), or in additional data supplied with some commands.
- 6 UNIT ATTENTION. Media changed or drive reset from front panel.
- 7 DATA PROTECT. Write attempted to file protected drive or cartridge.
- 8 BLANK CHECK. Read of unrecorded media.
- D VOLUME OVERFLOW. Indicates that the capacity of the tape has been exceeded and that data may be retained in the buffer which cannot be written to tape. A RECOVER BUFFERED DATA command may be issued to recover the unwritten data.

Information Bytes

The interpretation of these bytes is variable depending on the nature of the error and the sense key. For most commands the contents represent the difference (residue) of the requested length minus the actual length in either bytes or blocks, as determined by the command. When a MEDIUM ERROR is detected writing in buffer modes 1h and 2h these bytes represent the number of blocks and filemarks remaining in the buffer if in the FIXED mode. Or, the number of bytes and filemarks remaining in the buffer if operating in the variable mode.

Additional Sense Length

This byte denotes the number of additional sense bytes to follow.

Additional Sense Code (ASC)

The additional sense code (ASC) field indicates further information related to the error or exception condition reported in the sense key field. If the drive does not have further information related to the error or exception condition, the additional sense code is set to NO ADDITIONAL SENSE INFORMATION.

Additional Sense Code Qualifier (ASCQ)

The additional sense code qualifier (ASCQ) indicates detailed information related to the additional sense code. If the target does not have detailed information related to the error or exception condition, the additional sense code qualifier is set to zero.



SCSI

SenseKey	ASC	ASCQ	Description
00h	00h	00h	NO ADDITIONAL SENSE INFORMATION
00h	00h	01h	FILEMARK DETECTED
00h	00h	02h	LEOT DETECTED ON READ
00h	00h	04h	BEGINNING-OF-MEDIUM DETECTED
01h	17h	01h	RECOVERED DATA WITH RETRIES
01h	18h	00h	RECOVERED DATA WITH ERROR CORRECTION APPLIED
02h	04h	00h	LOGICAL UNIT NOT READY, CAUSE NOT REPORTABLE
02h	04h	01h	LOGICAL UNIT IS IN PROCESS OF BECOMING READY
02h	04h	02h	LOGICAL UNIT NOT READY, INITIALIZING COMMAND REQUIRED
02h	3Ah	00h	MEDIUM NOT PRESENT
02h	3Eh	00h	LOGICAL UNIT HAS NOT SELF-CONFIGURED YET
03h	0Ch	00h	WRITE ERROR
03h	11h	00h	UNRECOVERED READ ERROR
03h	11h	01h	READ RETRIES EXHAUSTED
03h	11h	02h	ERROR TOO LONG TO CORRECT
03h	11h	08h	INCOMPLETE BLOCK READ
03h	14h	04h	BLOCK SEQUENCE ERROR
03h	15h	00h	RANDOM POSITIONING ERROR
03h	30h	00h	INCOMPATIBLE MEDIUM INSTALLED
03h	30h	01h	CANNOT READ MEDIUM - UNKNOWN FORMAT
03h	30h	02h	CANNOT READ MEDIUM - INCOMPATIBLE FORMAT
03h	30h	03h	CLEANING CARTRIDGE INSTALLED
03h	33h	00h	TAPE LENGTH ERROR
03h	3Bh	00h	SEQUENTIAL POSITIONING ERROR
03h	3Bh	08h	REPOSITION ERROR
04h	03h	01h	NO WRITE CURRENT
04h	03h	02h	EXCESSIVE WRITE ERRORS
04h	08h	00h	LOGICAL UNIT COMMUNICATION FAILURE
04h	08h	01h	LOGICAL UNIT COMMUNICATION TIME-OUT
04h	11h	0Ah	MISCORRECTED ERROR
04h	15h	01h	MECHANICAL POSITIONING ERROR
04h	15h	02h	POSITIONING ERROR DETECTED BY READ OF MEDIUM
04h	1Bh	00h	SYNCHRONOUS DATA TRANSFER ERROR
04h	40h	NNh	DIAGNOSTIC FAILURE ON COMPONENT NN (80H-FFH)
04h	44h	00h	INTERNAL TARGET FAILURE
04h	45h	00h	SELECT OR RESELECT FAILURE
04h	4Ch	00h	LOGICAL UNIT FAILED SELF-CONFIGURATION
04h	51h	00h	ERASE FAILURE
04h	52h	00h	CARTRIDGE FAULT
04h	53h	00h	MEDIA LOAD OR EJECT FAILED
04h	53h	01h	UNLOAD TAPE FAILURE
05h	1Ah	00h	PARAMETER LIST LENGTH ERROR
05h	20h	00h	INVALID COMMAND OPERATION CODE
05h	21h	00h	LOGICAL BLOCK ADDRESS OUT OF RANGE

Table 6-33a Sense Codes, Additional Sense Codes & Additional Sense Code Qualifiers (1 of 2)



SCSI

Sense Key	ASC	ASCQ	Description
05h	24h	00h	INVALID FIELD IN CDB
05h	25h	00h	LOGICAL UNIT NOT SUPPORTED
05h	26h	00h	INVALID FIELD IN PARAMETER LIST
05h	26h	01h	PARAMETER NOT SUPPORTED
05h	26h	02h	PARAMETER VALUE INVALID
05h	3Dh	00h	INVALID BITS IN IDENTIFY MESSAGE
06h	0Ah	00h	ERROR LOG OVERFLOW
06h	28h	00h	NOT RDY TO RDY TRANSITION, MEDIUM MAY HAVE CHANGED
06h	29h	00h	POWER ON, RESET, OR BUS DEVICE RESET OCCURRED
06h	2Ah	00h	PARAMETERS CHANGED
06h	2Ah	01h	MODE PARAMETERS CHANGED
06h	37h	00h	ROUNDED PARAMETER
06h	5Ah	01h	OPERATOR MEDIUM REMOVAL REQUEST
06h	5Ah	02h	OPERATOR SELECTED WRITE PROTECT
06h	5Ah	03h	OPERATOR SELECTED WRITE PERMIT
06h	5Bh	00h	LOG EXCEPTION
06h	5Bh	02h	LOG COUNTER AT MAXIMUM
07h	27h	00h	WRITE PROTECTED
08h	00h	05h	END-OF-DATA DETECTED
08h	14h	01h	RECORD NOT FOUND
08h	14h	02h	FILEMARK NOT FOUND
0Bh	00h	06h	I/O PROCESS TERMINATED
0Bh	45h	00h	SELECT OR RESELECT FAILURE
0Bh	47h	00h	SCSI PARITY ERROR
0Bh	48h	00h	INITIATOR DETECTED ERROR MESSAGE RECEIVED
0Bh	49h	00h	INVALID MESSAGE ERROR
0Bh	4Ah	00h	COMMAND PHASE ERROR
0Bh	4Bh	00h	DATA PHASE ERROR
0Dh	00h	02h	END-OF-MEDIUM DETECTED ON WRITE

Table 6-33b Additional Sense Codes & Additional Sense Code Qualifiers (2 of 2)

6.21 RESERVE UNIT Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (16h)							
1	LUN			3rdP	3rd Party ID			0
2	0							
3	0							
4	0							
5	Control Byte						Flag	Link

Table 6-34: RESERVE UNIT Command

The RESERVE UNIT and RELEASE UNIT commands provide the basic mechanism for contention resolution in multiple-initiator systems.

The RESERVE UNIT command is used to reserve logical units for the exclusive use of the requesting initiator, or if it is a third-party reservation, to another specified SCSI device. This command requests that the entire logical unit be reserved for the exclusive use of the initiator until the reservation is superseded by another valid RESERVE UNIT command from the initiator that made the reservation or until released by a RELEASE UNIT command from the same initiator that made the reservation, by a BUS DEVICE RESET message from any initiator, by a hard reset condition, or by a power on cycle. The reservation shall not be granted if the logical unit is reserved by another initiator. It shall be permissible for an initiator to reserve a logical unit that is currently reserved by that initiator. If the logical unit is reserved for another initiator, the target shall return RESERVATION CONFLICT status.

See RELEASE UNIT (Section 6.19) for description of CDB fields.

6.22 REWIND Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (01h)							
1	LUN			0				Imm
2	0							
3	0							
4	0							
5	Control Byte						Flag	Link

Table 6-35: REWIND Command

The REWIND command causes the logical unit to be positioned to the beginning-of-partition in the current partition. Prior to performing the rewind operation, the target shall ensure that all buffered data and filemarks have been transferred to the tape.

Imm

An immediate (Imm) bit of zero indicates that the target shall not return status until the rewind operation has completed.

An Imm bit of one indicates that the target shall return status as soon as all buffered commands have completed execution and the command descriptor block of the REWIND command has been validated. If CHECK CONDITION status is returned for a REWIND command with an Immed bit of one, the rewind operation shall not be performed.

When operating in buffered modes 1h, 2h, or 3h (see MODE SELECT), the target shall discard any unwritten buffered data after the REWIND command is validated if the previous command was terminated with CHECK CONDITION status and the device is unable to continue successfully writing.

6.23 SEND DIAGNOSTIC Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Dh)							
1	LUN			PF	0	SIfTst	DOFL	UOFL
2	0							
3	MSB Parameter List Length							
4	LSB							
5	Control Byte						Flag	Link

Table 6-36: SEND DIAGNOSTIC Command

The SEND DIAGNOSTIC command requests the target to perform diagnostic operations on itself, on the logical unit, or on both. Except when the self-test bit is one, this command is usually followed by a RECEIVE DIAGNOSTIC RESULTS command.

PF

A page format (PF) bit of one specifies that the SEND DIAGNOSTIC parameters conform to SCSI-II page structure.

A PF bit of zero indicates that the SEND DIAGNOSTIC parameters are as specified in SCSI-1 (i.e., all parameters are vendor specific).

SIfTst

A self-test (SIfTst) bit of one directs the target to complete its default self-test. If the self-test successfully passes, the command shall be terminated with GOOD status; otherwise, the command shall be terminated with CHECK CONDITION status and the sense key shall be set to HARDWARE ERROR.

A self-test bit of zero requests that the target perform the diagnostic operation specified in the parameter list. The diagnostic operation might or might not require a target to return data which contains diagnostic results. If the return of data is not

required, the return of GOOD status indicates successful completion of the diagnostic operation. If the return of data is required the target shall either:

- 1) perform the requested diagnostic operation, prepare the data to be returned and indicate completion by returning GOOD status. The initiator issues a RECEIVE DIAGNOSTIC RESULTS command to recover the data.
- 2) accept the parameter list and if no errors are detected in the parameter list return GOOD status. The requested diagnostic operation and the preparation of the data to be returned is performed upon receipt of a RECEIVE DIAGNOSTIC RESULTS command.

DOFL / UFOL

The device off-line (DevOfL) and unit off-line (UnitOfL) bits are generally set by operating system software, while the parameter list is prepared by diagnostic application software. These bits grant permission to perform vendor-specific diagnostic operations on the target which may be visible to attached initiators. Thus, by preventing operations that are not enabled by these bits, the target assists the operating system in protecting its resources.

UFOL

A UFOL bit of one grants permission to the target to perform diagnostic operations that may affect the user accessible medium on the logical unit, e.g., write operations to the user accessible medium, or repositioning of the medium on sequential access devices. A UOfL bit of zero prohibits any diagnostic operations that may be detected by subsequent I/O processes.

DOFL

A DOFL bit of one grants permission to the target to perform diagnostic operations that may affect all the logical units on a target, e.g., alteration of reservations, log parameters, or sense data. A DevOfL bit of zero prohibits diagnostic operations that may be detected by subsequent I/O processes.

Parameter List Length

The parameter list length field specifies the length in bytes of the parameter list that shall be transferred from the initiator to the target. A parameter list length of zero indicates that no data shall be transferred. This condition shall not be considered as an error. If the specified parameter list length results in the truncation of one or more pages (PF bit set to one) the target shall return CHECK CONDITION status with a sense key of ILLEGAL REQUEST and an additional sense code of INVALID FIELD IN CDB.

6.24 SPACE Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (11h)							
1	LUN			0		Code		
2	0							
3	0							
4	0							
5	Control Byte						Flag	Link

Table 6-37 SPACE Command

The SPACE command provides a variety of positioning functions that are determined by the code and count. Both forward and reverse positioning are provided. If an initiator requests an unsupported function, the command shall be terminated with CHECK CONDITION status and the sense key shall be set to ILLEGAL REQUEST. The code field is defined in below:

Code

000b	Space Blocks
001	Space Filemarks
010	Space Sequential Filemarks
011	Space to End of Data

Count

When spacing over blocks or filemarks, the count field specifies the number of blocks, or filemarks to be spaced over in the current partition. A positive value N in the count field shall cause forward positioning (toward end-of- partition) over N blocks or filemarks ending on the end-of-partition side of the last block or filemark. A zero value in the count field shall cause no change of logical position. A negative value -N (two's complement notation) in the count field shall cause reverse positioning (toward beginning-of- partition) over N blocks, filemarks, or setmarks ending on the beginning-of-partition side of the last block or filemark.

If a filemark is encountered while spacing over blocks, the command shall be terminated. The logical position shall be on the end-of-partition side of the filemark if movement was in the forward direction and on the beginning-of-partition side of the filemark if movement was in the reverse direction. CHECK CONDITION status shall be returned to the initiator, the sense key shall be set to NO SENSE, and the filemark and valid bits shall be set to one in the sense data. The information field shall be set to the requested count minus the actual number of blocks spaced over (not including the filemark).

6.25 SYNCHRONIZE Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (C3h)							
1	L U N							Flus h
2	0							
3	0							
4	0							
5	0							
6	0							
7	0							
8	0							
9	Control Byte						Flag	Link

Table 6-38 SYNCHRONIZE Command

The SYNCHRONIZE command is used to manipulate the operation of the buffer. In Buffer Modes 0, 1 and 2 it forces all unwritten, buffered data and filemarks to be written to the media. In these modes, it may only be used following a series of WRITE or WRITE FILEMARKS commands. If Buffer Mode 3 (Special Buffer Mode) is enabled it performs the same function following WRITE and WRITE FILEMARKS commands. This may cause a block shorter than the size specified in the MODE SELECT Block Descriptor to be written. This shall not be considered an error. Status shall not be returned until all data is written, or an unrecoverable error occurs. The FLUSH bit is ignored in these buffer modes.

In Buffer Mode 3 the command also has a read function. The FLUSH bit allows the unread data from a block which has been partially read from the buffer to be ignored, causing subsequent READ commands to return data from the succeeding block.

Other commands which cause the same action as SYNCHRONIZE:

LOCATE

REWIND

SPACE

READ

READ REVERSE

WRITE FILEMARKS (depending on SOCF setting in mode select command)

6.25 TEST UNIT READY Command

Bit Byte	7	6	5	4	3	2	1	0					
0	Operation Code (00h)												
1	LUN												
2	0												
3	0												
4	0												
5	Control Byte						Flag	Link					

Table 6-39: TEST UNIT READY Command

The TEST UNIT READY command provides a means to check if the logical unit is ready (loaded and ready to accept a motion command.) This is not a request for a self- test. If the logical unit would accept an appropriate medium-access command without returning CHECK CONDITION status, this command shall return a GOOD status. If the logical unit cannot become operational or is in a state such that an initiator action (e.g., START UNIT command) is required to make the unit ready the target shall return CHECK CONDITION status with a sense key of NOT READY.

STATUS	SENSE KEY	ASC AND ASCQ
Good	No Sense	No Additional Sense Information
Check Condition	Illegal Request	Logical Unit Not Supported
Check Condition	Not Ready	Logical Unit Does Not Respond
Check Condition	Not Ready	Medium Not Present
Check Condition	Not Ready	Logical Unit Not Ready, Cause Not Reportable
Check Condition	Not Ready	Logical Unit In Process Of Becoming Ready
Check Condition	Not Ready	Logical Unit Not Ready, Initializing Command Required
Check Condition	Not Ready	Logical Unit Not Ready, Manual Intervention Required

Table 6-40 Normal Responses to TEST UNIT READY

6.26 WRITE Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (0Ah)							
1	LUN			0	0	0	0	Fixed
2	MSB							
3	Transfer Length							
4	LSB							
5	Control Byte						Flag	Link

Table 6-41: WRITE Command

The WRITE command requests that the target write the data that is transferred from the initiator to the current position on the logical unit.

Write Operation in Buffer Modes 0, 1 & 2

Fixed

The fixed bit specifies whether fixed-length or variable-length blocks are to be transferred. See the READ BLOCK LIMITS command (6.x.x) for additional information about fixed and variable block mode.

If the fixed bit is one, the transfer length specifies the number of fixed-length blocks to be transferred, using the current block length reported in the mode parameter block descriptor (6.x.x).

If the fixed bit is zero, a single block is transferred with the transfer length specifying the block length in bytes. If the transfer length is zero, no data shall be transferred and the current position on the logical unit shall not be changed. This condition shall not be considered an error.

Write Operation in Buffer Mode 3 (Special Buffer Mode)

In Buffer Mode 3h, the size of the physical write block is defined in the MODE SELECT block descriptor. Actual writes to the buffer may be of any length. The transfer length field defines the number of bytes transferred during a single operation. Some, all or none of this data may be written to the medium by an individual write command depending on whether or not it comprises a full, fixed length tape block, as defined by the mode block descriptor. (See Appendix A).

Responses

A WRITE command may be buffered or unbuffered, as indicated by the buffered mode field of the mode parameter header (Table 6.12). For unbuffered operation (buffered mode 0h), the target shall not return GOOD status until all data block(s) are successfully written to the medium. For buffered operation (buffered mode 1h, 2h or 3h), the target will return GOOD status as soon as all data block(s) are successfully transferred to the target's buffer.

If the logical unit encounters early-warning during a WRITE command, an attempt to finish writing any data may be made, as determined by the current settings of the REW and SEW bits in the device configuration page (See MODE SELECT). The command shall terminate with CHECK CONDITION status and the EOM and valid bits shall be set to one in the sense data. If all data that is to be written is successfully transferred to the medium, the sense key shall be set to NO SENSE or RECOVERED ERROR, as appropriate. If any data that is to be written cannot be transferred to the medium when early-warning is encountered, the sense key shall be set to VOLUME OVERFLOW.

The information field is defined as follows:

- 1) If unbuffered mode is reported in the mode parameter header and the fixed bit is set to one, the information field shall be set to the requested transfer length minus the actual number of blocks written.
- 2) If unbuffered mode is reported and the fixed bit is set to zero, the information field shall be set to the requested transfer length.
- 3) If buffered mode is reported in the mode parameter header and the fixed bit is set to one, the information field shall be set to the total number of blocks, filemarks, and setmarks not written (the number of blocks not transferred from the initiator plus the number of blocks, filemarks, and setmarks remaining in the target's buffer). Note that the value in the information field may exceed the transfer length.

- 4) If buffered mode is reported and the fixed bit is set to zero, the information field shall be set to the total number of bytes, filemarks, and setmarks not written (the number of bytes not transferred from the initiator plus the number of bytes, filemarks, and setmarks remaining in the target's buffer). Note that the value in the information field may exceed the transfer length.

If a WRITE command is received while the logical unit is positioned between early-warning and end-of-partition, the target shall return CHECK CONDITION status after attempting to perform the command. The EOM and valid bits shall be set to one in the sense data. If all data that is to be written is successfully transferred to the medium, the information field shall be set to zero. If any data that is to be written is not transferred to the medium prior to encountering end-of-partition, the sense key shall be set to VOLUME OVERFLOW and the information field shall be defined as follows:

- 1) If the fixed bit is one, the information field shall be set to the requested transfer length minus the actual number of blocks written to the medium.
- 2) If the fixed bit is zero, the information field shall be set to the requested transfer length.

6.28 WRITE BUFFER Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (3Bh)							
1	L U N			0	0	Mode		
2	Buffer ID							Comp
3	MSB							
4	Buffer Offset							
5	LSB							
6	MSB							
7	Allocation Length							
8	LSB							
9	Control Byte						Flag	Link

Table 6-42: WRITE BUFFER Command

The WRITE BUFFER command is used in conjunction with the READ BUFFER command as a diagnostic for testing target memory, data compression/decompression hardware and SCSI bus integrity. Additional modes are provided for downloading microcode and for downloading and saving microcode. This command shall not alter any medium of the target when the data mode is specified. The function of this command and the meaning of fields within the command descriptor block depend on the contents of the mode field.

Mode

001b - Test Buffer and/or data compression hardware.



SCSI

- 100b - Download Microcode
- 101b - Download Microcode and Save

Comp

- The COMP bit is valid only when MODE is 001b.
- 0 - Data written to buffer w/o compression enabled.
 - 1 - Data written to buffer with compression enabled.

Buffer ID

The Buffer ID field is valid only when MODE is set to 100b or 101b. It is used to distinguish which area of microcode storage is to be affected by the command.

Buffer Offset

The Buffer Offset field is used to set an offset into an area of buffer or microcode storage to be affected by the command.

Allocation Length

The allocation Length field denotes the number of bytes to follow in the DATA OUT phase.

The Write microcode modes 100b & 101b must be preceded by setting the CHANGE MICROCODE parameter in the SETUP mode, controlled from the front panel of the drive.

If the setting of this parameter is DISABLED, attempted executions of modes 100b & 101b will not alter the microcode, and will return CHECK CONDITION status with ILLEGAL REQUEST set in the SENSE KEY. If set to ENABLED, and the microcode download has completed successfully the target shall generate a unit attention condition for all initiators except the one that issued the WRITE BUFFER command. The additional sense code shall be set to MICROCODE HAS BEEN CHANGED.

Mode 100b will allow the microcode to be tested without storing it to the non-volatile region of the controllers memory. If the power is cycled, the drive will return to the previously stored version of microcode.

Mode 101b will change both the operating and stored versions of the microcode such that subsequent power cycles will cause the drive to operate with the new version of microcode.

6.29 WRITE FILEMARKS Command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (10h)							
1	LUN			0				Immed
2	MSB							
3	Transfer Length							
4	LSB							
5	Control Byte						Flag	Link

Table 6-43: WRITE FILEMARKS Command

The WRITE FILEMARKS command requests that the target write the specified number of filemarks to the current position on the logical unit.

Immed

An immediate (Immed) bit of one indicates that the target shall return status as soon as the command descriptor block has been validated. An Immed bit of one is only valid if buffered mode is reported in the mode parameter header. An Immed bit of zero indicates that the target shall not return status until the write operation has completed. Any buffered data, and or filemarks shall be written to the medium prior to completing the command.

Transfer Length

The transfer length specifies the number of filemarks to be written. If zero and away from BOT, buffered write data will be written to tape without a filemark. If zero and at BOT, this command will cause the tape to be initialized in the current density by writing the ID burst and ID separator marks as well as the VOLID mark if enabled by the current density selection and VOLID Page (21h) of the MODE SELECT data.

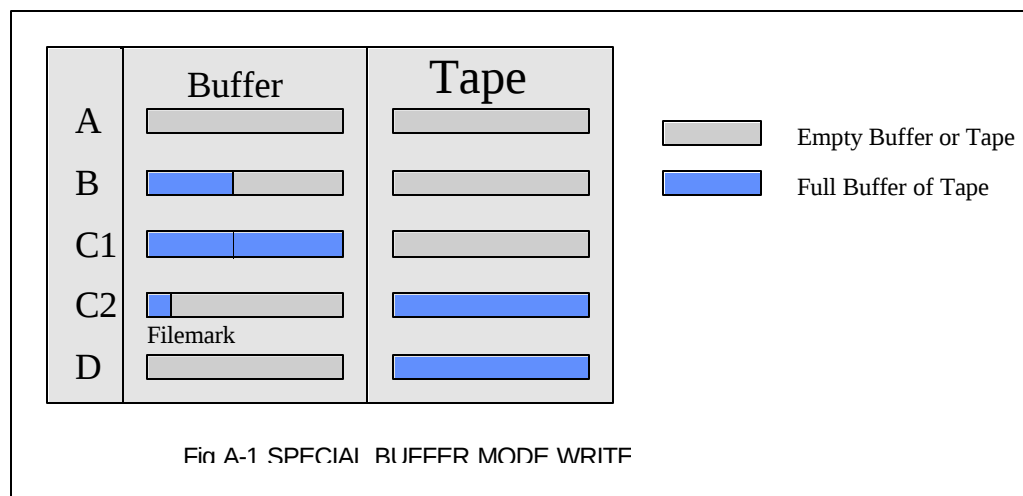
Appendix A Buffer Mode 3h

Description

Special Buffer Mode (3h) is used to permit initiators to transfer data between a host application and a SCSI device without the need of a host resident block buffer. It allows variable length data blocks to be buffered in the SCSI device, and permits SCSI READ and WRITE commands to send or receive only the amount of data requested by an applications program while giving the host control over variable write block sizes and knowledge of read block sizes. This substantially reduces the overhead required by host resident device driver programs by saving both host memory and the time required to transfer SCSI data between a host resident block buffer and an application's memory space.

WRITE OPERATION

Before commencing a write operation, the initiator must issue a MODE SELECT command and transfer both a HEADER which specifies BUFFER MODE 03h and a BLOCK DESCRIPTOR which specifies the desired write BLOCK LENGTH. Following this, the standard SCSI write command is used. The TRANSFER LENGTH field of this command defines the actual length in bytes of the write data moved during the DATA OUT PHASE of this command regardless of whether this is an integer multiple of the specified BLOCK LENGTH. Whenever data in the target's buffer meets or exceeds the BLOCK LENGTH parameter, a data block is written (targets may buffer several blocks depending on other considerations). Remaining data is stored in the buffer. GOOD status is returned as soon as the data is successfully stored in the target's buffer. Subsequent WRITE commands append data to that which is already stored. At no time does a SCSI WRITE command cause a data block to be written which is not the length specified in the BLOCK LENGTH parameter of the last MODE SELECT



COMMAND.

Residual data is written to tape in a short block (equal in length to the length of the residual data) by the action of SYNCHRONIZE, WRITE FILEMARKS, or other non-write commands which cause tape motion.

Consider fig A-1.

- A. MODE SELECT issued which sets write block length
- B. WRITE command issued which transfers less than one block length, data remains in the buffer, tape remains blank.
- C. Second WRITE command issued, this transfer crosses block length boundary (C1). Block is written, and some residual data remains (C2).
- D. WRITE FILEMARKS command issued which writes both the residual data to tape as a short block, and a filemark.

Note that data shown as written to tape in this example may actually be held in the buffer until one or more blocks are stored in order to enhance streaming modes. This example is accurate in that data shown as actually written to tape could be written, and data shown as held in the buffer would remain held regardless of streaming considerations.

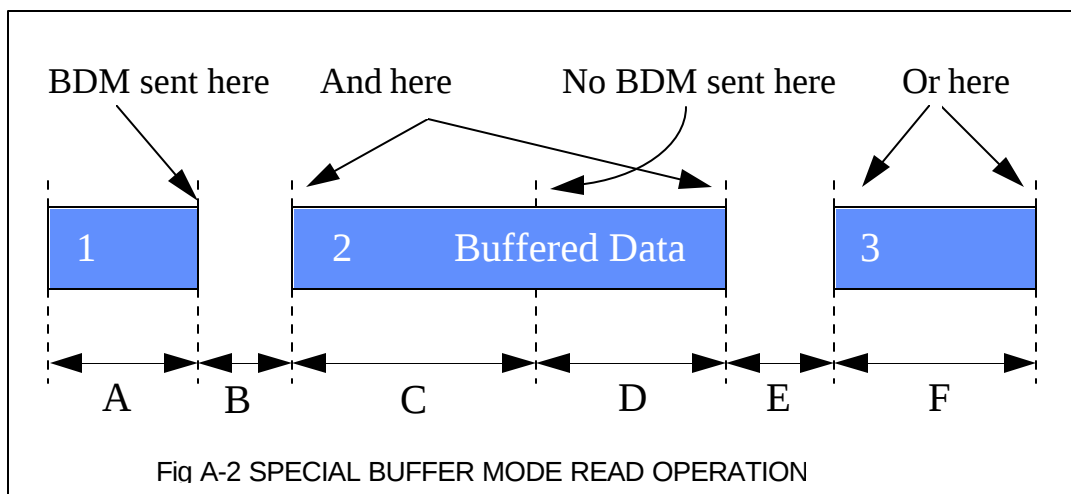
READ OPERATION

When operating in Buffer Mode 3h, SCSI READ commands return only data specified by the TRANSFER LENGTH field of the CDB, or buffered bytes up to and including the last byte of a data tape data block. If the tape data block is longer than the specified TRANSFER LENGTH, residual data will remain in the target's buffer and will be accessible on subsequent READ commands. If the tape data block (or residual data) is shorter than or equal to the TRANSFER LENGTH, the READ command terminates after reading the last byte of the current block.

The SYNCHRONIZE command and others which result in tape motion REWIND, SPACE, LOCATE, etc. may be used to delete any residual data remaining in the buffer without reading it over the SCSI bus.

BLOCK DESCRIPTOR MESSAGE

Whenever a READ command causes data from an as yet unread block to be transferred, the READ command terminates in a MESSAGE IN phase which transfers a BLOCK DESCRIPTOR MESSAGE (BDM). This is an extended length message defined in Table A-1. The BDM contains the length in bytes of the entire current block. See Fig A-2.



Consider Fig A-2.

- A. READ command specifies length greater than that of block 1. READ terminates at end of block 1, and BDM returned which describes block 1.
- B. READ command reads only a small portion of block 2, BDM for block 2 returned.
- C. READ command reads portion of block 2, remainder of block 2 data stays in buffer, no BDM sent.
- D. READ command specifies more data than remains from block 2, READ terminates at end of block 2. No BDM sent
- E. READ command reads a small portion of block 3, remainder of block 3 stays in buffer, block 3 BDM sent.
- F. READ command requests remainder of block 3, no BDM sent.

BLOCK DESCRIPTOR MESSAGE FORMAT

Bit Byt e	7	6	5	4	3	2	1	0
0	Extended Message Indicator (01h)							
1	Message Length (08h)							
2	Vendor Unique Message Code (81h)							
3	MSB							
4	Block Number							
5	LSB							
6	MSB							
7	Block							
8	Size							
9	LSB							

Table A-1: Block Descriptor Message

Message Length

08h

Block Number

The Block number indicates the position of the block. This is the same quantity as would be returned by the READ POSITION Command in the FIRST BLOCK POSITION field had that command been issued when positioned over the block.

Block Size

Appendix A

To receive log sense Read/Write error information from Echo:

PAGE CODE = 0x07 Transfer Length = 0x40

TEMPORARY READ/WRITE ERRORS:

write temp errors = log_data[1]

readf temp errors = log_data[3]

readb temp errors = log_data[5]

SINGLE, DOUBLE, TRIPLE AND QUADRUPLE TRACKS IN ERROR PER RECORD

single track errors = log_data[12]

double track errors = log_data[13]

triple track errors = log_data[14]

quadruple track errors = log_data[15]

To receive log sense SCSI-CNTL communication data:

PAGE CODE = 0x00 Transfer Length = 0x40

To receive log sense CONFIGURATION data :

PAGE CODE = 0x02 Transfer Length = 0x30

To receive log sense DISPLAY AREA data :

PAGE CODE = 0x03 Transfer Length = 0x20

To receive log sense CODE REVISION data :

PAGE CODE = 0x04 Transfer Length = 0x80

To receive log sense CARD REVISION/SERIAL data :

PAGE CODE = 0x05 Transfer Length = 0x10

To receive log sense CONFIGURATION data :

PAGE CODE = 0x06 Transfer Length = 0x20

To receive log sense FORMATTER STATISTCAL data :

PAGE CODE = 0x07 Transfer Length = 0x40

To receive log sense data :

PAGE CODE = 0x08 Transfer Length = 0x280

To receive log sense COTROLLER TRACE data :

PAGE CODE = 0x09 Transfer Length = 0x800

To receive log sense CONTROLER ERROR TRACE data :

PAGE CODE = 0x0A Transfer Length = 0x400

To receive log sense SCSI/CNTL TRACE data :

PAGE CODE = 0x0B Transfer Length = 0x400

To receive log sense FORMATTER TRACE data :

PAGE CODE = 0x0C Transfer Length = 0x400

To receive log sense SCSI TRACE data :

PAGE CODE = 0x0D Transfer Length = 0x200

To receive log sense SERVO TRACE data :

PAGE CODE = 0x0E Transfer Length = 0x200

To receive log sense CONTROLER ERROR TRACE data :

PAGE CODE = 0x0A Transfer Length = 0x400

TO CLEAR READ/WRITE ERROR COUNTERS:

PAGE CODE = 0x07 Transfer Length = 0x00 Control byte = 0x80

0x4D,0x00,0x07,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x80