S39H-4500-02

OEM HARD DISK DRIVE SPECIFICATIONS

for

DPRS-20810/21215 (810/1215 MB)

2.5-Inch Hard Disk Drive with SCSI Interface

Revision (1.2)

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Revision (1.2)

1st Edition (ver.1.0) S39H-4500-00 (June 16, 1995)
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Contents

1.0 General

| This document describes the characteristics of the following IBM 2.5-inch, SCSI interface hard disk drives:

- DPRS-20810 (810 MB)
- DPRS-21215 (1215 MB)

1.1 Glossary

Word	*Meaning*
Kbpi	1 000 Bit Per Inch
Mbps	1 000 000 Bit per second
MB	1 000 000 bytes
KB	1 000 bytes
32 KB	32 x 1 024 bytes
64 KB	64 x 1 024 bytes
Mb/sq.in	1 000 000 bits per square inch
MLC	Machine Level Control

1.2 General Caution

The drive can be easily damaged by shocks or ESD (Electric Static Discharge), so any damages applied to the drive after taking out from shipping package and opening ESD protective bag are user's responsibilities.
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1.2.1 Caution of usage

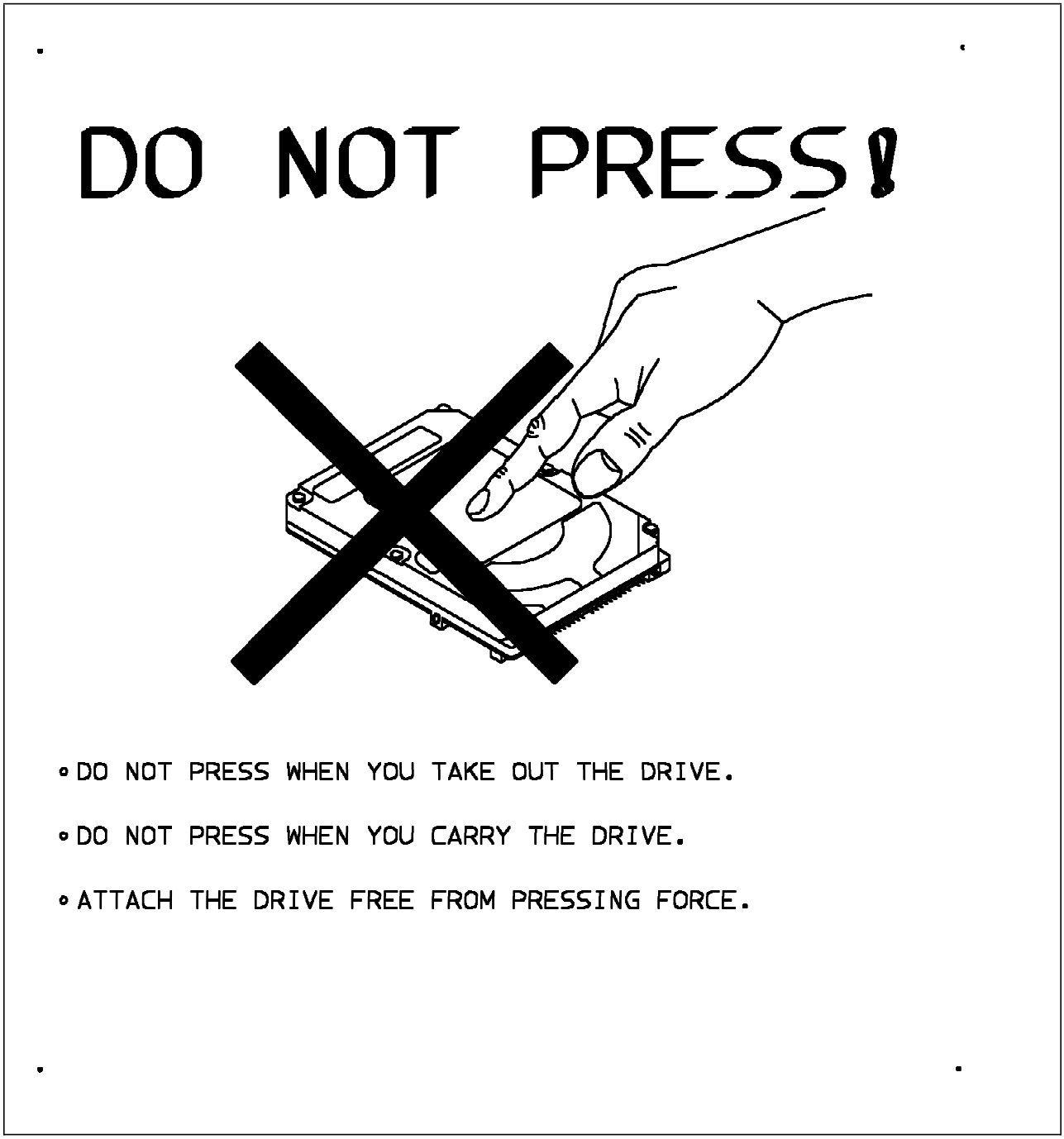


Figure 1. Handling and attachment caution of DPRS-20810/21215

2.0 General Features

- 17 mm Height SFF Compliance
- 2.5-inch form factor
- 810/1215 MB formatted capacity
- 512 bytes/sector
- MR Head
- No-ID (TM) Format
- SCSI-2 Fast Interface
- Integrated controller
- 1:1 Interleave
- 1,7 Run-Length Limited (RLL) Code
- Multi Zone Recording (8)
- Enhanced ECC On-The-Fly
  - 128-bit Reed Solomon Code operation 10-bit symbol.
  - Multi Burst OTF correction.
- Automatic retry on errors
- 64 KB Segmented Buffer
- Self-diagnostics in power up and in execute drive diagnostics
- Media data transfer rate 36.3 - 57.0 Mbit/second (4.5 - 7.1 MB/sec)
- Interface data transfer capability 10 MByte/sec
- Average seek time 12 milliseconds for read
- Closed-loop actuator servo (Embedded Sector Servo)
- Rotary voice coil motor actuator
- Automatic Actuator lock
- Dedicated head landing zone
- All axis(6 directions) mounting permitted
- No preventive maintenance required
- 1.6 Watt idle power
- Motor speed 4900 RPM
- 3.8 sec Power on to ready
- MTTF 300 000 power on hours
- Shock Sensor for Maximum Operating Shock 100G/2msec

Part 1. Functional Specification

3.0 Drive Characteristics

This chapter provides the characteristics of the drives.

3.1 Logical Drive Format

The customer usable data capacity is as shown below.

Figure 2. Drive Parameter

Descriptions	DPRS-20810	DPRS-21215
Bytes per Sector	512	512
Total Customer Usable Data Sectors	1 584 576	2 376 864
Total Customer Usable Data Bytes	810 MB (811,302,912)	1215 MB (1,216,954,368)

3.2 Data Sheet

Figure 3. Data Sheet

Media transfer rate [Mb/sec]	36.3 - 57.0
Interface transfer rate [MB/sec]	10 MB/sec
Data buffer size [KB]	64 KB (Read/Write)
Rotational speed [RPM]	4900
Average latency [msec]	6.1
Recording density [Kbpi]	110.3 Maximum
Track density [TPI]	6350 Maximum
Areal density [Mb/sq.in.]	700 Maximum
Number of zone	8
Number of disks DPRS-20810 DPRS-21215	 2 3
Servo design method	Embedded sector servo

3.3 Performance Characteristics

The drive performance is characterized by the following parameters:

- Command Overhead
- Mechanical Positioning
  - Seek Time
  - Latency
- Data Transfer Speed
- Buffering Operation

Note: All the above parameters contribute to a file performance. There are other parameters which contribute to the performance on the actual system. This specification tries to define the bare file characteristics, not the system throughput which is dependent on the system and the application.

The following table gives a **typical value** of each parameter. The detail descriptions are followed in the next sections.

Function	Typical
Average Random Seek Time For Read	12 msec
Average Random Seek Time For Write	13 msec
Rotational Speed	4900 rpm
Power On To Ready	3.8 sec
Command Overhead	1.0 msec
Disk-Buffer Data Transfer	36.3 - 57.0 Mbit/sec
Buffer-Host Data Transfer Maximum	10 MB/sec

Figure 4. Performance Parameter

3.3.1 Command Processing

Command overhead time is defined as the total time from when the command is received by the drive to the start of motion of the actuator.

3.3.2 Average Seek Time (Including Settling)

Command Type	Typical	Max
Read	12 msec	15 msec
Write	13 msec	16 msec

Figure 5. Mechanical Positioning Performance

'Typical' and 'Max' are given throughout the performance specification by;

Typical Average of the drive population tested at nominal environmental and voltage conditions.

Max Maximum value measured on any one drive over the full range of the environmental and voltage conditions. (See section on Environment and D.C. Power Requirements.)

The seek time is measured from the start of motion of the actuator to the start of **a reliable read or write operation**. Reliable read or write implies that error correction/recovery is not employed to correct for arrival problems. The Average Seek Time is measured as the weighted average of all possible seek combinations.

$$Weight\ Average = \frac{\sum_{n=1}^{max} (max + 1 - n)\ (Tn.in + Tn.out)}{(max + 1)(max)}$$

Where:

max = Maximum Seek Length
n = Seek Length (1 to max)
Tn.in = Inward measured seek time for a n track seek
Tn.out = Outward measured seek time for a n track seek

3.3.3 Single Track Seek Time

Function	Typical	Max
READ	4 msec	5.5 msec
Write	4 msec	6.5 msec

Figure 6. Single Track Seek Time

Single track seek is measured as the average of one (1) single track seek from every track with a **random head switch** in both directions (inward and outward).

3.3.4 Full Stroke Seek

Function	Typical	Max
Read	23 msec	30 msec
Write	24 msec	31 msec

Figure 7. Full Stroke Seek Time

Full stroke seek is measured as the average of 1000 full stroke seeks.

3.3.5 Average Latency

RPM	Time for a revolution	Average Latency
4900	12.2 msec	6.1 msec

Figure 8. Latency Time

3.3.6 Drive Ready Time

Condition	Typical	Max
Power On To Ready	3.8 sec	10.0 sec

Figure 9. Drive Ready Time

Ready The condition in which the drive is able to perform a media access command (e.g. read, write) immediately.

Power On This includes the time required for the internal self diagnostics.

3.3.7 Operating Modes.

Operating mode		Description
Spin–Up	:	Start up time period from spindle stop or power down.
Seek	:	Seek operation mode
Write	:	Write operation mode
Read	:	Read operation mode
Idle	:	Spindle motor and Servo system are working normally. Other modules except the servo control and Host Interface are in sleep mode. Commands can be received and processed immediately.
Standby	:	Spindle motor is stopped. All modules except the Host Interface are powered off. Commands can be received and processed after a short delay.
Sleep	:	Spindle motor is stopped. Most modules are powered off and power consumption is minimized. The drive can get active by a soft reset or a hard reset.

Note–1 : Upon power down or Spindle stopped, a head locking mechanism will secure the heads in the ID parking position.

Figure 10. Operating Mode

3.3.7.1 Mode Transition Time.

From	To	Transition Time
Standby	Idle	2.3 sec typ, 9.5 sec max.
Idle	Standby	1.7 sec typ, 5.0 sec max.

Figure 11. Mode Transition Time

4.0 Data Integrity

4.1 Data loss on Power Off or Hard Reset

- Power off or hard reset during any operations except for write operation will not cause any data loss.
- Power off or hard reset during write operation causes the loss of the data which the drive has received but not written on the disk media.
- There is a possibility that power off or hard reset during write operation might make a maximum of 1 sector of data unreadable. This state can be recovered by a re-write operation.

4.2 Write Cache

- When write cache is enabled, there is a possibility that the write command completes before the actual disk write operation finishes. This means that there is a possibility that power off or hard reset even after write command completion might cause the loss of the data which the drive has received but not written on the disk.
- In order to prevent this data loss, confirm the completion of the actual write operation prior to the power off or hard reset by issuing the Recalibrate command and confirming its completion.

4.3 Equipment Status

Equipment status is available to the host system any time the drive is not ready to read, write, or seek. This status normally exists at power-on time and will be maintained until the following conditions are satisfied:

- Access recalibration/tuning is complete.
- Spindle speed meets requirements for reliable operation.
- Self-check of drive is complete.

Appropriate error status is made available to the host system if any of the following conditions occur after the drive has once become ready:

- Spindle speed outside requirements for reliable operation.
- Occurrence of a WRITE FAULT condition.

4.4 WRITE Safety

The verification process of write operation usually involves a read back check of the ECC in conjunction with WRITE FAULT detection circuits. The WRITE FAULT detection circuits reveal conditions where a write operation was intended and did not occur properly and the ECC verification occurred for old information.

4.5 Data buffer test

The data buffer is tested at Power-on-reset and when a drive self-test is requested by the host. The tests are consisted of write/read '00'x and 'ff'x pattern on all buffer.

4.6 Error Recovery

Errors occurring on the drive are handled by the error recovery procedure.

Errors that are uncorrectable after application of the error recovery procedures are reported to the host system as non-recoverable errors.

5.0 Specification

5.1 Environment

5.1.1 Temperature and Humidity

Operating Conditions	
Temperature	5 to 55 deg C (*1)
Relative Humidity	8 to 90 % non-condensing
Minimum Dew Point	-18 deg C
Maximum Wet Bulb Temperature	29.4 deg C non-condensing
Maximum Temperature Gradient	20 deg C / Hour
Altitude	-300 to 3,000 meter
Shipping Conditions	
Temperature	-40 to 65 deg C
Relative Humidity	5 to 95 % non-condensing
Minimum Dew Point	-18 deg C
Maximum Wet Bulb Temperature	40 deg C non-condensing
Maximum Temperature Gradient	20 deg C / Hour
Altitude	-300 to 12,000 meter
Storage Conditions	
Temperature	0 to 65 deg C
Relative Humidity	5 to 95 % non-condensing
Minimum Dew Point	-18 deg C
Maximum Wet Bulb Temperature	40 deg C non-condensing
Maximum Temperature Gradient	20 deg C / Hour
Altitude	-300 to 12,000 meter

Note *1:

The system is responsible to provide sufficient air ventilation to maintain surface temperature below 60 deg C at the center of top cover of the drive.

5.1.2 Magnetic Fields

The disk drive will withstand the radiation & conductive noise limit shown below.

5.1.2.1 Radiation Noise

The disk drive shall work without degradation of the soft error rate under the following Magnetic Flux Density Limits at the enclosure surface.

Frequency (KHz)	Limits (Gauss rms)
0 - 60	5.0
61 - 100	2.5
101 - 200	1.0
201 - 400	0.5

Figure 12. Magnetic Flux Density Limits

5.1.2.2 Conductive Noise

The disk drive shall work without degradation of the soft error rate, with an AC current of up to 45 mA(p-p), in the frequency range from DC to 20 MHz, injected through any two of the mounting screw holes of the drive via 50ohm resistor.

5.2 DC Power Requirements

Item	Requirements	Notes
Nominal Supply	+5 Volt	
Power Supply Ripple (0- 20Mhz)	100 mv p-p max	*1
Tolerance	+/-5%	*2
Supply Current	Pop.Mean (Nominal Condition)	
Idle average Read / Write Seek average Standby Start up(maximum peak) (average from power on to ready)	0.32 A RMS max (1.6W) 0.52 A RMS max (2.6W) 0.52 A RMS max (2.6W) 0.12 A RMS max (0.6W) 1.20 A RMS max (6.0W) 0.80 A RMS max (4.0W)	*3 *4 *5 *6
Supply Rise Time	7 - 100 ms	

Figure 13. Power Requirement

Notes (*):

(*1) The maximum fixed disk ripple is measured at 5V input of the drive.

(*2) The disk drive shall not incur damage for an over voltage condition of +25% (maximum duration of 20 ms) on the 5-volt nominal supply.

(*3) The idle current is specified at an inner track.

(*4) The read/write current is specified based on three operations of 63 sector read/write per 100 msec.

(*5) The seek average current is specified based on three operations per 100 msec.

(*6) The worst case operating current includes motor surge.

5.2.1 Start Up Current

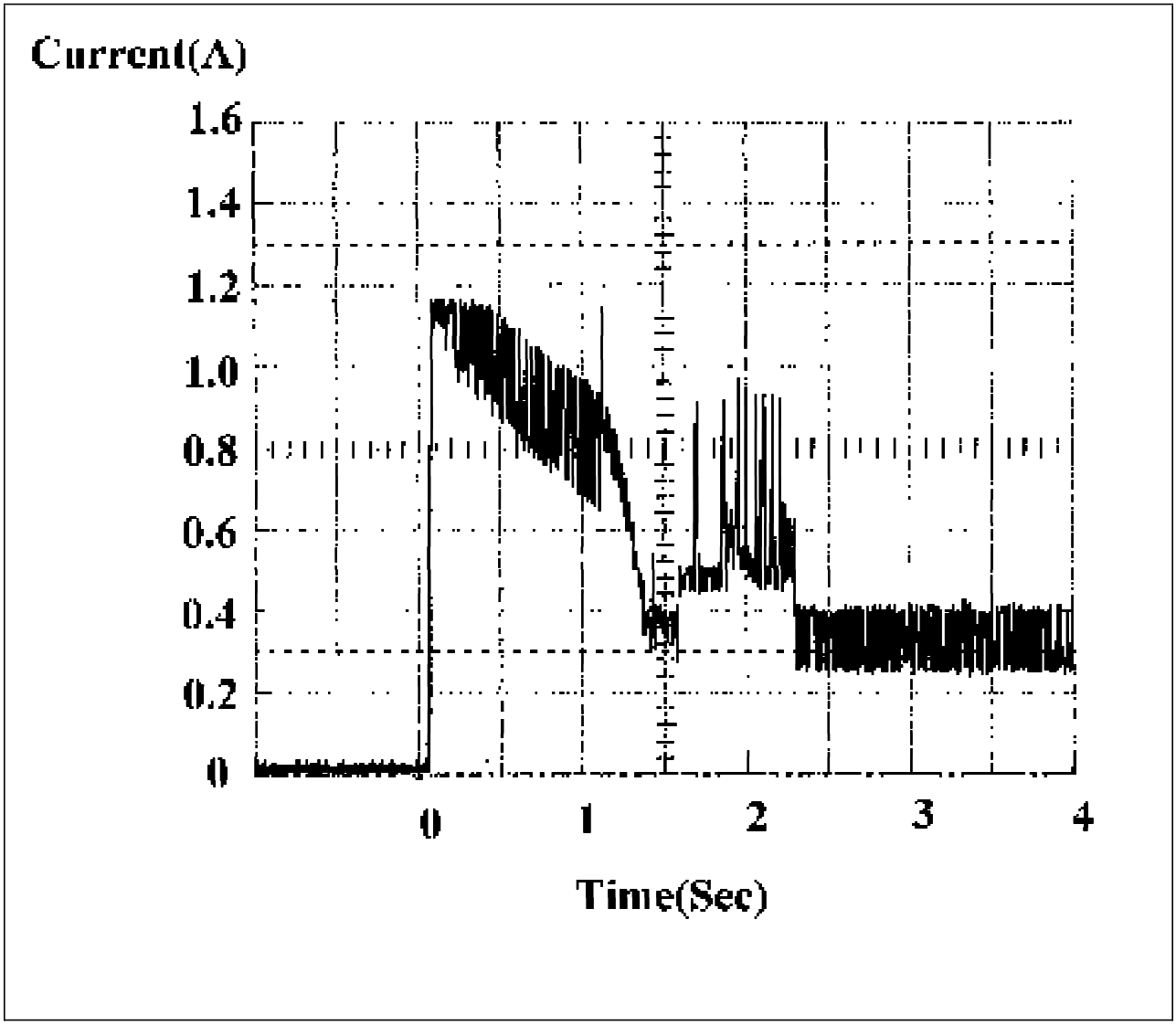


Figure 14. Typical Current Wave Form at Start Up of DPRS-21215

5.3 Reliability

5.3.1 Failure Rate

The failure rate is less than 3.3 fails per million Device-hrs of Operations.

5.3.2 MTTF

300 000 power-on hours (POH) under the following conditions
- 4,000 POH per year (333 POH per Month)
- Seeking/Writing/Reading operation to be less than 20% of POH at 40 deg C or lower environmental temperature.

5.3.3 Contact Start Stop(CSS)

The disk drive will meet the specified error rates after the following Start/Stop or Power ON/OFF cycles.

A) At a condition of Temperature/Humidity of 40C / 15–20% : 52,000

B) At an extreme condition of Temperature/Humidity of 55C / 8–15%: 10,400

5.3.4 Warranty

The warranty will be covered by contracts.

5.3.5 Useful Life

The useful life of the drives is 5 years minimum.

5.3.6 Preventive Maintenance

None.

5.3.7 Error rate

- Probability of not recovering data ..... 1 in 10^{13} bits read

5.4 Mechanical Specifications

5.4.1 Mechanical Dimensions and Weight

The following chart describes the dimensions for the 2.5" hard disk drive form factor.

	DPRS-20810/21215
Height (mm)	17.0 +0.0/-0.5
Width (mm)	69.85 ± 0.25
Length (mm)	100.2 ± 0.25
Weight (gram)	186 Max

Figure 15. Physical Dimension and Weight

5.4.2 Hole Locations

The Figure 16 on page 20 shows the outline of DPRS-20810/21215 which includes the hole locations.

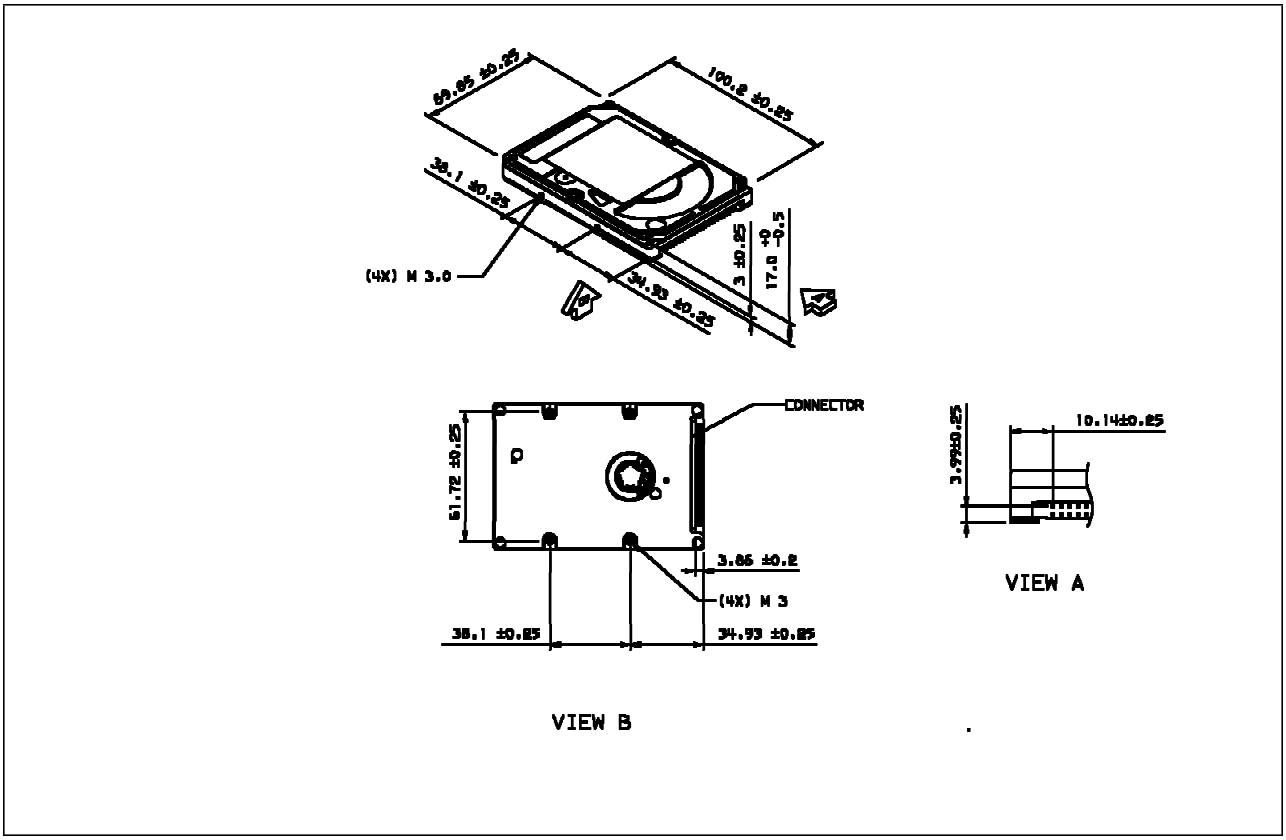


Figure 16. Outline of DPRS-20810/21215

5.4.3 Mounting Orientation

The drive will operate in all axes (6 directions). The drive will operate within the specified error rates when tilted ± 5 degree from these positions.

Performance and error rate will stay within specification limits if the drive is operated in the other permissible orientations from which it was formatted. Thus a drive formatted in a horizontal orientation will be able to run vertically and vice versa.

The recommended mounting screw torque is 3 +/- 0.5 kgf.cm.
The recommended mounting screw depth is 3.5 +/- 0.5 mm for bottom and 5.0 +/- 0.5 mm for horizontal mounting.

The system is responsible for mounting the drive securely enough to prevent from excessive motion or vibration of the drive at seek operation or spindle rotation, using appropriate screws or equivalent mounting hardware.

Vibration test and shock test are to be conducted by mounting the drive to the table using bottom four screws.

5.4.4 Shipping Zone and Lock

A "shipping" (or "landing") zone on the disk, not on the data area of the disk, is provided to protect the disk data during shipping, movement, or storage. Upon power down, a head locking mechanism will secure the heads in this zone. See Non-Operating Shock section for additional details.

5.5 Vibration and Shock

All vibration and shock measurements in this section shall be for the disk drive without the mounting attachments for the systems. The input level shall be applied to the normal drive mounting points.

5.5.1 Operating Vibration

The disk drive will operate without a hard error while being subjected to the following vibration levels.

The test will be 30 minutes of random vibration using the power spectral density (PSD) levels specified in IBM Standard C-S 1-9711-002 (1990-03) as V5L. The vibration test level for V5L is 0.67G RMS (Root Mean Square).

Random vibration PSD profile Breakpoint

5 Hz	2.0 x E−5	g**2/Hz
17 Hz	1.1 x E−3	
45 Hz	1.1 x E−3	
48 Hz	8.0 x E−3	
62 Hz	8.0 x E−3	
65 Hz	1.0 x E−3	
150 Hz	1.0 x E−3	
200 Hz	5.0 x E−4	
500 Hz	5.0 x E−4	

The specified levels are measured at the mounting points.

5.5.2 Non-Operating Vibrations

5.5.2.1 Random Vibration

The test consists of a random vibration applied in each of three mutually perpendicular axes with the time duration of 15 minutes per axis. The PSD levels for the test simulates the shipping and relocation environment which is shown below.

Figure 17. Random Vibration PSD Profile Breakpoints (Non-Operating)

Hz	**Random Vibration PSD Profile Breakpoints (Non-Operating)**						
Hz	2	4	8	40	55	70	200
G**2/Hz	0.001	0.03	0.03	0.003	0.01	0.01	0.001

Overall RMS level of vibration is 1.04G (RMS).

5.5.2.2 Swept Sine Vibration

- 2 G (Zero to peak), 5 to 200 to 5 Hz sine wave
- 0.5 oct/min sweep rate
- 15 minutes dwell at two major resonances

5.5.3 Operating Shock

The hard disk drive meets the following criteria while operating in the conditions described below. The shock test consists of ten shock inputs in each axis and direction for a total of 60. There must be a minimum 3 seconds delay between shock pulses. Soft errors and automatic retries are allowed during the test.

No data loss or permanent damage : 100G, 2 msec half-sine shock pulse

The input level shall be applied to the normal disk drive subsystem mounting points, as mounted in normal system use.

5.5.4 Non-Operating Shock

The disk drive must withstand with no damage or degradation of performance, a 120G half-sine wave shock pulse of 11 ms duration and a 300G half-sine wave shock pulse of 2 ms duration on six sides when heads are parked. (When the power is not applied to the unit, the heads are automatically located on the parked position.)

All shocks shall be applied in each direction of the drive's three mutually perpendicular axes, one axis at a time. Input levels shall be measured at the frame of the disk drive.

5.6 Acoustics

5.6.1 Sound Power Levels

The upper limit criteria of the octave sound power levels are given in Bels relative to 1 pico Watt and are shown in the following table with A-weighted levels.

Figure 18. Octave band sound power levels

	Octave Band Center Frequency (Hz)							
Mode	125	250	500	1k	2k	4k	8k	LwAu
Idle	4.8	4.1	3.6	3.6	3.9	3.9	3.6	4.5
Operating	5.0	4.3	4.2	4.2	4.2	4.2	3.8	4.8

Background power levels of the acoustic test chamber for each octave band are to be recorded.

Sound power tests are to be conducted with the drive supported by spacers so that the lower surface of the drive be located at 25 +/- 3mm height from the chamber floor. No sound absorbing material shall be used.

The acoustical characteristics of the disk drive subsystem are measured under the following conditions.

Idle mode :

Power on, disks spinning, track following, unit ready to receive and respond to control line commands.

Operating mode :

Continuous random cylinder selection and seek operation of actuator with a dwell time at each cylinder. Seek rate for the drive can be calculated as shown below.

Dwell time = (0.5 + N) x 60/RPM

Seek rate = 1/(Average seek time + Dwell time)

Where N = number of maximum data surfaces (n=6 for DPRA-21215)

5.6.2 Sound Power Acceptance Criteria

Statistical upper limit $(L_{Woct})_{stat}$ is calculated with following formula.

$$(L_{Woct})_{stat} = (L_{Woct})_m + k \times (s_t)_{Woct}$$

where:

$(L_{Woct})_m$ is the mean value of the sound power level for a sample of N drives.

$(s_t)_{Woct}$ is the total standard deviation for sound power level at each octave band.
$(s_t)_{Woct} = SQRT((s_R)_W^2 + (s_P)_{Woct}^2)$

$(s_R)_W$ is the standard deviation of reproducibility for sound power level.
Assume $(s_R)_W = 0.075$ B.

$(s_P)_{Woct}$ is the standard deviation of the samples for pound power level at each octave band.

k is a coefficient determined by number of samples (N) as shown below.

N	3	4	5	6	7	8	9	10	11	12	13	14	15
k	3.19	2.74	2.74	2.49	2.33	2.22	2.13	2.07	2.01	1.97	1.93	1.90	1.87

The calculated left hand side of the criterion equation above is referred to as LWU and is rounded to the nearest 0.05 bel. The individual terms may be rounded to the nearest 0.01 bel before calculation.

5.7 Identification

5.7.1 Labels

The following labels are affixed to every disk drive .

1. A label placed on the top of the HDA containing the statement 'Made by IBM' or equivalent, Part No., EC No. and FRU No.
2. A bar code label placed on the disk drive based on user request. The location on the disk drive is to be designated in the drawing.
3. Labels containing the vendor's name, disk drive model number, serial number, place of manufacture and UL/CSA logos.

Except for the bar code, the labels may be integrated.

5.8 Electromagnetic Compatibility

The fixed disk, when installed in the host system and exercised with a random accessing routine at maximum data rate shall meet the worldwide EMC requirements listed below.

IBM will provide technical support to assist users in complying with the EMC requirements.

- United States Federal Communications Commission (FCC) Rules and Regulations (Class B), Part 15.
- European Economic Community (EEC) directive number 76/889 related to the control of radio frequency interference and the Verband Deutscher Elektrotechniker (VDE) requirements of Germany (GOP).

5.9 Safety

5.9.1 Underwriters Lab(UL) Approval

DPRS-20810/21215 complies with UL 1950.

5.9.2 Canadian Standards Authority(CSA) Approval

DPRS-20810/21215 complies with CSA C22.2, #950-M89.

5.9.3 IEC Compliance

DPRS-20810/21215 complies with IEC 950.

5.9.4 German Safety Mark

DPRS-20810/21215 are approved by TUV on Test Requirement:

EN 60 950:1988/A1:1990/A2:1991.

5.9.5 Flammability

Printed Circuit boards used in this product are made of material with a UL recognized flammability rating of V-1 or better. The flammability rating is marked or etched on the board. All other parts not considered electrical components are made of material with a UL recognized flammability rating of V-1 or better except minor mechanical parts.

5.9.6 Safe Handling

The products are designed for safe handling in regards to sharp edges and corners.

5.9.7 Environment

The product does not contain any known or suspected carcinogens.

Environmental controls meet or exceed all applicable government regulations in the country of origin. Safe chemical usage and manufacturing control are used to protect the environment. An environmental impact assessment has been done on the manufacturing process used to build the drive, the drive itself and the disposal of the drive at the end of its life.

Production also meets the requirements of the international treaty on chloroflurocarbon (CFC) control known as the United Nations Environment Program Montreal Protocol, and as ratified by the member nations. Material to be controlled include CFC-11, CFC-12, CFC-113, CFC-114, CFC-115, Halon 1211, Halon 1301 and Halon 2402. Although not specified by the Protocol, CFC-112 is also controlled. In addition to the Protocol IBM requires the following:

- All packaging used for the shipment of the product do not use controlled CFCs in the manufacturing process.
- All manufacturing processes for parts or assemblies, including printed circuit boards, does not use controlled CFC materials after December 31, 1993.

5.9.8 Secondary Circuit Protection

This product utilizes printed circuit wiring that must be protected against the possibility of sustained combustion due to circuit or component failure. Adequate secondary over current protection is the responsibility of the using system.

.User must protect the drive from it's electrical short circuit problem . 10 A limit is required for safety purpose.

5.10 Packaging

Drives will be shipped in appropriate containers and placed on pallets.

Drives are shipped in ESD protective bags.

6.0 Electrical Interface Specifications

DPRS-20810/21215 uses single-ended SCSI Bus drivers and receivers. The Low Power SCSI Bus termination resistors are externally equipped to interface lines by User.

6.1 Connector

The SCSI signal connector is designed to mate with AMP part number 6-176135 or equivalent. Figure 5 is provided for reference to show pin locations on the connectors.

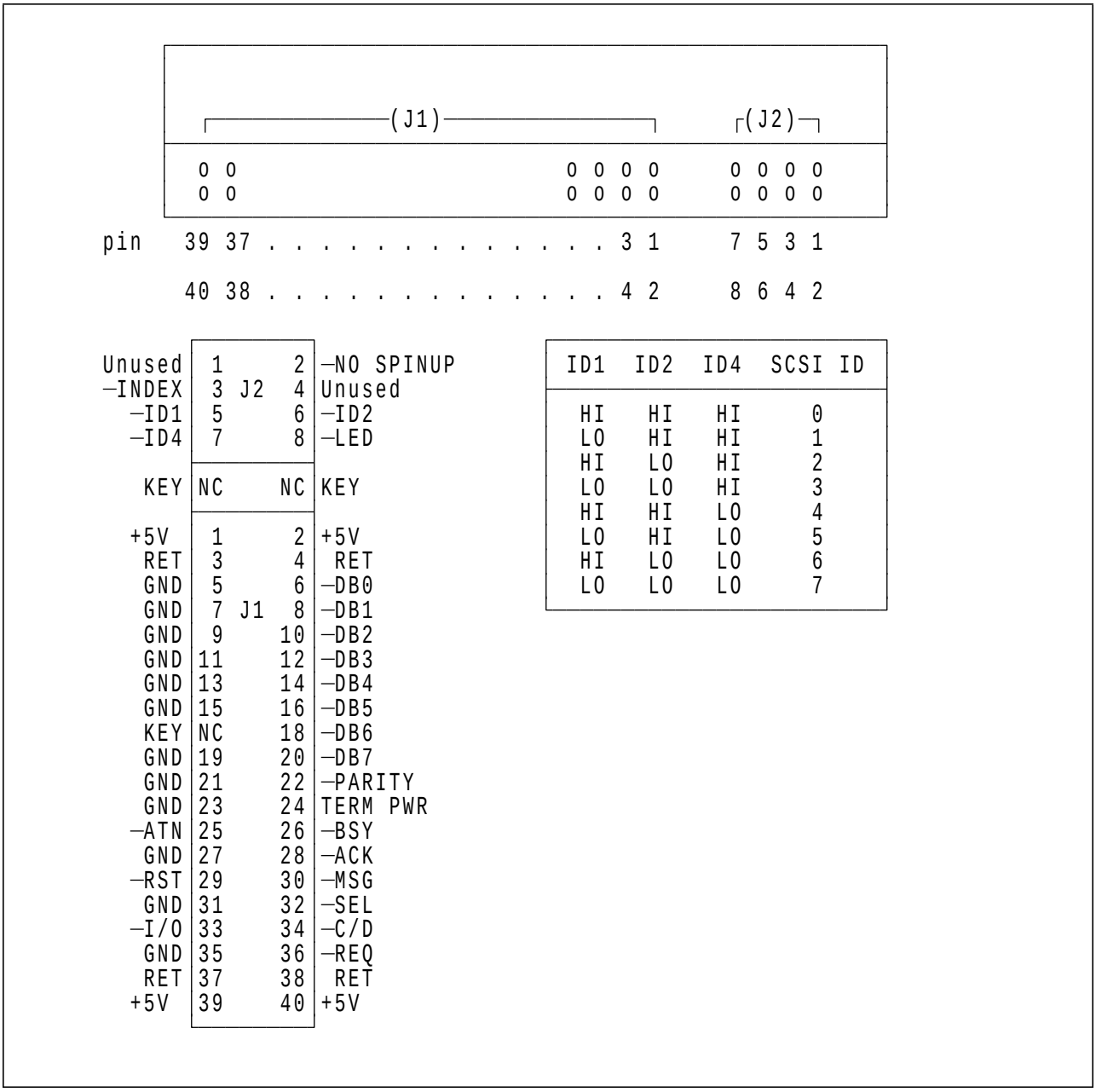


Figure 19. 40 pin SCSI Connector

6.2 SCSI Interface Connector Pin Assignments

Signal Name	Pin Number		Signal Name
+5	1	2	+5
RET	3	4	RET
GND	5	6	−DB(0)
GND	7	8	−DB(1)
GND	9	10	−DB(2)
GND	11	12	−DB(3)
GND	13	14	−DB(4)
GND	15	16	−DB(5)
KEY	17	18	−DB(6)
GND	19	20	−DB(7)
GND	21	22	−DB(P)
GND	23	24	TERMPWR
−ATTN	25	26	−BSY
GND	27	28	−ACK
−RST	29	30	−MSG
GND	31	32	−SEL
−I/O	33	34	−C/D
GND	35	36	−REQ
RET	37	38	RET
+5	39	40	+5

Figure 20. SCSI Drive Cable Signal Lines.

Note:

- The minus sign next to a signal indicates active low.

6.2.1 Signal Line Descriptions

The SCSI bus consists of nine control and nine data lines. Each line is described below.

Name	Description
BSY	BUSY indicates that the bus is in use.
SEL	SELECT is used by an Initiator to select a Target or by a Target to reselect an Initiator.
C/D	CONTROL DATA indicates whether control (1) or data (0) information is on the bus.
I/O	INPUT/OUTPUT indicates whether the data on the bus is an input (1) to the Initiator or an output (0) to the Target. This line is also used to differentiate between SELECTION phase (0) and RESELECTION phase (1).
MSG	MESSAGE is driven by Target and indicates a message phase.
REQ	REQUEST is driven by Target and indicates a request for a REQ/ACK data transfer handshake.
ACK	ACKNOWLEDGE is driven by the Initiator and indicates an acknowledgement of a REQ/ACK data transfer handshake.
ATN	ATTENTION is driven by an Initiator to inform a Target that the Initiator has a message ready.
RST	RESET clears all SCSI devices from the bus and resets them. **Note:** The target will not drive this line.

DB(n) 8 data bits are used to transfer data over the bus. DB(7) is the most significant.

DB(P) PARITY bit associated with DB(7-0). Data parity is odd.

6.2.2 Driver/Receiver Specification

The file supports single ended drivers and receivers.

6.2.2.1 Output Characteristics.

Each signal driven by the file will have the following output characteristics when measured at the file connector:

Signal assertion 0.0 volt DC to 0.5 volt DC

Minimum driver output capability 48 milliamps (sinking) at 0.5 volt DC

Signal negation 2.5 volt DC to 5.25 volt DC at 250 micro ampere (open collector)

6.2.2.2 Input Characteristics.

Each signal received by the file will have the following input characteristics when measured at the file's connector:

Signal true 0.0 volt DC to 0.8 volt DC

Maximum total input load -0.4 milliamps at 0.5 volt DC

Signal false 2.0 volt DC to 5.25 volt DC

Minimum input hysteresis 0.2 volt DC

6.2.3 SCSI Bus Cable

The maximum cable length from the host system to the drive is limited to 6 inches with external 1 K-ohm pull up resistors.

In case that appropriate termination resistors are externally equipped to the interface lines, the cable length can be extended.

The stub length is less than 0.1 meter.

6.2.4 Signal Termination

The file does not have termination nor pull up resistors for SCSI interface.

6.2.5 Device Address Selection

To set the SCSI device address for the file to 0 through 7, the host system must have a equipment to control ID signal. This address setting is read during processing

- Power Up
- RST on SCSI BUS (RESET).

This value is used by the file firmware as the device ID to

- respond to selection
- place the device ID on the bus during reconnection.

Note: Changing the ID setting after Power On is neglected until RST or another Power On. The default ID of the shipped file is 0.

6.2.6 Parity Implementation

The file supports odd parity. Parity checking may not be turned off. When a Parity Error is detected, the file notifies to the initiator to retry the last operation once. If the error persists, the file will go into Bus Free Phase. (See 10.4, “SCSI Bus Related Error Handling Protocol” on page 136 for more detail.)

6.2.7 SCSI Bus Timings

The file conforms to the timings as specified in the ANSI SCSI-2 October 17, 1991.

6.2.8 Reset Implementation

The file implements the Hard Reset option as defined in the SCSI-2 standard.

The file responds to RST by

1. Clear all commands for all initiators, including commands in the queue.
2. Release all SCSI device reservations
3. Generate Unit Attention Condition
4. Restore Mode Parameters to last saved values
5. Go into Bus Free Phase

Note: If a reset occurs during a write operation, the file will complete the write operation for the current sector. This is to protect the sector from being partially updated, which will later cause ECC error.

The RST line should be held active for at least 25 usec to reset the file. The file, however, may respond to a reset which is active for less than 25 usec.

ACTION	TYPE	SELF–TEST	CLEAR COMMAND	CLEAR QUEUE	UNIT ATTN
RST	Hardware	no	yes	yes	yes
Power On	Hardware	yes	yes	yes	yes
BUS DEVICE RESET	Message	no	yes	yes	yes
ABORT	Message	no	yes	no	no
SEND DIAGNOSTICS	Command	yes	no	no	no

Figure 21. Matrix of resets/abort and self test actions

6.2.9 Multi-Initiator Support

The file implements 'Untagged Queuing' as specified in SCSI-2 to support the multiple initiator environment.

The actual implementation is described as following;

- Only one command for each Initiator may be accepted at a time. If the second command is received, the file will respond with CHECK CONDITION status and sense data of OVERLAPPED COMMANDS ATTEMPTED. Both commands are aborted.
- If the disconnect privilege is not granted for the command other than listed below from an initiator while one or more commands are in progress from different initiator(s), the file responds with BUSY status.

- TEST UNIT READY
- INQUIRY
- REQUEST SENSE

- The priority of execution is described as following;

  1. TEST UNIT READY , INQUIRY or REQUEST SENSE command will be executed immediately without disconnect.
  2. All other commands will be queued in the drive internal stack, and will be executed in FIFO fashion.
  3. When a linked command has been executed, the file wait for the the command from the linked initiator instead of processing command from other initiators stacked in the drive command queue.
  4. Separate request sense data is provided for each initiator.
  5. Separate synchronous data period and offset are supported for each initiator by means of the SYNCHRONOUS DATA TRANSFER REQUEST message.

Part 2. SCSI Interface Specification

7.0 SCSI COMMAND SET

Summaries of the SCSI commands supported by the file are listed below. where O=optional, M=mandatory, E=extended, R=reserved and V=vendor unique. The column "SCSI-1" refers to ANSI version 1 standard. The column "CCS" refers to the ANSI sub-committee Common Command Subset for DASD devices. The column "SCSI-2" refers to ANSI version 2 standard.

SCSI–1	CCS	SCSI–2	CODE	COMMAND
V	V	V	F6h	DISABLE PASSWORD
V	V	V	F4h	ERASE UNIT
M	M	M	04h	FORMAT UNIT
V	V	V	F5h	FREEZE LOCK
E	M	M	12h	INQUIRY
O	O	O	15h	MODE SELECT
O	O	O	1Ah	MODE SENSE
O	O	O	34h	PRE–FETCH
M	M	M	08h	READ
R	O	O	3Ch	READ BUFFER
E	M	M	25h	READ CAPACITY
R	R	O	37h	READ DEFECT DATA
E	M	M	28h	READ EXTENDED
R	R	O	3Eh	READ LONG
O	O	O	07h	REASSIGN BLOCKS
O	M	M	17h	RELEASE
M	M	M	03h	REQUEST SENSE
O	M	M	16h	RESERVE
O	O	O	01h	REZERO UNIT
O	O	O	0Bh	SEEK
O	O	O	2Bh	SEEK EXTENDED
O	M	M	1Dh	SEND DIAGNOSTIC
V	V	V	F1h	SET PASSWORD
O	O	O	1Bh	START/STOP UNIT
R	R	O	35h	SYNCHRONIZE CACHE
O	M	M	00h	TEST UNIT READY
V	V	V	F2h	UNLOCK
O	O	O	2Fh	VERIFY
M	M	M	0Ah	WRITE
O	O	O	2Eh	WRITE AND VERIFY
R	O	O	3Bh	WRITE BUFFER
E	M	M	2Ah	WRITE EXTENDED
R	R	O	3Fh	WRITE LONG

Figure 22. SCSI Commands Supported. (In Alphabetical order)

SCSI–1	CCS	SCSI–2	CODE	COMMAND
O	M	M	00h	TEST UNIT READY
O	O	O	01h	REZERO UNIT
M	M	M	03h	REQUEST SENSE
M	M	M	04h	FORMAT UNIT
O	O	O	07h	REASSIGN BLOCKS
M	M	M	08h	READ
M	M	M	0Ah	WRITE
O	O	O	0Bh	SEEK
E	M	M	12h	INQUIRY
O	O	O	15h	MODE SELECT
O	M	M	16h	RESERVE
O	M	M	17h	RELEASE
O	O	O	1Ah	MODE SENSE
O	O	O	1Bh	START/STOP UNIT
O	M	M	1Dh	SEND DIAGNOSTIC
E	M	M	25h	READ CAPACITY
E	M	M	28h	READ EXTENDED
E	M	M	2Ah	WRITE EXTENDED
O	O	O	2Bh	SEEK EXTENDED
O	O	O	2Eh	WRITE AND VERIFY
O	O	O	2Fh	VERIFY
O	O	O	34h	PRE–FETCH
R	R	O	35h	SYNCHRONIZE CACHE
R	R	O	37h	READ DEFECT DATA
R	O	O	3Bh	WRITE BUFFER
R	O	O	3Ch	READ BUFFER
R	R	O	3Eh	READ LONG
R	R	O	3Fh	WRITE LONG
V	V	V	F1h	SET PASSWORD
V	V	V	F2h	UNLOCK
V	V	V	F4h	ERASE UNIT
V	V	V	F5h	FREEZE LOCK
V	V	V	F6h	DISABLE PASSWORD

Figure 23. SCSI Commands Supported. (By Command Code)

7.1 Flag and Link Bits

Many of the structures in this section have fields names FLAG and LINK. The meaning of these fields is defined below.

FLAG The Flag bit specifies which message the target shall return to the initiator if the link bit is one and the command completes without any error. If Link is zero, Flag must also be zero. If Link is one and the command terminates successfully, the file will send either the LINKED COMMAND COMPLETE message (FLAG=0) or the LINKED COMMAND COMPLETE WITH FLAG message (FLAG=1). Typically this bit is used to cause an interrupt in the initiator between linked commands.

LINK This bit is set to one to indicate that the initiator desires an automatic link to the next command upon successful completion of the current command. Upon successful completion of the command, the file will return INTERMEDIATE GOOD status and then send one of the two messages defined under Flag above.

Upon unsuccessful completion of the command, the file will return CHECK CONDITION status or RESERVATION CONFLICT status and then send the COMMAND COMPLETE message. No further commands in the chain are executed.

7.2 Abbreviations

These abbreviations are used throughout the following sections:

LUN. Logical Unit Number. An encoded three bit identifier for the logical unit.

VU. Vendor Unique bits.

LBA. Logical Block Address.

RSVD. Reserved.

MSB. Most Significant bit.

LSB. Least Significant bit.

7.3 Byte ordering conventions

In this specification, where it is not explicitly stated, all multi-byte values are stored with the most significant byte first. For example in a 4 byte field byte 0 will contain the MSB and byte 3 the LSB.

7.4 FORMAT UNIT (04)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command code (04h)							
BYTE 1	LUN			Fmt Data	Cmp List	List Format		
BYTE 2	VU = 0							
BYTE 3	(MSB)							
BYTE 4	Interleave Factor (LSB)							
BYTE 5	VU = 0		RSVD = 0				Flag	Link

Figure 24. FORMAT UNIT (04)

This includes handling of defective sectors, and the overwriting of all data areas with a constant data pattern. (Reserved areas of the media are not affected by the FORMAT command.)

- **FmtDt** set to one specifies that a Data Out phase follows the Command phase. FmtDt set to zero specifies that no Data Out phase follows.
- **Cmplt** set to one specifies that the GList (Grown Defect List) existing prior to the format **not** be used and is discarded. The Drive is formatted with PList and DList (if specified). DList becomes the new GList.

  Note: The file manages two internal defect lists and one external. The primary defect list ("P"List) is created at time of manufacture and cannot be altered. The grown defect list ("G"List) is built after manufacture by the Initiators use of the REASSIGN BLOCK command and the Automatic Reallocate functions. The data defect list ("D"List) is an external list. It is supplied by the initiator in the DATA OUT phase of the FORMAT UNIT command.
- **List Format** specifies the format of the defect descriptor transferred to the Target when FmtData bit is set to one. This value must be set to zero as the only supported format is logical block. If the FmtData bit is set to zero this field must also be zero otherwise the command will complete with a check condition with a sense key of illegal request and an additional sense code of invalid field in CDB.
- **Interleave Factor** may be zero or one, either of which specifies an interleave of 1:1. Other Interleave Factors are ignored because of the extensive buffering implemented in the file.

7.4.1 Defect List

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Reserved = 0							
BYTE 1	FOV	DPRY =0	DCRT	STPF	IP =0	DSP =0	Immd	0
BYTE 2	Defect list length MSB							
BYTE 3	Defect list length LSB							

Figure 25. Format of Defect List Header. Format of the defect list header sent during the data out phase when FmtDt set to one.

The Target has a limited implementation of the Format Option bits located in Bits 2 through 7 of Byte 1 of the Defect List Header (See Figure 25). If the Initiator attempts to select any function not implemented by the Target, the Target terminate the command with *Check Condition Status*. The sense key is set to *Illegal Request* and the additional sense code is set to *Invalid Field in Parameter List*.

- **FOV** (Format Options Valid) bit of zero causes the Target to verify that the setting for the DPRY (Disable Primary), DCRT (Disable Certification), STPF (stop Format), IP (Initialize Pattern), and DSP (Disable Saving Parameters) bits are zero. If any of these bits are not zero, the Target terminates the command with *Check Condition Status*. The sense key is set to *Illegal Request* and the additional sense code is set to *Invalid Field in Parameter List*.

  Note: When FOV bit is one there is only one combination of the DPRY, DCRT, STPF, IP and DSP bits allowed. Any other combinations return a *Check Condition Status* With a sense key of *Illegal Request* and an additional sense code of *Invalid Field In Parameter List*. The supported combination are:

  DPRY=0 DCRT=1 STPF=1 IP=0 DSP=0

- **DPRY**(Disable Primary) bit set to zero indicates that the Target does not use portions of the medium identified as defective in the primary defect PList for Initiator addressable logical blocks. If the Target cannot locate the PList or it cannot determine whether a PList exists, the target terminates the Format Unit command as described for STPF=1.
- **DCRT** (Disable certification) bit must be set to one. The Target does not generate a CList (certification list) nor perform a certification process while executing the Format Unit Command.
- **STPF** (stop Format) bit must be set to one. If one or both of the following conditions occurs, the Target terminates the Format Unit command with *Check Condition Status*. The sense key is set to *Medium Error* and the additional sense code is set to either *Defect List Not Found* if the first condition occurred, or *Defect List Error* if the second condition occurred.
  - The Target cannot locate a required defect list nor determine that the list exists.
  - The Target encounters an unrecoverable error while accessing a required defect list.
- **IP** (Initialization Pattern) bit must be set to zero. The Target initializes all data with zeros.
- **DSP** (Disable Saving Parameters) bit must be set to zero. The Target saves all the Mode Select savable parameters during the format operation.
- **IMMD** (immediate) bit set to zero requests that status be returned at the end of the format operation. An immediate bit set to one requests that status be returned immediately. *Good Status* is returned following the CDB validation and transfer of data in the Data Out phase. If the immediate format operation terminates in error, Deferred Error Sense data is generated. With the immediate bit set to one, the Link bit must be set to zero.

The Defect List Length field specifies the total length in bytes of the defect descriptors that follow. The Target has an implementation limitation for number of defect descriptors. The number of defect descriptor shall be less than **128**. The defect list length must be equal to four times the number of defect descriptors to follow, otherwise the command is terminated with *Check Condition Status* The sense key is set to *Illegal Request* and the additional sense code is set to *Invalid Field In Parameter List*. The defect descriptors must specify the defect based on the current Format Device parameters reported by the Mode Sense command.

The only format for the defect list supported by the file is by logical block where the location of defective sectors is given by their LBA.

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Defect Descriptor 0 LBA MSB							
BYTE 1	Defect Descriptor 0 LBA							
BYTE 2	Defect Descriptor 0 LBA							
BYTE 3	Defect Descriptor 0 LBA LSB							
BYTE 4n – 4n + 3	Defect Descriptor n LBA							

Figure 26. Format of Defect List. Format of the defect list sent during the data out phase when FmtDt set to one.

7.5 INQUIRY (12)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 12h							
BYTE 1	LUN			RSVD = 0				EVPD
BYTE 2	PAGE CODE							
BYTE 3	RSVD = 0							
BYTE 4	ALLOCATION LENGTH							
BYTE 5	VU = 0		RSVD = 0				FLAG	LINK

Figure 27. INQUIRY (12)

The INQUIRY command requests the parameters of the target to be sent to the initiator.

An EVPD bit of one specifies that the file shall return the vital product data page identified by the Page Code field in the CDB.[1] **Page code** specifies which page of vital product data information the file shall return.

EVPD	PAGE CODE	Description
0	0	The file returns the standard INQUIRY data.
0	Non Zero	The file returns CHECK CONDITION status with the sense key of ILLEGAL REQUEST and the additional sense code of INVALID FIELD IN CDB.
1	Supported	The file returns the vital product data of page code requested.
1	Unsupported	The file returns CHECK CONDITION status with the sense key of ILLEGAL REQUEST and the additional sense code of INVALID FIELD IN CDB.

Allocation Length specifies the number of bytes that the initiator has allocated for INQUIRY data to be returned. An allocation length of zero implies that no data is to be returned. The file will terminate the DATA IN phase when all available INQUIRY data has been transferred or when allocation length bytes have been transferred, whichever is less.

If an INQUIRY command is received from an initiator with a pending unit attention condition (before the target reports CHECK CONDITION status), the file processes the INQUIRY command. The unit attention condition is not cleared by this action.

[1] The available VPD pages are defined in the section entitled **Inquiry Data Format**.

7.5.1 Inquiry data

Two different formats for the INQUIRY data are defined.

- The first format is returned when an invalid LUN is specified by the initiator.
- The second format is returned when a valid LUN is specified by the initiator.

Each of these formats is described in the following sections.

Note: Fields with a value shown inside quotes (e.g. Value = 'xyz') are character fields. A value not in quotes is a numeric value. Character fields are alpha-numeric and represented in either ASCII or EBCDIC as stated.

7.5.1.1 INQUIRY Data Format (When Invalid LUN is Specified)

BYTE	BIT 7	6	5	4	3	2	1	0
0	Qualifier				Peripheral Dev. Type=1Fh			
1	RMB=0	Device–type Modifier=0						
2	ISO=0		ECMA=0			ANSI=2		
3	RSVD = 0					RDF=2		
4	Additional Length = 0							

Figure 28. INQUIRY DATA Invalid LUN Specified

- **Qualifier** is set to 011b. This indicates the LUN specified in the Command Block is not present.[2]
- **Peripheral Dev. Type** is set to 1Fh.
- **Removal Media Bit (RMB)** is always set to zero to indicate no removal media exist.
- **Device-Type Modifier** is set to zero.
- **ISO** is set to zero to indicate that this product does not claim compliance to the International Organization for Standardization (ISO) version of SCSI (ISO DP 9316).
- **ECMA** is set to zero to indicate that this product does not claim compliance to the European Computer Manufacturers Association (ECMA) version of SCSI (ECMA-111).
- **ANSI** indicates the level of the ANSI standard that is supported by the product. The file supports ANSI SCSI version 2.
- **RDF** is set to two to indicate that the Inquiry Data Format as specified in ANSI SCSI version 2 is supported by the file.

[2] For all commands, except inquiry and request sense, if an invalid lun is specified a check condition will be returned.

7.5.1.2 Inquiry Data Format - EVPD = 0

Figure 29 shows the data format.

BYTE	BIT 7	6	5	4	3	2	1	0
0	Qualifier = 0				Peripheral Device Type = 0			
1	RMB=0	Device–Type Modifier = 0						
2	ISO = 0		ECMA = 0			ANSI = 2		
3	RSVD = 0				RDF = 2			
4	Additional Length = 143 (8Fh)							
5–6	Reserved = 0							
7	REL_A = 0	Wb_32 = 0	Wb_16 = 0	Sync = 1	Link = 1	TTD = 0	CmdQu = 1	SftRe = 0
8–15	Vendor ID = 'IBM ' (ASCII)							
16–29	Product ID (ASCII)							
30–31	Reserved (ASCII)							
32–35	Product Revision Level (ASCII)							
36–43	Unit Serial Number (ASCII)							
44–95	Reserved							
96–97	Password Status							
98–147	Reserved. Contents are changed without notice.							

Figure 29. INQUIRY Data - EVPD = 0

- **Qualifier** is set to zero to indicate that the LUN specified in the Command Block is currently supported.
- **Peripheral Device Type** is set to zero to indicate that the device is a Direct-Access.
- **Removal Media Bit (RMB)** is always set to zero to indicate no removal media exist.
- **Device-Type Modifier** is set to zero.
- **ISO** is set to zero to indicate that this product does not claim compliance to the International Organization for Standardization (ISO) version of SCSI (ISO DP 9316).
- **ECMA** is set to zero to indicate that this product does not claim compliance to the European Computer Manufacturers Association (ECMA) version of SCSI (ECMA-111).
- **ANSI** indicates the level of the ANSI standard that is supported by the product. The file supports ANSI SCSI version 2.
- **RDF** is set to two to indicate that the Inquiry Data Format as specified in ANSI SCSI version 2 is supported by the file.
- **Additional Length** indicates the number of bytes of inquiry information that follows.

- **REL_A** is set to zero to indicate that the file does not support 'Relative Address Mode'.
- **Wb_32** is set to zero to indicate that the file does not support 32-bit wide data transfers.
- **Wb_16** is set to zero to indicate that the file does not support 16-bit wide data transfers.
- **Sync** is set to one to indicate that the file supports synchronous data transfer.
- **Link** is set to one to indicate that the file supports linked commands.
- **TTD** is set to zero to indicate that the file does not support the CONTINUE I/O PROCESS and TARGET TRANSFER DISABLE message for this logical unit.
- **CmdQu** is set to one to indicate that the file supports command queuing
- **SftRe** is set to zero to indicate that the target supports Hard Reset only.
- **Vendor ID** is 'IBM' padded with ASCII blanks.
- **Product ID** is specified in ASCII character.

Product ID	DPRS-20810	DPRS-21215
Physical Layout		
Bytes per Sector	512	512
Number of heads	4	6
Number of disks	2	3
Maximum LBA (decimal)	182DBFh (1584575)	24449Fh (2376863)
Number of Blocks (decimal)	182DC0h (1584576)	2444A0h (2376864)

Figure 30. Product ID vs. Formatted Capacity

- **Unit Serial Number** contains the file serial number. If the media is not available, this field will contain ASCII spaces (20h).
- **Password Status** indicates the status of the password for the drive. Please refer to 8.2.6, “ Inquiry Command data” on page 124.

7.5.1.3 Inquiry Data Format - EVPD = 1 - Page Code = 00

BYTE	BIT 7	6	5	4	3	2	1	0
0	Qualifier = 0			Peripheral Dev Type = 0				
1	Page Code = 00h							
2	Reserved = 0							
3	Page Length = 04h							
4	First Supported Page Code = 01h							
5	Second Supported Page Code = 03h							
6	Third Supported Page Code = 80h							
7	Fourth Supported Page Code = 82h							

Figure 31. INQUIRY DATA - EVPD = 1 (Page Code = 00)

- **Qualifier** is set to zero to indicate that the LUN specified in the Command Block is currently supported.
- **Peripheral Device Type** is set to zero to indicate that the device is a Direct-Access.
- **Page Code** is set to 0, and this field contains the same value as in the page code field of the INQUIRY command descriptor block.
- **Page length** is set to 02h, and this field specifies the length of the following page data.
- **The Supported Page Code** field contains the Page Codes supported by the target. The list is ascending order.

7.5.1.4 Inquiry Data Format - EVPD = 1 - Page Code = 01

BYTE	BIT 7	6	5	4	3	2	1	0
0	Qualifier = 0			Peripheral Dev Type = 0				
1	Page Code = 01h							
2	Reserved = 0							
3	Page Length = 47 (2Fh)							
4	ASCII Length = 24 (18h)							
5–16	Reserved							
17	0							
18–27	Reserved							
28	0							
29–40	Reserved							
41–50	Reserved							

Figure 32. INQUIRY DATA - EVPD = 1 (Page Code = 01)

- **Qualifier** is set to zero to indicate that the LUN specified in the Command Block is currently supported.
- **Peripheral Device Type** is set to zero to indicate that the device is a Direct-Access.
- **Page Code** is set to 1, and this field contains the same value as in the page code field of the INQUIRY command descriptor block.
- **Page length** is set to 47, and this field specifies the length of the following page data.
- **ASCII Length** gives the number of bytes of ASCII data to follow.

7.5.1.5 Inquiry Data Format - EVPD = 1 - Page Code = 03

BYTE	BIT 7	6	5	4	3	2	1	0
0	Qualifier = 0			Peripheral Dev Type = 0				
1	Page Code = 03h							
2	Reserved = 0							
3	Page Length = 36 (24h)							
4–7	Reserved = ' ' (ASCII)							
8–11	LOAD ID (ASCII)							
12–15	Mod Level (ASCII)							
16–19	PTF Number = 0							
20–23	Patch Number = 0							
24–35	ROM Code P/N (ASCII)							
36–39	Reserved = 0							

Figure 33. INQUIRY DATA - EVPD = 1 (Page Code = 03)

- **Qualifier** is set to zero to indicate that the LUN specified in the Command Block is currently supported.
- **Peripheral Device Type** is set to zero to indicate that the device is a Direct-Access.
- **Page Code** is set to 3, and this field contains the same value as in the page code field of the INQUIRY command descriptor block.
- **Page length** is set to 36, and this field specifies the length of the following page data.
- **LOAD ID** field is used to verify that the RAM code to be downloaded is compatible with the level of ROM. That is, this field specifies current ROM revision.
- **Mod Level** field specifies the latest RAM code's revision.
- **PTF Number** field is not used and is zero.
- **Patch Number** field is not used and is zero.
- **ROM Code P/N** in ASCII, the ROM code part number. It is left aligned and unused fields are filled with 20h.

7.5.1.6 Inquiry Data Format - EVPD = 1 - Page Code = 80

BYTE	BIT 7	6	5	4	3	2	1	0
0	Qualifier = 0			Peripheral Dev Type = 0				
1	Page Code = 80h							
2	Reserved = 0							
3	Page Length = 16 (10h)							
4–19	Serial Number (ASCII)							

Figure 34. INQUIRY DATA - EVPD = 1 (Page Code = 80)

- **Qualifier** is set to zero to indicate that the LUN specified in the Command Block is currently supported.
- **Peripheral Device Type** is set to zero to indicate that the device is a Direct-Access.
- **Page Code** is set to 80h, and this field contains the same value as in the page code field of the INQUIRY command descriptor block.
- **Page length** is set to 16, and this field specifies the length of the following page data.
- **Serial Number** gives the drive serial number.

7.5.1.7 Inquiry Data Format - EVPD = 1 - Page Code = 82h

BYTE	BIT 7	6	5	4	3	2	1	0
0	Qualifier = 0			Peripheral Dev Type = 0				
1	Page Code = 82h							
2	Reserved = 0							
3	Page Length = 51 (33h)							
4	ASCII Length = 28 (1Ch)							
5–9	Product Type (ASCII)							
10	0							
11–15	Model Number (ASCII)							
16	0							
17–25	Serial Number (ASCII)							
26	0							
27–31	Vendor IBM 'IBM' (ASCII)							
32	0							
33–36	Product Type (EBCDIC)							
37–39	Model Number (EBCDIC)							
40	Reserved = 0							
41–48	Serial Number (EBCDIC)							
49–54	Vendor IBM 'IBM' (EBCDIC)							

Figure 35. INQUIRY DATA - EVPD = 1 (Page Code = 82h)

- **Qualifier** is set to zero to indicate that the LUN specified in the Command Block is currently supported.
- **Peripheral Device Type** is set to zero to indicate that the device is a Direct-Access.
- **Page Code** is set to 82h, and this field contains the same value as in the page code field of the INQUIRY command descriptor block.
- **Page length** field specifies the length of the following page data.
- **ASCII Length** gives the number of bytes of ASCII data to follow.
- **Product Type (ASCII)** gives a 4 digit product type code for the drive. The field is left aligned and unused bytes are filled with 20h.
- **Model Number (ASCII)** gives a 3 digit product type code for the drive. The field is left aligned and unused bytes are filled with 20h.

- **Serial Number (ASCII)** gives the file serial number. The field is left aligned and unused bytes are filled with 20h.
- **Vendor ID (ASCII)** gives the vendor as IBM. The field is left aligned and unused bytes are filled with 20h.
- **Product Type (EBCDIC)** gives a 4 digit product type code for the drive. The field is left aligned and unused bytes are filled with 40h.
- **Model Number (EBCDIC)** gives a 3 digit product type code for the drive. The field is left aligned and unused bytes are filled with 40h.
- **Serial Number (EBCDIC)** gives the file serial number. The field is left aligned and unused bytes are filled with 40h.
- **Vendor ID (EBCDIC)** gives the vendor as IBM. The field is left aligned and unused bytes are filled with 40h.

7.6 MODE SENSE (1A)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command code = 1Ah							
BYTE 1	LUN				RSVD = 0			
BYTE 2	PCF			Page Code				
BYTE 3	RSVD = 0							
BYTE 4	Allocation Length							
BYTE 5	VU = 0		RSVD = 0				FLAG	LINK

Figure 36. MODE SENSE (1A)

The MODE SENSE command provides a means for the file to report various device parameters to the initiator. It is the complement to the MODE SELECT command.

Allocation Length indicates the maximum number of bytes the initiator has set aside for the DATA IN phase. A value of zero is not considered an error. If the allocation length is smaller than the amount available, then that portion of the data up to the allocation length will be sent. It is noted that this may result in only a portion of a multi†byte field being sent.

7.6.1.1.1 Page Control Field: PCF (Page Control Field) defines the type of Page Parameter values to be returned.

PCF **Meaning**

0 0 **Report current values.** The file returns the current values under which the logical unit is presently configured for the page code specified. The current values returned are:

1. The parameters set in the last successful MODE SELECT command.
2. The saved values if a MODE SELECT command has not been executed since the last power-on, hard RESET condition, or BUS DEVICE RESET message .

Note: The file will not process the Mode Select command until the completion of spin-up. Therefore, the initiator cannot modify the current values prior to the saved values being read in.

0 1 **Report changeable value.** The file returns the changeable values for the page code specified. The page requested shall be returned containing information that indicate which fields are changeable. All bits of parameters that are changeable shall be set to one. Parameters that are *defined by the file* shall be set to zero. If any part of a field is changeable all bits in that field shall be set to one.

Note: For a value field such as the buffer ratios of page 2, the bit field will not indicate the range of supported values but rather that the field is supported.

1 0 **Report default value.** The file returns the default values for the page code specified. The parameters not supported by the file are set to zero.

1 1 **Report saved value.** The file returns the saved value for the page code specified.

Saved values are one of following :

- the values saved as a result of MODE SELECT command
- identical to the default values
- zero when the parameters are not supported

The Page Length byte value of each page returned by the file indicates up to which fields are supported on that page.

7.6.1.1.2 Page Code: This field specifies which page or pages to return. Page code usage is defined in Figure 37.

Page Code	Description
01h – 38h	Return specific page.
3Fh	Return all available pages.

Figure 37. Page Code Usage

7.6.2 Mode Parameter List

The mode parameter list contain a header, followed by zero or more block descriptors, followed by zero or more variable†length pages.

7.6.2.1 HEADER

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Mode Data Length							
BYTE 1	Medium Type = 0							
BYTE 2	WP	Reserved = 0						
BYTE 3	Block Descriptor Length (=0 or 8)							

Figure 38. MODE Parameter List (Header)

- **Mode Data Length**. When using the MODE SENSE command, the mode data length field specifies the length in bytes of the following data that is available to be transferred. The mode data length does not include the length byte itself. When using the MODE SELECT command, this field is reserved.
- **Medium Type** field is always set to zero in the file. (Default medium type)
- **WP**. When used with the MODE SELECT command, the write protect (WP) bit is reserved.

  When used with the MODE SENSE command, a write protect (WP) bit of zero indicates that the medium is write enabled.
- **Block Descriptor Length**. This field specifies the length in bytes of the block descriptors.

  When used with the MODE SELECT command, zero or eight are supported by the file.

  When used with the MODE SENSE command, the file returns eight to indicate that only a single block descriptor is available.

7.6.2.2 Block Descriptor

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Density code = 0							
BYTE 1 BYTE 2 BYTE 3	Number of Blocks (MSB) (LSB)							
BYTE 4	RSVD = 0							
BYTE 5 BYTE 6 BYTE 7	Block Length							

Figure 39. MODE Parameter Block Descriptor

The Block descriptor provides formatting information about the Number of Blocks (user addressable) to format at the specified Block Length.

- **Number of Blocks**

  When used with the MODE SELECT command, the **Number of Blocks** field must be;

  – Zero to indicate all available blocks
  – The exact number of blocks in the data area of the file, which can be obtained with the MODE SENSE command.

  Any other value is invalid, and causes the command to fail with CHECK CONDITION status.

  When used with the MODE SENSE command, the field contain exact number of blocks.

- **Block Length**

  When used with the MODE SELECT command, the **Block length** field must contain 512 or zero, or the file will terminate the command with CHECK CONDITION status.

  When used with the MODE SENSE command, the field will return always contain 512 .

7.6.2.3 Page Descriptor

	BIT 7	6	5	4	3	2	1	0
BYTE 0	PS	RSVD=0	Density code = 0					
BYTE 1	Page Length							
BYTE 2–n	Mode Parameters							

Figure 40. MODE Parameter Page Format

Each mode page contains a page code, a page length, and a set of mode parameters.

When using the MODE SENSE command, a parameter savable (PS) bit of one indicates that the mode page can be saved by the file in the reserved area of the file.

A PS bit of zero indicates that the supported parameters cannot be saved. When using the MODE SELECT command, the PS bit is reserved (zero).

7.6.3 Mode Select Data

The file supports the following mode page code:

Page	Description	PS
00h	Vendor Unique Parameters (Unit attention)	1
01h	Read–Write Error Recovery Parameters	1
02h	Disconnect/Reconnect Control Parameters	1
03h	Format Device Parameters	0
04h	Rigid Disk Geometry Parameters	0
07h	Verify Error Recovery Parameters	1
08h	Caching Parameters	1
0Dh	Power Condition Parameters	1
38h	Standby Timer Parameters	1

Figure 41. Page Code Usage

The page length field specifies the length in bytes of the mode parameters that follow. If the initiator does not set this value to the value that is returned for the page by the MODE SENSE command, the file will terminate the command with CHECK CONDITION status.

7.6.3.1 Page 0 (Vendor Unique Parameters)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	PS	RSVD=0	Page Code = 00h					
BYTE 1	Page Length = 0Eh							
BYTE 2	RSVD=0	UQE	DWD	UAI	RSVD = 0			
BYTE 3	ASDPE =0	RSVD=0	CMDAC	RPFAE	RSVD = 0			CPE
BYTE 4	Ignore							
BYTE 5	RSVD=0	TCC	DSN	FRDD	DPSDP =0	RSVD=0	CAEN	LITF
BYTE 6	RSVD = 0							
BYTE 7	RSVD = 0							
BYTE 8	RSVD=0	ADC	QEMC	DRD	LED			
BYTE 9	RSVD = 0							
BYTE 10	Command Aging Limit (Hi byte)							
BYTE 11	Command Aging Limit (Low byte)							
BYTE 12	RSVD = 0							
BYTE 13	RSVD = 0							
BYTE 14	DRRT	DNR	RSVD = 0					
BYTE 15	RSVD = 0							

Figure 42. Page 0

Fields marked in the table as 'Ignore' are not used or checked by the file. They will be initialized to zero but may be set as desired. This is for compatibility with older drives.

Changeable Parameter	Default Value
UQE	1
DWD	0
UAI	1
CMDAC	0
RPFAE	0
CPE	1
TCC	0

DSN	0
FRDD	0
CAEN	1
LITF	1
ADC	1
QEMC	0
DRD	0
LED	0
Command Aging Limit	48
DRRT	0
DNR	0

- **UQE**, The UQE(untagged queuing enable) bit controls whether or not untagged queuing is allowed.
- **DWD**, Disable Write Disconnect bit, is set to zero to indicate that the drive is allowed to disconnect from the SCSI bus after receiving a Write(6),Write extend(10), Write and verify or Write long command and prior to starting the data out phase. (The previous identify message must grant the drive the privilege of disconnection or the drive does not disconnect.)
  A DWD bit of one indicates that the drive is not allowed to disconnect from the SCSI bus after receiving a Write(6),Write extend(10), Write and verify or Write long command and prior to the data out phase is started. After the data out phase is started, the drive may disconnect to free the SCSI bus. This occurs if the Target's internal control algorithms and other disconnect/reconnect control parameters indicate that this is appropriate and permissible.

  Within the file this bit is actually ignored. If no other commands are in progress then the file will not disconnect. If other commands are in progress then the file will disconnect to avoid possible deadlock conditions.
- **UAI**, Unit Attention Inhibit bit, is set to zero to indicate that the drive posts Unit Attention conditions.
  A UAI bit of one indicates that the drive does not post Unit Attention conditions.
- **ASDPE**, Additional Save Data Pointer Enable bit, is used to control the sedning of additional save data pointers messages. When set it will cause a save data pointers message to be sent on every disconnection. When not set a save data pointers message is only sent if the current connection contained a data phase and a further data phase will be required to complete the command. This field must be set to zero as this function is not currently supported
- **CMDAC** determines if an LED on the file is activated while commands are active. As this file does not support an LED this bit is allowed to be changed by the initiator for host system device driver compatibility.
- **RPFAE**, Report Predictive Failure Analysis Error bit. This bit when set allows the drive to report the result of predictive failure analysis. As this drive does not support predictive failure analysis this bit is ignored. It is allowed to be modified by the initiator for host system device driver compatibility.
- **CPE**, Concurrent processing enable bit, is set to zero to indicate that only untagged and unlinked Request Sense or Inquiry can be executed concurrently.
  A CPE bit of one indicates that Read(6), Read extend(10), Write(6) and Write extend(10), as well as the above 2 commands, can be executed concurrently.
- **TCC**Thermal Compensation bit controls when the drive will perform thermal compensation. As this drive does not perform thermal compensation this bit is ignored internally. It is allowed to be modified by the initiator for host system device driver compatibility.

- **DSN** Disable Target Initiated Synchronous Negotiation. When this bit is set the drive will perform a synchronous negotiation if one is not initiated by the initiator after power on, reset etc. As this bit is read from the disk only after the motor has been started the target will not initiate a negotiation until this point in time after the power is applied. This bit is ignored internally.
- **FRDD** When set this bit stops the drive reporting a format degraded condition after a failed format or reassign command. As this drive does not have a format degraded mode this bit is ignored. It is allowed to be modified by the initiator for host system device. This bit is ignored internally.
- **DPSDP**, Data Phase Save Data Pointer bit, controls whether the drive sends a save data pointer message at the end of a data phase. When set the drive will send the message after every data phase. When reset the message will only be sent if another data phase is required to complete the command. This bit is ignored internally.
- **CAEN** When set this bit causes the Command Age Limit timer to be used to avoid commands waiting in the command queue for an indefinite period. When commands have been in the queue for a period of time greater than the timer limit they will be re-ordered to be executed in on a first come first served basis. When this bit is reset commands are always executed based on the queue re-ordering rules.
- **LITF** This bit disables the file idle time function which saves the log select counters. If this bit is set these counters are not written to disk and so will be lost at the next power cycle.
- **ADC** Adaptive Cache Enable, when set, allows the file to modify the read-ahead caching algorithm, ignoring parameters in Page 8. The adaption is based on analyzing the most recent command history and the current contents of the cache buffers.
- **QEMC**, Queue Error Management Control, bit effects how the queue is managed after an error has occurred. If the Qerr bit in page 0Ah is zero then this bit is ignored. If however Qerr is set then this bit controls the action taken with queued commands which originated from initiators other than that which has experienced the error. If this bit is zero then there is no effect on commands from other initiators. If this set commands from all initiators will be aborted. This bit must be set to zero as this function is not currently supported.
- **DRD** Disable Read Disconnect bit, when set, disables the file from dis-connecting from the bus on a read or read extended command until the contents of the cache have been checked. This bit is ignored internally by the file. When a read command arrives the file will automatically disconnect if any other command is in progress. If no commands are in progress then the file will stay connected until the cache has been checked. It is allowed to be modified by the initiator for host system device driver compatibility.
- **LED** This field is designed to control the operation of a file LED driver. As this file does not support an LED the field is internally ignored. It is allowed to be modified by the initiator for host system device driver compatibility.
- **Command Aging Limit** This value is used to control the maximum time a command should wait in the command queue when the CAEN bit is set. Each unit of this timer is 50ms.
- **DRRT** Disable Read Reassign Target, when set, will stop the file attempting to move the data in a sector to the new location, when the LBA is being reassigned. This bit is internally ignored by the file which will always attempt to move the data. It is allowed to be modified by the initiator for host system device driver compatibility.
- **DNR** Disable Nested Reassigns, when set, disables nested reassigns and means only the target LBA will be moved on a reassign command. This file never performs nested reassigns, as it is not required by the disk format, so this bit is ignored internally. It is allowed to be modified by the initiator for host system device driver compatibility.

7.6.3.2 Page 1 (Read/Write Error Recovery Parameters)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	PS	RSVD=0	Page Code = 01h					
BYTE 1	Page Length = 0Ah							
BYTE 2	AWRE	ARRE	TB	RC = 0	EER=0	PER	DTE	DCR
BYTE 3	Read Retry Count							
BYTE 4	Correction Span							
BYTE 5	Head Offset Count (Not used)							
BYTE 6	Data Strobe Offset Count (Not used)							
BYTE 7	Reserved							
BYTE 8	Write Retry Count							
BYTE 9	Reserved							
BYTE 10	(MSB) Recovery Time Limit (Not Used)							
BYTE 11								(LSB)

Figure 43. Page 1

Changeable Parameter	Default Value
AWRE	1
ARRE	1
TB	0
PER	0
DTE	0
DCR	0
Correction Span	0
Read Retry Count	01h
Write Retry Count	01h

The Read-Write recovery parameters that will be used during any command that performs a read or write operation to the medium.

- **AWRE**, an Automatic write reallocation enabled bit is set to zero to indicate that the file shall not perform automatic reallocation of defective data blocks during write operations.
  A AWRE bit is set to one to indicate that the file shall perform automatic reallocation of defective data blocks during write operations.
- **ARRE**, an Automatic read reallocation enabled bit is set to zero to indicate that the file shall not perform automatic reallocation of defective data blocks during read operations.

A ARRE bit is set to one to indicate that the file shall perform automatic reallocation of defective data blocks during read operations.

- **TB**, Transfer Block bit, is set to one to indicate that a data block that is not recovered within the recovery limits specified shall be transferred to the initiator before CHECK CONDITION status is returned.
  A TB bit of zero indicates that such a data block shall not be transferred to the initiator. Data blocks that can be recovered within the recovery limits are always transferred, regardless of the value of the bit.
- **RC**, A read continuous bit. **Must be set to zero** , indicating that the error recovery operations that cause delays are acceptable during the data transfer. Data shall not be fabricated.
- **EER**,An enable early recovery bit. **Must be set to zero** , indicating that the file shall use an error recovery procedure that minimizes the risk of mis-detection or mis-correction during the data transfer. Data shall not be fabricated.
- **PER**, Post Error bit, is set to one to indicate that the file reports recovered errors.
- **DTE**, Disable Transfer on Error bit, is set to one to indicate that the file terminates the DATA phase upon detection of a recovered error .
- **DCR**, Disable Correction bit, is set to one to indicate that Error Correction Code is not used for data error recovery.
  A DCR bit of zero indicates that ECC is applied to recover the data.
- **Read Retry Count** sets a limit on the amount of data recovery procedure(DRP) passes the Target attempts when recovering read errors. One pass through DRP involves executing all steps of DRP. Only values of 00h and 01h are valid. A value of zero disables all error recovery procedures.
- **Correction Span** field specifies the size, in bits, of the largest data error burst for which data error correction may be attempted. Any value may be set into this field, including zero. The file will always use it's default correction capabilities.
- **Head Offset Count** is not supported by the file.

  Note: Head Offset is implemented in the read error recovery routine. The user can not modify the offset value.
- **Write Retry Count** sets a limit on the amount of data recovery procedure(DRP) passes the Target attempts when recovering write errors. One pass through DRP involves executing all steps of DRP. Only values of 00h and 01h are valid. A value of zero disables all error recovery procedures.

The following summarizes valid modes of operation. If an illegal mode is set the mode select command will complete successfully but the action of the file when an error occurs is undefined.

PER	DTE	DCR	TB	DESCRIPTION
0	**0**	**0**	**0**	Retries and Error Correction are attempted. Recovered and/or corrected data (if any) is transferred with no CHECK CONDITION status at the end of the transfer. **no err** The transfer length is exhausted. **soft err** The transfer length is exhausted. Transferred data includes blocks containing recovered errors. **hard err** Data transfer stops when an unrecoverable error is encountered. The unrecoverable block is not transferred to the initiator. The file then creates the CHECK CONDITION status with the appropriate Sense Key.
0	**0**	**0**	**1**	Retries and Error Correction are attempted. Recovered and/or corrected data (if any) is transferred with no CHECK CONDITION status at the end of the transfer. **no err** The transfer length is exhausted. **soft err** The transfer length is exhausted. Transferred data includes blocks containing recovered errors. **hard err** Data transfer stops when an unrecoverable error is encountered. The unrecoverable block is transferred to the initiator. The file then creates the CHECK CONDITION status with the appropriate Sense Key.
0	**0**	**1**	**0**	Retries are attempted but no error correction (ECC) is applied. Recovered data (if any) is transferred with no CHECK CONDITION status at the end of the transfer. **no err** The transfer length is exhausted. **soft err** The transfer length is exhausted. Transferred data includes blocks containing recovered errors. **hard err** Data transfer stops when an unrecoverable error is encountered. The unrecoverable block is not transferred to the initiator. The file then creates the CHECK CONDITION status with the appropriate Sense Key.
0	**0**	**1**	**1**	Retries are attempted but no error correction (ECC) is applied. Recovered data (if any) is transferred with no CHECK CONDITION status at the end of the transfer. **no err** The transfer length is exhausted. **soft err** The transfer length is exhausted. Transferred data includes blocks containing recovered errors. **hard err** Data transfer stops when an unrecoverable error is encountered. The unrecoverable block is transferred to the initiator. The file then creates the CHECK CONDITION status with the appropriate Sense Key.
0	**1**	**0**	**0**	Illegal Request-DTE must be zero when PER is zero
0	**1**	**0**	**1**	Illegal Request-DTE must be zero when PER is zero
0	**1**	**1**	**0**	Illegal Request-DTE must be zero when PER is zero
0	**1**	**1**	**1**	Illegal Request-DTE must be zero when PER is zero

1 0 0 0 The highest level error is reported at the end of transfer. Retries and error correction are attempted. Recovered and/or corrected data (if any) is transferred with CHECK CONDITION status and RECOVERED ERROR Sense Key set at the end of the transfer.

no err The transfer length is exhausted.

soft err The transfer length is exhausted. Transferred data includes blocks containing recovered errors. The information byte in the sense data will contain the logical block address of the last recovered error.

hard err Data transfer stops when an unrecoverable error is encountered. The unrecoverable block is not transferred to the initiator. The file then creates the CHECK CONDITION status with the appropriate Sense Key.

1 0 0 1 The highest level error is reported at the end of transfer. Retries and error correction are attempted. Recovered and/or corrected data (if any) is transferred with CHECK CONDITION status and RECOVERED ERROR Sense Key set at the end of the transfer.

no err The transfer length is exhausted.

soft err The transfer length is exhausted. Transferred data includes blocks containing recovered errors. The information byte in the sense data will contain the logical block address of the last recovered error.

hard err Data transfer stops when an unrecoverable error is encountered. The unrecoverable block is transferred to the initiator. The file then creates the CHECK CONDITION status with the appropriate Sense Key.

1 0 1 0 The highest level error is reported at the end of transfer. Retries are attempted but ECC is not applied. Recovered and/or corrected data (if any) is transferred with CHECK CONDITION status and RECOVERED ERROR Sense Key set at the end of the transfer.

no err The transfer length is exhausted.

soft err The transfer length is exhausted. Transferred data includes blocks containing recovered errors. The information byte in the sense data will contain the LBA of the last recovered error.

hard err Data transfer stops when an unrecoverable error is encountered. The unrecoverable block is not transferred to the initiator. The file then creates the CHECK CONDITION status with the appropriate Sense Key.

1 0 1 1 The highest level error is reported at the end of transfer. Retries are attempted but ECC is not applied. Recovered and/or corrected data (if any) is transferred with CHECK CONDITION status and RECOVERED ERROR Sense Key set at the end of the transfer.

no err The transfer length is exhausted.

soft err The transfer length is exhausted. Transferred data includes blocks containing recovered errors. The information byte in the sense data will contain the LBA of the last recovered error.

hard err Data transfer stops when an unrecoverable error is encountered. The unrecoverable block is transferred to the initiator. The file then creates the CHECK CONDITION status with the appropriate Sense Key.

1 1 0 0 The highest level error is reported at the end of transfer. Retries and error correction are attempted. Recovered and/or corrected data (if any) is transferred with CHECK CONDITION status and RECOVERED ERROR Sense Key set at the end of the transfer.

no err The transfer length is exhausted.

soft err The transfer stops on the first soft error detected. The information in the sense data shall contain the LBA of the block in error.

hard err Data transfer stops on the unrecoverable error. The file then creates the CHECK CONDITION status with the appropriate Sense Key.

1 1 0 1 The highest level error is reported at the end of transfer. Retries and error correction are attempted. Recovered and/or corrected data (if any) is transferred with CHECK CONDITION status and RECOVERED ERROR Sense Key set at the end of the transfer.

no err The transfer length is exhausted.

soft err The transfer stops on the first soft error detected. The information in the sense data shall contain the LBA of the block in error.

hard err Data transfer stops on the unrecoverable error. The unrecoverable error block is returned to the initiator. The file then creates the CHECK CONDITION status with the appropriate Sense Key.

1 1 1 0 The highest level error is reported at the end of transfer. Retries are attempted but ECC is not applied. Recovered data is transferred with CHECK CONDITION status and RECOVERED ERROR Sense Key set at the end of the transfer.

no err The transfer length is exhausted.

soft err The transfer stops on the first soft error detected. The recovered error block is returned to the initiator. The information in the sense data shall contain the logical block address of the block in error.

hard err Data transfer stops on the unrecoverable error. The file then creates the CHECK CONDITION status with the appropriate Sense Key.

1 1 1 1 The highest level error is reported at the end of transfer. Retries are attempted but ECC in not applied. Recovered and/or corrected data (if any) is transferred with CHECK CONDITION status and RECOVERED ERROR Sense Key set at the end of the transfer.

no err The transfer length is exhausted.

soft err The transfer stops on the first soft error detected. The information in the sense data shall contain the logical block address of the block in error.

hard err Data transfer stops on the unrecoverable error. The unrecoverable error block is returned to the initiator. The file then creates the CHECK CONDITION status with the appropriate Sense Key.

7.6.3.3 Page 2 (Disconnect/Reconnect Parameters)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	PS	RSVD=0	Page Code = 02h					
BYTE 1	Page Length = 0Ah							
BYTE 2	Read Buffer Full Ratio							
BYTE 3	Write Buffer Empty Ratio							
BYTE 4 – 11	Reserved=0							

Figure 44. Page 2

Changeable Parameter	**Default Value**
Read Buffer Full Ratio	00h
Write Buffer Empty Ratio	00h

The disconnect / reconnect page provides the initiator the means to tune the performance of the SCSI bus.

An initiator may use the IDENTIFY message to grant the file the general privilege of disconnecting. (Disconnect requests may still be selectively rejected by the initiator by issuing a MESSAGE REJECT).

The file uses the disconnect/reconnect parameters to control reconnection during READ (operation code 08h and 28h) and WRITE (0Ah , 2Ah and 2E).

- **Read Buffer Full Ratio** is the numerator of a fraction whose denominator is 256. The fraction indicates how full the file data buffer should be before attempting to reconnect to the SCSI bus. If the ratio is set to 0h, the target will calculate and use an optimal ratio based on the negotiated transfer rate.
- **Write Buffer Empty Ratio** is the numerator of a fraction whose denominator is 256. The fraction indicates how empty the file data buffer should be before attempting to reconnect to the SCSI bus. If the ratio is set to 0h, the target will calculate and use an optimal ratio based on the negotiated transfer rate.

7.6.3.3.1 Reconnection to a disconnected read command: For a read command, the reconnect is delayed relative to the availability of the first block in the file data buffer by the fraction of the file data buffer size. If the remaining data transfer length is less than the fraction of the file data buffer size, the file control program calculates the optimal reconnection point to complete the data transfer as early as possible while minimizing the time connected to the SCSI bus.

7.6.3.3.2 Reconnection to a disconnected write command: For a write command, the Write Buffer Ratio is significant only if the total data transfer length is greater than the size of the file data buffer. The fraction determines how empty the file data buffer should be before reconnecting to begin filling the buffer again.

7.6.3.4 Page 3 (Format Device Parameters)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	PS = 0	RSVD=0	Page Code = 03h					
BYTE 1	Page Length = 16h							
BYTE 2	(MSB) Track per Zone = 01E4h							
BYTE 3	(LSB)							
BYTE 4	(MSB) Alternate Sectors per Zone = 0032h							
BYTE 5	(LSB)							
BYTE 6	(MSB) Alternate Tracks per Zone = 0001h							
BYTE 7	(LSB)							
BYTE 8	(MSB) Alternate Tracks per Logical Unit = 0008h							
BYTE 9	(LSB)							
BYTE 10	(MSB) Sectors per Track = 003Fh							
BYTE 11	(LSB)							
BYTE 12	(MSB) Data Bytes per Physical Sector = 0200h							
BYTE 13	(LSB)							
BYTE 14	(MSB) Interleave = 0001h							
BYTE 15	(LSB)							
BYTE 16	(MSB) Track Skew Factor = 000Bh							
BYTE 17	(LSB)							
BYTE 18	(MSB) Cylinder Skew Factor = 000Fh							
BYTE 19	(LSB)							
BYTE 20	SSEC =0	HSEC =1	RMB =0	SURF =0	RESERVED			
BYTE 21–23	RESERVED							

Figure 45. Page 3

The format device page contains parameters which specify the medium format.

SSEC Zero. Indicates that the file does not support soft sector formatting.

HSEC One. Indicates that file support hard sector formatting.

RMB Zero. Indicates that the media does not support removable. Fixed Disk.

SURF Zero. Indicates that progressive address are assigned to all logical blocks a cylinder prior to allocating address within the next cylinder.

7.6.3.5 Page 4 (Rigid Disk Drive Geometry Parameters)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	RSVD = 0				Page Code = 04h			
BYTE 1	Page Length = 0016h							
BYTE 2	(MSB) Number of Cylinders = 0624h (DPRS—20810) 0936h (DPRS—21215)							
BYTE 4								(LSB)
BYTE 5	Number of Heads = 010h							
BYTE 6	(MSB) Starting Cylinder—Write Precompensation = 0							
BYTE 8								(LSB)
BYTE 9	(MSB) Starting Cylinder—Reduced Write Current = 0							
BYTE 11								(LSB)
BYTE 12	(MSB) Drive Step Rate (Not used)							
BYTE 13								(LSB)
BYTE 14	(MSB) Landing Zone Cylinder (Not used)							
BYTE 16								(LSB)
BYTE 17	RESERVED						RPL = 0	
BYTE 18	Rotational Offset = 00 (Not used)							
BYTE 19	RESERVED							
BYTE 20	(MSB) Medium Rotation Rate = 1306h							
BYTE 21								(LSB)
BYTE 22	RESERVED							
BYTE 23								

Figure 46. Page 4

The rigid disk drive geometric page specifies various parameters for the file.

RPL Zero. Indicates that the file does not support spindle synchronization.

7.6.3.6 Page 7 (Verify Error Recovery Parameters)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	PS	RSVD=0	Page Code = 07h					
BYTE 1	Page Length = 0Ah							
BYTE 2	Reserved = 0				EER=0	PER	DTE=0	DCR
BYTE 3	Verify Retry Count							
BYTE 4	Correction Span							
BYTE 5	Reserved = 0							
BYTE 6	Reserved = 0							
BYTE 7	Reserved = 0							
BYTE 8	Reserved = 0							
BYTE 9	Reserved = 0							
BYTE 10	(MSB) Verify Recovery Time Limit (Not Used)							
BYTE 11								(LSB)

Figure 47. Page 7

Changeable Parameter	Default Value
PER	1
DCR	0
Correction Span	00h
Verify Retry Count	01h

The Verify recovery parameters are used by the Target when recovering from and reporting errors associated with the verification of the initiator's Data for the following commands:

- Verify
- Write and Verify - the verify portion of the command only.

Since bytes 4-11 are not changeable, the Mode Select Commands accepts only the values indicated for bytes 4 - 11.

- **EER**, This bit is 0 since the Target does not support early recovery.
- **PER**, See below for description of bit values.
- **DTE**, This bit is 0 since the Target always continues on recovered verify operation errors.
- **DCR**, See below for description of bit values.

PER, DTE, and DCR bit settings in page 7 override those of page 1 during Verify and the Verify portion of Write and Verify. There are only four valid conditions for the PER, DTE, and DCR bits. All other combinations return Check Condition Status.

PER	DTE	DCR	DESCRIPTION
0	**0**	**0**	Soft errors are not reported. ECC is applied to recover the data.
1	**0**	**0**	Soft errors are reported. ECC is applied to recover the data.
0	**0**	**1**	Soft errors are not reported. ECC is not used to recover the data.
1	**0**	**1**	Soft errors are reported. ECC is not used to recover the data.

- **Verify Retry Count** sets a limit on the amount of verify recovery procedure(VRP) passes the Target attempts when recovering verify errors. The Verify Retry Count of one causes the Target to attempt up to one VRP pass per command when a medium error occurs during a verify operation. Only values of 0h and 01h are valid. The value of 0h disables all recovery.
- **Verify Correction Span** field specifies the size, in bits, of the largest data error burst for which data error correction may be attempted. The field may be set to any value but the file will not use offline correction during verify operations.

7.6.3.7 Page 8 (Caching Parameters)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	PS	RSVD=0	Page Code = 08h					
BYTE 1	Page Length = 0Ch							
BYTE 2	RESERVED = 0					WCE	MF	RCD
BYTE 3	Read Retention Priority=0				Write Retention Priority=0			
BYTE 4–5	Disable Pre–fetch Transfer Length							
BYTE 6–7	Minimum Pre–fetch							
BYTE 8–9	Maximum Pre–fetch							
BYTE 10–11	Maximum Pre–fetch Ceiling							
BYTE 12	RESERVED = 0							
BYTE 13	Number of Cache Segments							

Figure 48. Page 8

Changeable Parameter	Default Value
WCE	0
MF	0
RCD	0
Disable Pre-fetch transfer length	0
Minimum Pre-fetch	0
Maximum Pre-fetch	0
Maximum Pre-fetch Ceiling	0
Number of Cache Segments	4

The caching parameters page defines parameters that affect the use of the cache.

- **WCE**, Write Cache enable bit, is set to zero to indicate that the drive must issue Good Status for Write(6) or Write extend(10) command only after successfully writing the data to the media. A WCE bit of one indicates that the drive may issue Good Status for a Write(6) or Write extend(10) command after successfully receiving the data but before writing it to the media.

  Note: When WCE = 1, a Synchronize Cache command must be done to assume data is written to the media before powering down the Target.
- **MF**, Multiplication Factor determines how the Maximum Pre-fetch field is interpreted. When this bit is set the data to pre-fetch is given by the command length multipled by the value in the Maximum Pre-

fetch field. When this bit is reset the value in the Maximum pre-fetch field is used as the absolute length to pre-fetch.

- **RCD**, Read Cache disable bit, of zero indicates that the file may return data requested by a READ command by accessing either the cache or the Read Ahead Buffer, or media. A RCD bit of one indicates that the file shall transfer all data requested by a READ command by accessing the media (i.e., data cannot be transferred from the cache or Read Ahead Buffer).
- **Read Retention Priority**, Demand Read Retention Priority is not supported.
- **Write Retention Priority**, Write Retention Priority is not supported.
- **Disable Pre-fetch Transfer Length** specifies a number of LBA's which if a read command length exceeds will cause the file not to perform read ahead buffering after the command has completed. A value of zero specifies read ahead should always be performed.
- **Minimum Pre-fetch** specifies the minimum number of LBA's that the file should read ahead after each read command. A value of zero indicates that read ahead should be terminated immediately a new command arrives, except in the case when the new command is on the current head and track. In addition pre-fetch will be abandoned at the end of the current track.
- **Maximum Pre-fetch** specifies the maximum number of LBA's to read ahead after a read command. This field can either be used as an absolute value, if the MF bit is 0, or else it will be multipled by the read command length to give the actual length to read ahead. A value of zero indicates that read ahead will be performed until the segment is full of read ahead data. If the length of a read command is less than the segment size then read ahead will be continued until the segment is full regardless of this setting (except when the read ahead is pre-empted by a subsequent command).
- **Maximum Pre-fetch ceiling** specifies the maximum number of blocks the file should attempt to read ahead. It is particularly relevant when the MF bit is set. A value of zero indicates no limit. If the length of a read command is less than the segment size then read ahead will be continued until the segment is full regardless of this setting (except when the read ahead is pre-empted by a subsequent command).
- **Number of Cache Segments**

  This field is used to indicate to the file how many segments are requested by the initiator. Segments can be either 32K or 64K in size and all segments must be the same size. The file will attempt to partition the buffer into 64K segments but if there is not enough space for the number of segments requested in this field it will partition the buffer as 32K segments.

7.6.3.8 Page 0D (Power Condition)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	PS	RSVD=0	Page Code = 0Dh					
BYTE 1	Page Length = 0Ah							
BYTE 2	Reserved = 0							
BYTE 3	Reserved = 0						RSVD = 0	RSVD = 0
BYTE 4	Reserved = 0							
BYTE 5								
BYTE 6								
BYTE 7								
BYTE 8	(MSB)							
BYTE 9	Reserved = 0							
BYTE 10								
BYTE 11								(LSB)

Figure 49. Page 0D

The power condition page provides the initiator the means to control the length of time a target will delay before changing its power requirements. There is no notification to the initiator that a target has entered into one of the power conditions. On the receipt of a command, only the timer(s) controlling power for the command shall be reset and then restarted on completion of that command.

7.6.3.9 Page 38 (Standby Timer Parameters)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	PS	RSVD=0	Page Code = 38h					
BYTE 1	Page Length = 04h							
BYTE 2	Reserved = 0							
BYTE 3	Auto Standby Time (Minutes)							
BYTE 4	Reserved = 0							
BYTE 5	Reserved = 0							

Figure 50. Page 38

Changeable Parameter	**Default Value**
Auto Standby Time	6Dh (109minutes)

The file will enter the standby condition automatically after the timer counts up to Auto Standby Time. The timer will be reset when the file receives any command except Inquiry, Request Sense and Test Unit Ready command. Zero of Auto Standby Time indicates that the file disables Auto Standby function.

- **Auto Standby Time.** Auto Standby Time field indicates the time that the drive changes to Standby mode automatically. The range of this field is from **00h** to **0FFh**(255min) in minutes.

7.7 MODE SELECT (15)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 15h							
BYTE 1	LUN			PF=1	RSVD = 0			SP
BYTE 2	RSVD = 0							
BYTE 3	RSVD = 0							
BYTE 4	Parameter List Length							
BYTE 5	VU = 0		RSVD = 0				FLAG	LINK

Figure 51. MODE SELECT (15)

The MODE SELECT command provides a means for the initiator to specify LUN or device parameters to the Target. It also allows an Initiator to specify options the Target uses in error recovery and Caching.

There is a single set of Mode Page parameters shared by all initiators.

PF A PF(Page Format) bit value of 1 indicates the data sent by the Initiator after the Mode Select Header and the Block Descriptor, if any, complies to the Page Format. The Target ignores this field since it only accepts mode parameters in the Page Format.

SP Save Pages. This indicates;

0 The drive shall not save the pages sent during the Data Out phase but will use them for all following commands until the power is removed, a reset is received or a new mode select command is received.

1 The drive will save the data in the reserved area of the disk. It will be used for all following commands until another mode select command is issued, this information is maintained over a power cycle or reset of the file.

Parameter List Length

This specifies the number of bytes to be sent from the initiator. A parameter list length of zero suppresses data transfer and is not considered as an error.

The MODE SELECT parameter list contains a four-byte header, followed by zero or one block descriptor followed by zero or more pages. The pages which are valid with this command are defined in the addendum under the heading **Mode Select Data**. as they vary with the file model.

7.7.1.1 Application Note

The initiator should issue a MODE SENSE command requesting all Changeable values (see PCF field in byte two of the CDB in 7.6, “MODE SENSE (1A)” on page 52) prior to issuing a MODE SELECT command. This is necessary to find out which pages are implemented by the file and the length of those pages. The file will return, in the Pages of the MODE SENSE command, the number of bytes supported for each Page. The Page Length set by the initiator in the MODE SELECT command must be the exact value as that returned by the file in MODE SENSE Page Length. If this is not true, the file will return CHECK CONDITION status with sense key of ILLEGAL REQUEST. See 7.6, “MODE SENSE (1A)” on page 52.

Note: If an initiator sends a MODE SELECT command that changes any parameters that apply to other initiators, the file shall generate an unit attention condition for all initiators except the one that issued the MODE SELECT command. The file shall set the additional sense code to PARAMETERS CHANGED (2Ah).

7.8 PRE-FETCH (34)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 34h							
BYTE 1	LUN			Reserved = 0			Immed	RelAdr = 0
BYTE 2	(MSB)	Logical Block Address						
BYTE 3								
BYTE 4								
BYTE 5								(LSB)
BYTE 6	Reserved = 0							
BYTE 7	(MSB)	Transfer Length						
BYTE 8								(LSB)
BYTE 9	VU = 0			Reserved = 0			FLAG	LINK

Figure 52. Pre-Fetch (34)

The PRE-FETCH command requests the file to transfer data to the cache. No data is transferred to the initiator.

Immed Immediate.

If the Immediate (Immed) bit of the CDB is zero:

- If an error occurs while reading,error recovery procedures are attempted. The Drive returns GOOD status or CHECK CONDITION status based on the setting of the MODE SELECT Page 1 parameters.
- If there is enough room in the segment for all of the Requested Data or if the Transfer Length is zero and no error occurs while reading,the Drive returns CONDITION MET status when the command completes.
- If there is not enough room in the segment,the Transfer Length is not zero, and no error occurred while reading,the Drive returns GOOD status when the command completes.

If the Immediate (Immed) bit of the CDB is one:

- If there is enough room in the segment for all of the Requested Data or if the Transfer Length is zero,the Drive returns CONDITION MET status as soon as the CDB is verified.
- If there is not enough room in the segment and the Transfer Length is not zero,the Drive returns GOOD status as soon as the CDB is verified.
- The reading of data is handled the same as Read-Ahead operation.This implies the prefetch may be terminated upon receipt of another command.
- if an error is encountered:
  1. The file terminates the Pre-Fetch operation and does not attempt to recover the data.

2. The error is not reported to the Initiator for the current command. (the error will be reported during the next command if the next command is a Read command that requests the block which encountered the error.)
3. The blocks which were successfully read prior to the block in error are retained in the cache.

RelAdr Relative Block Address. **Must be set to zero**, indicating that the logical block address field specifies the first logical block of the range of logical blocks to be operated on by this command. Relative address is not supported.

Transfer length The transfer length field specifies the number of contiguous blocks of data that are to be transferred into the cache. A transfer length of zero indicates that blocks are to be transferred into the cache until the segment is filled or there are no more blocks on the media.

7.9 READ (08)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 08h							
BYTE 1	LUN			(MSB)	LBA			
BYTE 2	LOGICAL BLOCK ADDRESS							
BYTE 3	LOGICAL BLOCK ADDRESS (LSB)							
BYTE 4	TRANSFER LENGTH							
BYTE 5	VU = 0		RSVD = 0				FLAG	LINK

Figure 53. READ (08)

The READ command requests the file to transfer the specified number of blocks of data to the initiator starting at the specified logical block address.

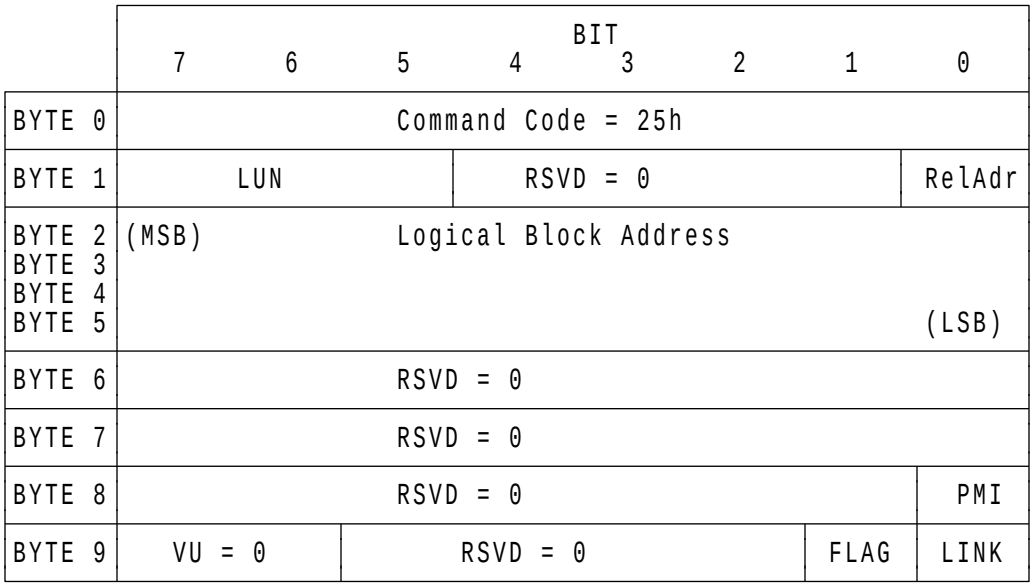
Logical block address This field specifies the logical unit at which the read operation shall begin.

Transfer length This field specifies the number of blocks to be transferred. A value of zero implies 256 blocks are to be transferred.[3]

Note: Errors are handled by ERP(error recovery procedure). ERPs are controlled by the error recovery parameters specified by MODE SELECT command.

[3] Block is 512 bytes in length.

7.10 READ CAPACITY (25)



	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 25h							
BYTE 1	LUN			RSVD = 0				RelAdr
BYTE 2	(MSB)	Logical Block Address						
BYTE 3								
BYTE 4								
BYTE 5								(LSB)
BYTE 6	RSVD = 0							
BYTE 7	RSVD = 0							
BYTE 8	RSVD = 0							PMI
BYTE 9	VU = 0			RSVD = 0			FLAG	LINK

Figure 54. READ CAPACITY (25)

The READ CAPACITY command returns information regarding the capacity of the file.

- **RelAdr**. A Relative Address is not supported. Must be set to zero.
- **Logical Block Address** is used in conjunction with the PMI bit.
- **PMI**, Partial Medium Indicator indicates;

PMI	Description
0	The drive returns the last logical block address of the file.
1	The drive returns the last logical block address and block length in bytes are that of the logical block address after which a substantial delay in data transfer will be encountered. This returned logical block address shall be greater than or equal to the logical block address specified by the RelAdr and logical block address fields in the command descriptor block. This option provides the information the initiator needs to determine the amount of space available on the same track which is accessible without a head switch or seek.

7.10.1.1 Returned Data Format

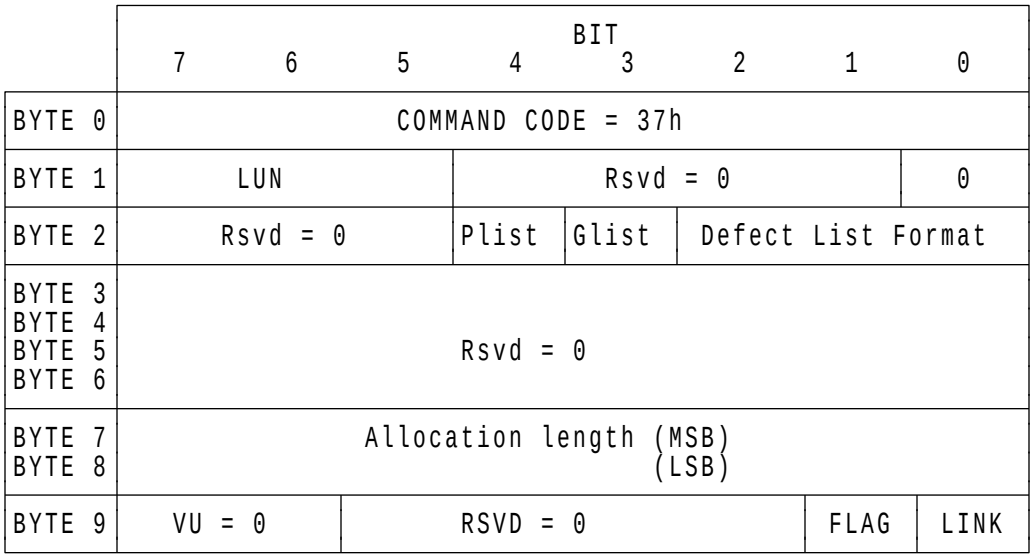
The data returned to the initiator in response to the READ CAPACITY command is described here. The data is returned in the DATA IN phase.

	BIT 7	6	5	4	3	2	1	0
BYTE 0	(MSB)		Logical Block Address					
BYTE 1								
BYTE 2								
BYTE 3								(LSB)
BYTE 4	(MSB)		Block Length			= 200h		
BYTE 5								
BYTE 6						= 512		
BYTE 7								(LSB)

Figure 55. Format of READ CAPACITY command reply

- **Block Length** specifies the length in bytes of the block. It is set to 512.

7.11 READ DEFECT DATA (37)



	BIT 7	6	5	4	3	2	1	0
BYTE 0	COMMAND CODE = 37h							
BYTE 1	LUN			Rsvd = 0				0
BYTE 2	Rsvd = 0			Plist	Glist	Defect List Format		
BYTE 3 BYTE 4 BYTE 5 BYTE 6	Rsvd = 0							
BYTE 7 BYTE 8	Allocation length (MSB) (LSB)							
BYTE 9	VU = 0		RSVD = 0				FLAG	LINK

Figure 56. Read Defect Data (37)

The READ DEFECT DATA command requests that the Target transfers the medium defect data to the initiator.

If the target is unable to access any medium defect data it will return a Check Condition status with the appropriate sense key. The sense key will be set to either Medium Error(03h) if a medium error occurred or No Sense(00h) if the list does not exist and the additional sense code will be set to Defect List Error(19h).

Plist The Primary Defect List (Plist) bit set to one indicates that the target returns the primary list of defects. A Plist bit of zero indicates that the target shall not return the Primary Defect list of defects.

Glist The Grown Defect List (Glist) bit set to one indicates that the target returns the grown defect list. A Glist bit of zero indicates that the target shall not return the Grown Defect list of defects.

Note: With both bits set to one Plist and Glist the target will return both the Primary and Grown defect lists. With both bits set to zero, the target will return only a four-byte Defect List Header.

Defect List format The Defect List Format Field is used by the initiator to indicate the preferred format for the defect list.

The Defect List Format of '100 (Bytes from Index Format) ' and '101 (Physical Sector Format)' are supported. If the requested format is not supported by the file, it will return the defect list in its default format '101' then terminates the command with Check Condition status. The sense key will be set to Recovered Error(01h) and the additional sense code will be set to Defect List Not Found(1Ch).

The file sends defect list (Defect Descriptors) in a four byte ABA (absolute block address) format which follows a four byte Defect List Header.

The target will transfer all of the Read Defect Data up to the number of bytes allocated by the initiator.

Note: The file will terminate the Data In phase when the Allocation Length has been transferred or when all available Defect Data has been transferred to the initiator, whichever is less.

The Read Defect Data contains a four byte header, followed by zero or more defect descriptors.

7.11.1 Defect List Header

	BIT 7	6	5	4	3	2	1	0
	Defect List Header							
BYTE 0	Rsvd = 0							
BYTE 1	Rsvd = 0				Plist	Glist	Defect List Format	
BYTE 2	Defect List Length (MSB)							
BYTE 3	(LSB)							

Figure 57. Defect List Header

7.11.2 Bytes from Index Format (100b)

	Defect Descriptors
BYTE 0	(MSB)
BYTE 1	Cylinder Number of Defect
BYTE 2	(LSB)
BYTE 3	Head Number of Defect
BYTE 4	(MSB)
BYTE 5	Defect Bytes from Index
BYTE 6	
BYTE 7	(LSB)

Figure 58. Defect Descriptors of Bytes from Index Format

Defect Bytes from Index is gotten using the following equation:

```
Bytes from Index = (Physical Sector Number) * N

      Where:  N = Bytes per sector (512 Bytes)
```

7.11.3 Physical Sector Format (101b)

	Defect Descriptors	
BYTE 0		(MSB)
BYTE 1	Cylinder Number of Defect	
BYTE 2		(LSB)
BYTE 3	Head Number of Defect	
BYTE 4		(MSB)
BYTE 5	Defective Sector Number	
BYTE 6		
BYTE 7		(LSB)
	8–byte sets of defect list follow.	

Figure 59. Defect Descriptors of Physical Sector Format

The defect list format field specifies the format of the defect list data returned by the target.

The Defect List Length field specifies the length in bytes of the defect descriptors that follow. The Defect List Length is equal to eight times the number of defect descriptors.

If the Allocation Length is insufficient to transfer all of the defect descriptors, the Defect List Length will not be adjusted to reflect the truncation. The target will not create a CHECK CONDITION status.

7.12 READ EXTENDED (28)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 28h							
BYTE 1	LUN			DPO = 0	FUA	Reserved = 0		RelAdr = 0
BYTE 2	(MSB) Logical Block Address							
BYTE 3								
BYTE 4								
BYTE 5								(LSB)
BYTE 6	Reserved = 0							
BYTE 7	(MSB) Transfer Length							
BYTE 8								(LSB)
BYTE 9	VU = 0		Reserved = 0				FLAG	LINK

Figure 60. Read Extended (28)

The READ EXTENDED command requests the file to transfer data to the initiator. The larger Logical Block Address and Transfer Length fields permit greater quantities of data to be requested per command than with the READ command and are required to access the full LBA range of the larger capacity drives.

DPO Disable page out. **Must be set to zero** Disable page out is not supported.

FUA Force unit access. A FUA bit of 1 indicates that the data is read from the media and not from the cache. A FUA bit of 0 allows the data to be read from either the media or the cache.

RelAdr Relative Block Address. **Must be set to zero**, indicating that the logical block address field specifies the first logical block of the range of logical blocks to be operated on by this command. Relative address is not supported.

Transfer length The number of contiguous blocks to be transferred. If the transfer length is zero,the seek occurs,but no data is transferred. This condition is not considered an error. If read ahead is enabled, a read ahead is started after the seek completes.

7.13 READ BUFFER (3C)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 3Ch							
BYTE 1	LUN			RSVD = 0		MODE		
BYTE 2	Buffer ID = 0							
BYTE 3	(MSB) Buffer Offset							
BYTE 4								
BYTE 5								(LSB)
BYTE 6	(MSB) Allocation length							
BYTE 7								
BYTE 8								(LSB)
BYTE 9	VU = 0		RSVD = 0				FLAG	LINK

Figure 61. READ BUFFER (3C)

The READ BUFFER command is used in conjunction with the WRITE BUFFER command as a diagnostic function for testing the file's memory and the SCSI bus integrity. This command does not alter the medium.

The function of this command and the meaning of fields within the command descriptor block depend on the contents of the mode field.

MODE	Description
000	Read combined header and data
010	Data
011	Descriptor
All others	Not supported.

7.13.1 Combined Header And Data (Mode 000)

In this mode, a four byte header followed by data bytes are returned to the initiator during the DATA IN phase. The buffer ID and the buffer offset field are reserved.

The file terminates the DATA IN phase when allocation length bytes of header plus data have been transferred or when the header and all available data have been transferred to the initiator, whichever is less.

The four-byte READ BUFFER header (Figure 62 on page 87) is followed by data bytes from the file's data buffer.

	BIT 7	6	5	4	3	2	1	0
BYTE 0	RSVD = 0							
BYTE 1	(MSB)			Buffer Capacity				
BYTE 2								
BYTE 3								(LSB)

Figure 62. READ BUFFER Header

The buffer capacity specifies the total number of data bytes that are available in the file's data buffer. This number is not reduced to reflect the allocation length nor is it reduced to reflect the actual number of bytes written using the WRITE BUFFER command.

Following the READ BUFFER header, the file will transfer data from its data buffer.

7.13.2 Read Data (Mode 010b)

In this mode, the DATA IN phase contains buffer data.

Buffer ID This field must be set to zero, indicating the data transfer buffer. If another value is specified, the command is terminated with CHECK CONDITION status. File shall set sense key to ILLEGAL REQUEST and additional sense code to ILLEGAL FIELD IN CDB.

Buffer Offset This specifies the offset of the memory space specified by the Buffer ID. The initiator should conform to the offset boundary requirements returned in the READ BUFFER descriptor. If the value exceeds the buffer specified, the command is terminated with CHECK CONDITION status. File shall set sense key to ILLEGAL REQUEST and additional sense code to ILLEGAL FIELD IN CDB.

Allocation Length The file terminates the DATA IN phase when allocation length bytes of data have been transferred or when the header and all available data have been transferred to the initiator, whichever is less.

7.13.3 Descriptor (Mode 011b)

In this mode, a maximum of four bytes of READ BUFFER descriptor information are returned. The file returns the descriptor information for the buffer specified by the buffer ID.

Buffer ID This field should normally be set to zero indicating the file data transfer buffer. If any other value is specified the file returns all zeros in the READ BUFFER descriptor.

Buffer Offset This field is reserved.

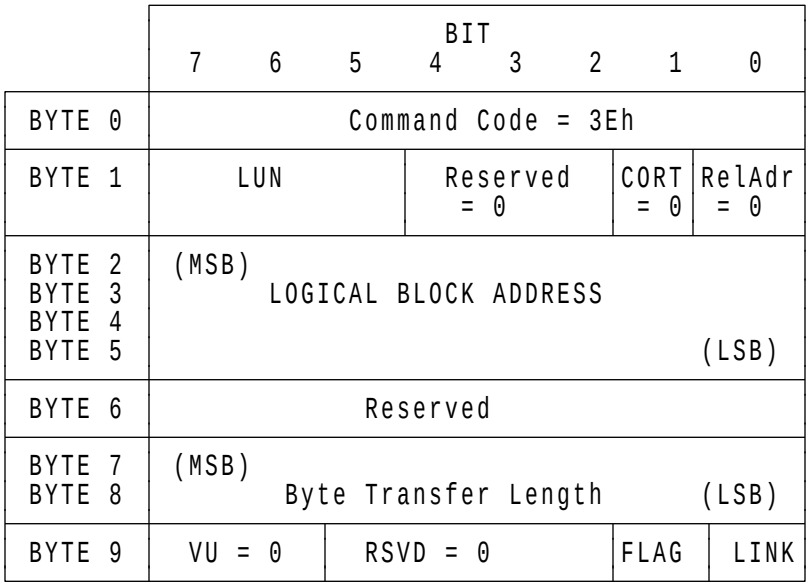
Allocation Length This must be set to four or greater. The file transfers the lesser of the allocation length or four bytes of READ BUFFER descriptor. The READ BUFFER descriptor is defined in Figure 63 on page 88.

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Offset Boundary							
BYTE 1	(MSB)	Buffer Capacity						
BYTE 2								
BYTE 3								(LSB)

Figure 63. READ BUFFER DESCRIPTOR

The value contained in the Buffer Offset field of subsequent WRITE BUFFER and READ BUFFER commands should be a multiple of two to the power of the offset boundary. The offset boundary is always set to nine, which indicates Sector(512 bytes) Boundaries.

7.14 READ LONG (3E)



	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 3Eh							
BYTE 1	LUN			Reserved = 0			CORT = 0	RelAdr = 0
BYTE 2 BYTE 3 BYTE 4 BYTE 5	(MSB) LOGICAL BLOCK ADDRESS (LSB)							
BYTE 6	Reserved							
BYTE 7 BYTE 8	(MSB) Byte Transfer Length (LSB)							
BYTE 9	VU = 0			RSVD = 0			FLAG	LINK

Figure 64. READ LONG (3E)

The READ LONG command requests the file to transfer **one block** of data to the initiator. The transfer data includes;

- 512 bytes of data
- 16 bytes of ECC data
- **CORT**

  0 A corrected bit of zero causes the logical block to be read without any correction made by the file.

  1 Not supported by the file. (A corrected bit of one causes the data to be corrected by ECC before transferring the data to the initiator.)

- **RelAdr** Relative Block Address is not supported by the file.
- **LOGICAL BLOCK ADDRESS** field specifies the logical block at which the read operation shall occur.
- **Byte Transfer Length**. This field must exactly specify the number of bytes of data that are available for transfer. If a non-zero byte transfer length does not match the available data length, the target terminates the command with CHECK CONDITION status, the sense key is set to ILLEGAL REQUEST and an additional sense code set to INVALID FIELD IN CDB. The valid and ILI bits is set to one and the information field is set to the difference of the requested length minus the actual length in bytes. Negative values is indicated by two's complement notation.

  The transfer length is calculated as follows:
  transfer length = logical block size + 16

7.15 REASSIGN BLOCKS (07)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 07h							
BYTE 1	LUN			RSVD = 0				
BYTE 2	RSVD = 0							
BYTE 3	RSVD = 0							
BYTE 4	RSVD = 0							
BYTE 5	VU = 0		RSVD = 0				FLAG	LINK

Figure 65. REASSIGN BLOCKS (07)

The REASSIGN BLOCKS command requests the file to reassign a logical block to an available spare. The REASSIGN BLOCKS command attempts to allocate spare blocks on a spare track. The logical block address is transferred to the file during the DATA OUT phase. One to four block(s) may be specified for relocation per REASSIGN BLOCKS command.

Reassignment is complete upon the completion of the REASSIGN BLOCKS command. At this time, the defective logical block address has been added to the grown (“G” list) defect list.

Data contained at the logical block address being reassigned is not preserved by the file, and is filled with a constant pattern.

Following is the format of the data sent by the initiator during the DATA OUT phase:

	BIT 7	6	5	4	3	2	1	0
BYTE 0	RSVD = 0							
BYTE 1	RSVD = 0							
BYTE 2	(MSB) Defect list length = 4/8/12/16							
BYTE 3								(LSB)
BYTE 4	(MSB) Defective							
BYTE 5	Logical							
BYTE 6	Block							
BYTE 7	Address No.1							(LSB)
BYTE 8	(MSB) Defective							
BYTE 9	Logical							
BYTE 10	Block							
BYTE 11	Address No.2							(LSB)
BYTE 12	(MSB) Defective							
BYTE 13	Logical							
BYTE 14	Block							
BYTE 15	Address No.3							(LSB)
BYTE 16	(MSB) Defective							
BYTE 17	Logical							
BYTE 18	Block							
BYTE 19	Address No.4							(LSB)

Figure 66. Format of REASSIGN BLOCKS data

Note: If the file finds a defective block by verifying ECC before it finds a spare, the file will not start the REASSIGN BLOCKS process, but will return CHECK CONDITION status with sense key set to MEDIUM ERROR.

- **Defect list length** must be 4,8,12 or 16. Otherwise, the drive returns Check Condition with Sense key = Illegal request.
- **Defective logical block address** is 4 bytes in length. The initiator can specify from 1 to 4 Defective logical block address according to the Defect list length from 4 to 16, respectively. Defective logical block addresses must be ordered in ascending order, or the drive returns Check Condition.

7.16 RELEASE (17)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 17h							
BYTE 1	LUN			3rdPty	3rd Party ID			Ext=0
BYTE 2	Reservation Identification							
BYTE 3	RSVD = 0							
BYTE 4	RSVD = 0							
BYTE 5	VU = 0		RSVD = 0				FLAG	LINK

Figure 67. RELEASE (17)

The RELEASE command is used to release a LUN previously reserved.

Note: It is not an error for an initiator to release a LUN that is not currently reserved.

- **3rdPty** bit indicates that :

  1 This release process is for a third party which is specified by 3rd Party ID.

  0 This release process is for the initiator itself.

- **3rd Party ID** specifies the ID of the third party for which the LUN is reserved.[4]
- **Ext**ents must be 0. Extension is not supported by the file.
- **Reservation Identification** field is ignored.

[4] Refer 7.18, “RESERVE (16)” on page 94

7.17 REQUEST SENSE (03)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 03h							
BYTE 1	LUN			RSVD = 0				
BYTE 2	RSVD = 0							
BYTE 3	RSVD = 0							
BYTE 4	ALLOCATION LENGTH							
BYTE 5	VU = 0		RSVD = 0				FLAG	LINK

Figure 68. REQUEST SENSE (03)

The REQUEST SENSE command requests the file to transfer sense data.

The sense data shall be available when following conditions,

- The previous command to the specified I_T_L nexus terminated with CHECK CONDITION status.[5]
- An other information (e.g. medium position) is available in any fields.
- The previous command to the specified I_T_L nexus ended unexpected BUS FREE error.

If REQUEST SENSE command with a invalid LUN is received, file return GOOD status and report a sense key of ILLEGAL REQUEST and an additional sense code of LOGICAL UNIT NOT SUPPORTED.

If the file has no sense data available to return, it shall return a sense key of NO SENSE and an additional sense code of NO ADDITIONAL SENSE INFORMATION.

The sense data shall be preserved by the file for the initiator until retrieved by the REQUEST SENSE command or until any other command for the same I_T_L nexus. Sense data shall be cleared upon receipt subsequent command including REQUEST SENSE to the same I_T_L nexus.

Separate sense data is maintained by the device for each initiator. Therefore, there is no requirement for an initiator to expeditiously clear a CHECK CONDITION as this will not affect other initiators in a multi-initiator system.

The file will return the number of bytes in the allocation length or 32 bytes whichever is less.

The contents of the sense data is defined in 12.0, “SCSI SENSE DATA” on page 161.

[5] **I_T_L nexus .** A nexus which exists between an initiator, a target and a logical unit.

7.18 RESERVE (16)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 16h							
BYTE 1	LUN			3rdPty	3rd Party ID			Ext=0
BYTE 2	Reservation Identification							
BYTE 3	(MSB)	Extent List Length = 0						
BYTE 4								(LSB)
BYTE 5	VU = 0			RSVD = 0			FLAG	LINK

Figure 69. RESERVE (16)

The RESERVE command is used to reserve a LUN for an initiator. This reservation can be either for;

- The initiator which sends this command.
- The third party which is specified in this command.

This command results in reserving the entire LUN for the initiator until one of the following occurs:

- The reservation is superseded by another valid RESERVE command from the initiator that made the reservation.
- The LUN is released by a RELEASE command from the same initiator.
- A hard reset condition occurs. (A SCSI bus Reset assertion)
- A BUS DEVICE RESET message is received from any initiator.
- Power off/on occurs.
- **3rdPty** bit is to indicates that :

  1 This reservation is for a third party which is specified by 3rd Party ID.

  0 This reservation is for the initiator itself.
- **3rd Party ID** specifies the ID of the third party for which the LUN is reserved.

  Note: The LUN may be only released by the initiator who sent the RESERVE command.
- **Ext**ents must be 0. Extension is not supported by the file.
- **Reservation Identification** is ignored.
- **Extent List** length must be zero. Extent List length is not supported.

7.19 REZERO UNIT (01)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 01h							
BYTE 1	LUN			RSVD = 0				
BYTE 2	RSVD = 0							
BYTE 3	RSVD = 0							
BYTE 4	RSVD = 0							
BYTE 5	VU = 0		RSVD = 0				FLAG	LINK

Figure 70. REZERO UNIT (01)

The REZERO UNIT command requests that the target seek to logical block address 0.

7.20 SEEK (0B)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 0Bh							
BYTE 1	LUN			(MSB)		LBA		
BYTE 2	LOGICAL BLOCK ADDRESS							
BYTE 3	LOGICAL BLOCK ADDRESS (LSB)							
BYTE 4	Reserved							
BYTE 5	VU = 0		RSVD = 0				FLAG	LINK

Figure 71. SEEK (0B)

The SEEK command requests the file to seek to the specified logical block address.

7.21 SEEK EXTENDED (2B)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 2Bh							
BYTE 1	LUN			RSVD = 0				0
BYTE 2	(MSB)		Logical Block Address					
BYTE 3								
BYTE 4								
BYTE 5								(LSB)
BYTE 6	RSVD = 0							
BYTE 7	RSVD = 0							
BYTE 8	RSVD = 0							
BYTE 9	VU = 0			RSVD = 0			FLAG	LINK

Figure 72. SEEK EXTENDED (2B)

The SEEK EXTENDED command requests the file to seek to the specified logical block address.

7.22 SEND DIAGNOSTIC (1D)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 1Dh							
BYTE 1	LUN			PF	RSVD=0	SlfTst	DevOfl	UntOfl
BYTE 2	RSVD = 0							
BYTE 3	(MSB)	Parameter List Length						
BYTE 4								(LSB)
BYTE 5	VU = 0		RSVD = 0				FLAG	LINK

Figure 73. SEND DIAGNOSTIC (1D)

The SEND DIAGNOSTIC command requests the file to perform its self-diagnostic test, or to perform a function based on a page of information sent in a Data Out phase during the command.

- **PF(Page Format)** bit set to 1 indicates the data sent by the Initiator comform to the page structure as specified in SCSI-2 standard. This bit must be set to 1 if the SlfTst bit is set to 0. This bit is ignored by the Target if the SlfTst bit is set.
- **SlfTst** set to 1 indicates the device should perform it's internal self test. If set to 0 then a parameter list should be sent by the initiator.
- **DevOfl** this bit is ignored by the target for compatibility.
- **UntOfl** this bit is ignored by the target for compatibility.
- **Parameter List Length** is ignored by the Target if the SlfTst bit is set. Otherwise it should be set to the length of the page to be transferred in the Data Out phase of the command. If it does not match the expected length of the page a CHECK CONDITION status will be generated with a Sense Key of Illegal Request and additional sense of Invalid Field in CDB.

If the SlfTst bit is set upon command completion, the following status is returned:

- GOOD status for successful test completion.
- CHECK CONDITION status for unsuccessful test completions.

The self diagnostics consists of two parts :[6]

- The first part is executed immediately after power up. This test is performed to verify all hardware which is not related to the disk drive. The local microprocessor, RAM (scratchpad and buffer), and control electronics are included here.
- The second part is executed after the spindle motor is started. This includes disk access (seek), R/W channel, and error correction circuitry verification. A reserved area on the disk is used for this test.

[6] See 11.16.2, “Diagnostics Command” on page 158 for a detailed listing of the operations carried out by the Diagnostics Command.

Both tests are performed as a result of the SEND DIAGNOSTIC command. The SEND DIAGNOSTICS will fail with CHECK CONDITION status if it is issued while the spindle motor is not turning. (Such as after STOP command has been received.)

Note: The self diagnostic is also performed at Power On Reset time.

Note: The SCSI bus signals will not be corrupted when the device is executing the SEND DIAGNOSTIC command.

7.22.1 Send Diagnostic Pages 0

This page requests that the file return a list of supported pages on the next receive diagnostics command.

Byte	7	6	5	4	3	2	1	0
0	Page Code = 0							
1	Reserved = 0							
2 - 3	Page Length = 0							

7.22.2 Send Diagnostic Pages 40

This allows the initiator to translate a logical block address or physical sector address to the other format. The address to be translated is passed to the target with the Send Diagnostic command and the results are returned to the initiator by the Receive Diagnostics command.

The target will read the parameter list from the initiator and if no errors are detected in the parameter list Good Status will be returned. The data translation will be performed upon receipt of the Receive Diagnostics command.

Byte	7	6	5	4	3	2	1	0
0	Page Code = 40h							
1	Reserved = 0							
2 - 3	Page Length = 0Ah							
4	Reserved = 0					Supplied Format		
5	Reserved = 0					Translate Format		
6 - 13	Address to Translate							

- **Supplied Format** may take either of the two following values
  - **000b** block format
  - **101b** physical sector format

  It specifies the format in which the address has been supplied.
- **Translate Format** may take either of the two formats specified above and specifies that format that the address should be translated into. If either of the format fields is invalid or they specify the same format the command will terminate with CHECK CONDITION status with a Sense of Illegal Request and Illegal Field in Parameter List.

- **Address to Translate** contains the address to translate. If the logical block format is specified then the first 4 bytes of the field, i.e. bytes 6 to 9, contain the LBA and the remainder must be zero. For the physical format the address must be specified as follows.

Byte	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
6 - 8	Cylinder Number							
9	Head Number							
10 - 13	Sector Number							

7.23 START/STOP UNIT (1B)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 1Bh							
BYTE 1	LUN			RSVD = 0				Immed
BYTE 2	RSVD = 0							
BYTE 3	RSVD = 0							
BYTE 4	RSVD = 0							Start
BYTE 5	VU = 0		RSVD = 0				FLAG	LINK

Figure 74. START/STOP Unit (1B)

The START/STOP UNIT command is used to spin up or stop the spindle motor.

- **Immed** bit is to specify

  0 Status is to be returned at the end of the operation.
  1 GOOD status shall always be returned immediately after command has been received. The TEST UNIT READY command may be used to determine when the file becomes ready after a spin-up.

- **Start** bit is to specify:

  0 Stop the spindle.
  1 Start the spindle.

  Note: Once the drive has become ready (after a power on) the Start/Stop UNIT command can be used without any errors, regardless of the state of the motor, stopped or spinning.

7.24 SYNCHRONIZE CACHE (35)

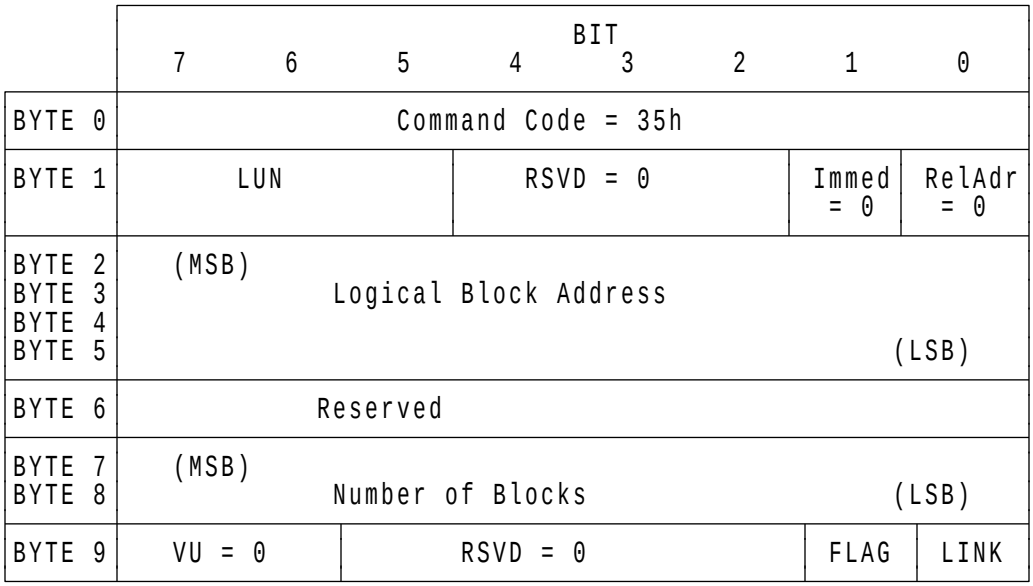


Figure 75. SYNCHRONIZE CACHE (35)

The SYNCHRONIZE CACHE Command ensures that logical blocks in the cache have their most recent data value recorded on the media.

- **Logical Block Address** is to specify:
  where the operation is to begin.
- **Number of Blocks** specifies:
  the total number of contiguous logical blocks within the range. Number of Blocks of zero indicates that all remaining logical blocks on the logical unit shall be within the range.
- **Immed** (immediate) must be zero.
  An immediate bit of zero indicates that the status shall not be returned until the operation has completed.
  If the Immd bit is set to one, the drive returns a Check Condition status. The sense key shall be set to Illegal Request and the additional sense code shall be set to Invalid Field in CDB.
- **RelAdr** (relative address) must be zero.
  The drive does not support the relative addressing.
  If the RelAdr bit is set to one, the drive returns Check Condition status. The sense key shall be set to Illegal Request and the additional sense code shall be set to Invalid Field in CDB.

7.25 TEST UNIT READY (00)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 00h							
BYTE 1	LUN			RSVD = 0				
BYTE 2	RSVD = 0							
BYTE 3	RSVD = 0							
BYTE 4	RSVD = 0							
BYTE 5	VU = 0		RSVD = 0				FLAG	LINK

Figure 76. TEST UNIT READY (00)

The TEST UNIT READY command allows the initiator to check if the file is READY. The SCSI specification defines READY as the condition where the device will accept a media-access command without returning CHECK CONDITION status.

The file will first verify that the motor is spinning at the correct speed.

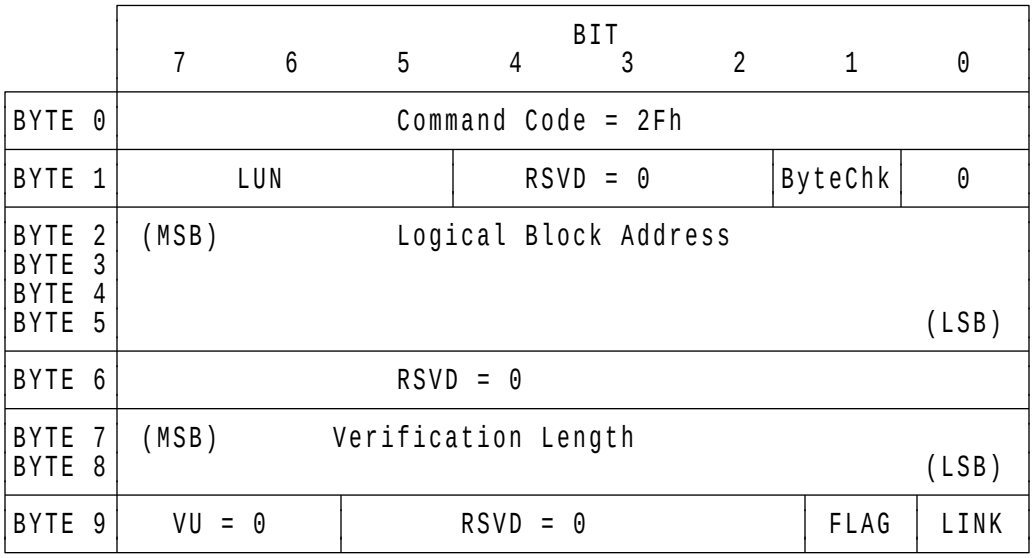
- If the spindle motor is not spinning at the correct speed, CHECK CONDITION status is returned with sense key of NOT READY.
- If the motor is spinning at the correct speed, the file accepts normal media access commands.

The TEST UNIT READY command is not intended as a diagnostic. No self diagnostic is performed by the device as a result of this command.

The TEST UNIT READY command has special significance for power sequencing using the START UNIT command with an Immediate bit of 1. In this mode the START UNIT command returns COMMAND COMPLETE status before the completion of motor spin-up and expects the initiator to issue TEST UNIT READY commands to determine when the motor has reached the proper speed.

Note: The spindle automatically starts in automatic spin†up Mode. The file does not execute any commands other than TEST UNIT READY, INQUIRY or REQUEST SENSE command until the the Power On sequence is complete. The file will return CHECK CONDITION status with NOT READY sense key and IN PROCESS OF BECOMING READY sense code for all other commands during the Power On period.

7.26 VERIFY (2F)



	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 2Fh							
BYTE 1	LUN			RSVD = 0			ByteChk	0
BYTE 2 BYTE 3 BYTE 4 BYTE 5	(MSB) Logical Block Address							(LSB)
BYTE 6	RSVD = 0							
BYTE 7 BYTE 8	(MSB) Verification Length							(LSB)
BYTE 9	VU = 0		RSVD = 0				FLAG	LINK

Figure 77. VERIFY (2F)

The VERIFY command requests that the file verify the data written on the media. A verification length of zero indicates that no data will be transferred. This condition is not considered an error.

- **ByteChk** indicates;

  0 The verification is performed by ECC check. No data transfer from the initiator is performed in this case. If an ECC check is detected on all re†reads and the data was not corrected(either because it was uncorrectable or the correction was not attempted), a Check Condition status is returned with a Medium Error sense key.

  1 Byte†by†byte comparison is not supported.

7.27 WRITE (0A)

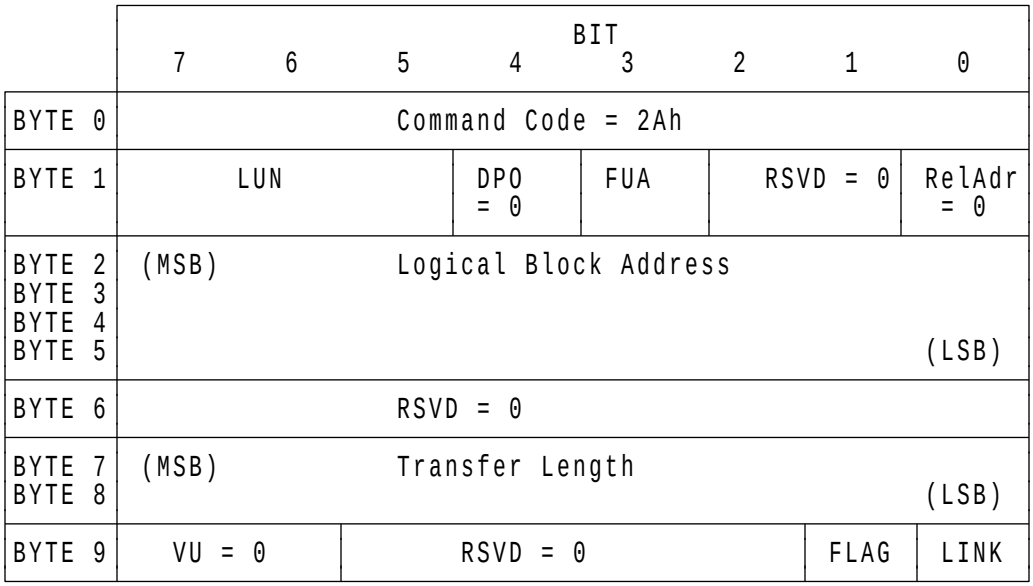
	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 0Ah							
BYTE 1	LUN			(MSB) LBA				
BYTE 2	LOGICAL BLOCK ADDRESS							
BYTE 3	LOGICAL BLOCK ADDRESS (LSB)							
BYTE 4	TRANSFER LENGTH							
BYTE 5	VU = 0		RSVD = 0				FLAG	LINK

Figure 78. WRITE (0A)

The WRITE command requests the file to write the specified number of blocks of data from the initiator to the medium starting at the specified logical block address.

See 7.9, “READ (08)” on page 79 for the parameters.

7.28 WRITE EXTENDED (2A)



	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 2Ah							
BYTE 1	LUN			DPO = 0	FUA		RSVD = 0	RelAdr = 0
BYTE 2 BYTE 3 BYTE 4 BYTE 5	(MSB) Logical Block Address							(LSB)
BYTE 6	RSVD = 0							
BYTE 7 BYTE 8	(MSB) Transfer Length							(LSB)
BYTE 9	VU = 0		RSVD = 0				FLAG	LINK

Figure 79. WRITE EXTENDED (2A)

The WRITE EXTENDED command requests that the file write the data transferred from the initiator. This command is processed like the standard WRITE command except for the longer transfer length .

DPO Disable page out. **Must be set to zero** Disable page out is not supported.

FUA Force unit access. A FUA bit of 1 indicates that the Target must write the data to the media before returning Good Status. A FUA bit of 0 indicates the Target may return Good Status prior to writing the data to the media.

RelAdr Relative Block Address. **Must be set to zero**, indicating that the logical block address field specifies the first logical block of the range of logical blocks to be operated on by this command. Relative address is not supported.

Transfer length The number of contiguous blocks to be transferred. If the transfer length is zero,the seek occurs,but no data is transferred. This condition is not considered an error.

7.29 WRITE AND VERIFY (2E)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 2Eh							
BYTE 1	LUN			DPO = 0	RSVD = 0		ByteChk = 0	RelAdr = 0
BYTE 2	(MSB) Logical Block Address							
BYTE 3								
BYTE 4								
BYTE 5								(LSB)
BYTE 6	RSVD = 0							
BYTE 7	(MSB) Transfer Length							
BYTE 8								(LSB)
BYTE 9	VU = 0		RSVD = 0				FLAG	LINK

Figure 80. WRITE AND VERIFY (2E)

WRITE AND VERIFY command requests that the file writes the data transferred from the initiator to the medium and then verify that the data is correctly written.

- **ByteChk** the options:

ByteChk	Description
0	The data is read back from the disk and verified using ECC after the successful write operation. If an ECC error is detected in the verify process, CHECK CONDITION status is returned with sense key set to MEDIUM ERROR.
1	Not supported by the file.

- DPO(Disable page out) **Must be set to zero** Disable page out is not supported.
- Relative Block Address **Must be set to zero**, indicating that the logical block address field specifies the first logical block of the range of logical blocks to be operated on by this command. Relative address is not supported.
- A transfer length of zero indicates that no data is transferred.
- If caching is enabled, the command performs an implied Force Unit Access (FUA) and an implied Synchronize Cache before starting the operation. This insures that the medium, not the cache, is being verified.

7.30 WRITE BUFFER (3B)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 3Bh							
BYTE 1	LUN			RSVD = 0		MODE		
BYTE 2	Buffer ID							
BYTE 3	(MSB) Buffer Offset							
BYTE 4								
BYTE 5								(LSB)
BYTE 6	(MSB) Parameter list length							
BYTE 7								
BYTE 8								(LSB)
BYTE 9	VU = 0		RSVD = 0				FLAG	LINK

Figure 81. WRITE BUFFER (3B)

The WRITE BUFFER command is used in conjunction with the READ BUFFER command as a diagnostic function for testing the file's memory and the SCSI bus integrity. This command does not alter the medium of the file. Additional modes are provided for downloading microcode and for downloading and saving microcode.

This command will cause the entire cache to be emptied.

The function of this command and the meaning of fields within the command descriptor block depend on the contents of the mode field.

MODE	Description
000	Write combined header and data
010	Data
100	Download Microcode
101	Download Microcode and Save
-	All other modes are not supported by the file.

7.30.1 Combined Header And Data (Mode 000b)

In this mode, the data to be transferred is preceded by a four-byte header.

Buffer ID This field must be zero. If another value is specified, no download function are performed and the command is terminated with CHECK CONDITION status. And File shall set sense key to ILLEGAL REQUEST and additional sense code to ILLEGAL FIELD IN CDB.

Buffer Offset This field must be zero. If another value is specified, no download function are performed and the command is terminated with CHECK CONDITION status. And File shall set sense key to ILLEGAL REQUEST and additional sense code to ILLEGAL FIELD IN CDB.

Parameter List Length This field specifies the number of bytes that shall be transferred during the DATA OUT phase. This number **includes** four bytes of header, so the data length to be stored in the file's buffer is transfer length minus four. If the length exceeds the buffer size, the command is terminated with CHECK CONDITION status. And File shall set sense key to ILLEGAL REQUEST and additional sense code to ILLEGAL FIELD IN CDB.

The four-byte header consists of all reserved bytes.

	BIT 7	6	5	4	3	2	1	0
BYTE 0	RSVD = 0							
BYTE 1	RSVD = 0							
BYTE 2	RSVD = 0							
BYTE 3	RSVD = 0							

Figure 82. WRITE BUFFER Header

7.30.2 Write Data (Mode 010b)

In this mode, the DATA OUT phase contains buffer data.

Buffer ID This field must be set to zero, indicating the data transfer buffer. If another value is specified, the command is terminated with CHECK CONDITION status. File shall set sense key to ILLEGAL REQUEST and additional sense code to ILLEGAL FIELD IN CDB.

Buffer Offset This specifies the offset of the memory space specified by the Buffer ID. The initiator should conform to the offset boundary requirements returned in the READ BUFFER descriptor. If the value exceeds the buffer specified, the command is terminated with CHECK CONDITION status. File shall set sense key to ILLEGAL REQUEST and additional sense code to ILLEGAL FIELD IN CDB.

Parameter List Length This field specifies the Parameter List Length. It must be;

- less than the capacity of the buffer size.
- on a sector boundary. In other words, it must be a multiple of 512.

If a invalid value is specified, the command is terminated with CHECK CONDITION status. File shall set sense key to ILLEGAL REQUEST and additional sense code to ILLEGAL FIELD IN CDB.

7.30.3 Download Microcode (Mode 100b)

In this mode, the microcode is transferred to the control memory space of the file. Once downloaded the file will operate with the newly downloaded code until the next power cycle.

Buffer ID The buffer ID field is used to indicate which portion of the microcode image is being downloaded. If it is set to '00'x then the main microprocessor code is updated. If the buffer ID is '01'x then the HDC pico code is updated.

Any other value for the buffer ID except '00'x and '01'x will cause the command to terminate with CHECK CONDITION status. The file shall set sense key to ILLEGAL REQUEST and additional sense code to ILLEGAL FIELD IN CDB.

Buffer Offset This specifies the starting address of the downloaded Microcode. It must be zero. If an invalid value is specified, the command is terminated with CHECK CONDITION status . File shall set sense key to ILLEGAL REQUEST and additional sense code to ILLEGAL FIELD IN CDB.

Transfer Length The total microcode length must be 0x8000 for both the main micro processor and the HDC pico processor updates. It may also be set to '0000'x in which case no code is updated. If an invalid value is specified, the command is terminated with CHECK CONDITION status. File shall set sense key to ILLEGAL REQUEST and additional sense code to ILLEGAL FIELD IN CDB.

This process generates a unit attention condition for MICROCODE HAS BEEN CHANGED for all initiators except the one which sent the write buffer command. Once the write buffer command has been completed the new microcode is immediately ready for operation.

Note: This option is documented within this spec to indicate that the file will accept a command of this form though it is not expected that a customer will ever issue such a command. To use the write buffer command in this manner a special microcode version will be required from development. If such a microcode is released from development then it will include appropriate instructions on the function of new microcode and its effect on file operations after downloading.

If the write buffer command is executed with this option and the code downloaded is not valid for this file then it is to be expected that the file will hang on this or a subsequent command. This should normally be recoverable by a power on/off cycle.

7.30.4 Download Microcode and Save (Mode 101b)

In this mode, the microcode is transferred to the file and saved into the System reserved area on the disk. The downloaded code becomes effective immediately after download and after each Power On Reset until it is overwritten by another download microcode and save option.

The code must be downloaded to the file in 5 separate blocks. Each of these being 32KB in size, giving a total code size of 160KB. The 5 blocks must be sent in the correct sequential order but other commands may be interspersed between them, however if power is cycled or a reset occurs the download procedure must be restarted. As the blocks are received they are stored into a reserved area of the file † at this stage they DO NOT overwrite the current microcode. When the last of the 5 blocks is received the download will be checked via checksum and signature for integrity and compatibility with the ROM code. Once these checks have passed the file will overwrite the old code stored on the disk with the new download. The new download will also be loaded into memory.

Buffer ID The buffer ID field is used to indicate which portion of the microcode image is being downloaded.

The buffer ID must be set to '00'x on the first block, '01'x on the second block etc. The blocks must be sent to the file in the correct logical order, with no omissions or resends of blocks. On all write buffer commands except the final one the file merely stores the code and no action is taken. When the final block is received the file then attempts to use the new microcode. In between down-

loading the code blocks the file will continue to accept and process other commands from this and any other initiator. It is not until the final block of code has been received that the code the processors is running is changed. In addition it is legal to send some but not all of the code and then to start sending a different level of code as long as this second level of code is started from the beginning, i.e. buffer ID '00'x.

Any value for the buffer ID except '00'x or an incrementing value based on the last block sent will cause the command to terminate with CHECK CONDITION status. The file shall set sense key to ILLEGAL REQUEST and additional sense code to ILLEGAL FIELD IN CDB.

Buffer Offset This specifies the starting address of the downloaded Microcode. It must be zero. If an invalid value is specified, the command is terminated with CHECK CONDITION status . File shall set sense key to ILLEGAL REQUEST and additional sense code to ILLEGAL FIELD IN CDB.

Transfer Length Total microcode length must be specified. This value should be 0x8000. It may also be set '0000'x in which case no code is updated. If an invalid value is specified, the command is terminated with CHECK CONDITION status. File shall set sense key to ILLEGAL REQUEST and additional sense code to ILLEGAL FIELD IN CDB.

Note: New code to be downloaded to the file will be provided by development either in request to a customers request for additional function or as a result of a bug fix to a critical file function. Please note however that not all possible fixes or new function can be applied to a file in this manner and that there is a very considerable dependency on the level of ROM code contained within the file. If invalid code or code that is not compatible with the ROM code is downloaded the file will normally reject this code and will continue normal operation. However there is a very small possibility of invalid code being accepted (about 1 in 4E9) and if this occurs the unit will usually become inoperable and have to be returned to the manufacturer to be recovered.

This process generates a unit attention condition of MICROCODE HAS BEEN CHANGED for all initiators except the one sending the last write buffer command (It is legal to send the different blocks of code from varying initiators as long as they arrive at the file in the correct logical order - although this is not recommended). Once the final write buffer command has completed the new code is immediately available and will be used for processing following commands. There is no delay required after the completion of the write buffer command before the file can start accepting new commands. However the final write buffer command may take up to 5 seconds to complete.

7.31 WRITE LONG (3F)

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Command Code = 3Fh							
BYTE 1	LUN			Reserved = 0				RelAd = 0
BYTE 2 BYTE 3 BYTE 4 BYTE 5	(MSB) LOGICAL BLOCK ADDRESS (LSB)							
BYTE 6	Reserved = 0							
BYTE 7 BYTE 8	(MSB) Byte Transfer Length (LSB)							
BYTE 9	VU = 0		RSVD = 0				FLAG	LINK

Figure 83. WRITE LONG (3F)

The WRITE LONG command requests the file to write **one block** of data transferred from the initiator. The transfer data must include;

- 512 bytes of data
- 16 bytes of ECC data

Parameters are;

- **RelAd** (Relative Block Address). This is not supported by the file.
- **LOGICAL BLOCK ADDRESS** field specifies the logical block at which the write operation shall occur.
- **Byte Transfer Length**. This field must exactly specify the number of bytes of data that are available for transfer. If a non-zero byte transfer length does not match the available data length, the target terminates the command with CHECK CONDITION status, the sense key is set to ILLEGAL REQUEST and an additional sense code set to INVALID FIELD IN CDB. The valid and ILI bits is set to one and the information field is set to the difference of the requested length minus the actual length in bytes. Negative values are indicated by two's complement notation.

7.32 SET PASSWORD (F1)

	7	6	5	4	3	2	1	0
BYTE 0	Command Code = F1h							
BYTE 1	LUN			Reserved = 0				
BYTE 2 : BYTE 8	Reserved = 0							
BYTE 9	VU = 0		Reserved = 0				FLAG	LINK

Figure 84. Set Password (F1)

The Set Password command requests to transfer 34 bytes data from the host including information specified in Figure 85. Set Password command update Password and Security Level. And if User Password is selected, the drive lock function will be enabled from the next power on. Setting Master Password does NOT affect to the drive lock function.

This command is not available in drive frozen mode.

If host set High level and User password is forgotten, the only Master Password can unlock the drive. If host sets Maximum level and User password is forgotten, only Erase Unit command is available.

	7	6	5	4	3	2	1	0
BYTE 0	Reserved = 0							Identifier
BYTE 1	Reserved = 0							Security Level
BYTE 2 : BYTE 33	Password							

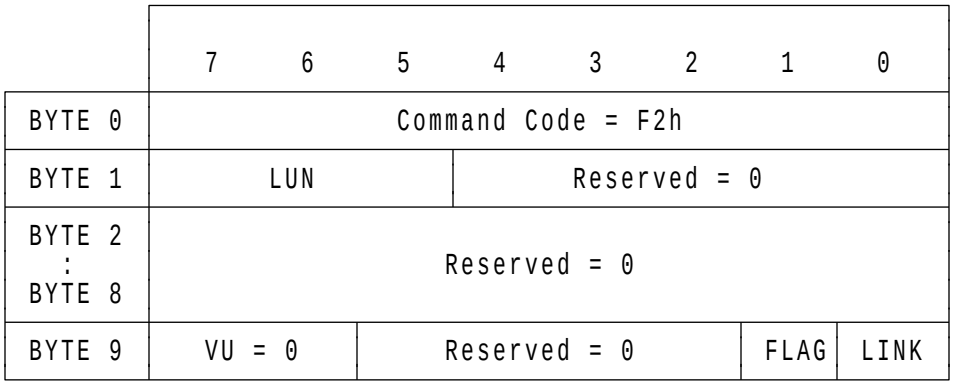
Figure 85. Set Password Information

Identifier Zero indicates that drive regards Password as User Password. One indicates that drive regards Password as Master Password.

Security Level Zero indicates High level, one indicates Maximum level.

Password On shipping from drive MFG, all '20'h (blank in ASCII) are filled.

7.33 UNLOCK (F2)



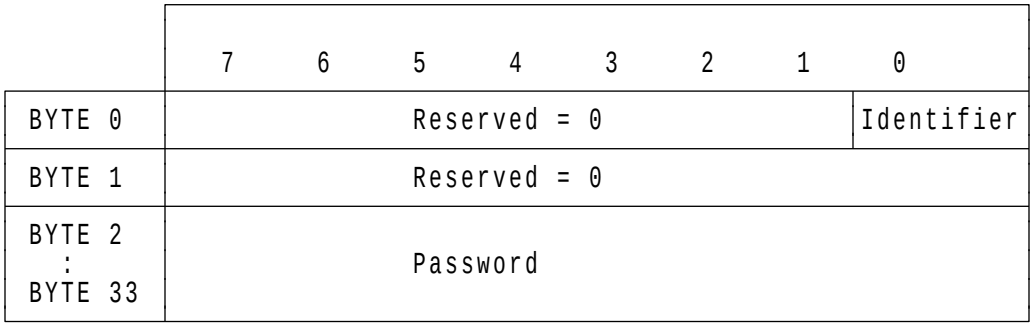
	7	6	5	4	3	2	1	0
BYTE 0	Command Code = F2h							
BYTE 1	LUN			Reserved = 0				
BYTE 2 : BYTE 8	Reserved = 0							
BYTE 9	VU = 0		Reserved = 0				FLAG	LINK

Figure 86. Unlock (F2)

The Unlock command requests to transfer 34 bytes data from the host including information specified in Figure 87. Then the drive compares transferred password and saved one. If User Password or Master Password is matched, the drive enters drive unlocked mode and enables all command. If neither passwords are not matched, the drive returns Check Condition status. If Unlock command fails 5 times, the drive rejects all command with Check Condition status until power off except Inquiry, Request Sense, and Test Unit Ready commands.

This command is not available in drive frozen mode.

The Unlock command will NOT allow Master Password if security level is maximum.



	7	6	5	4	3	2	1	0
BYTE 0	Reserved = 0							Identifier
BYTE 1	Reserved = 0							
BYTE 2 : BYTE 33	Password							

Figure 87. Unlock Information

Identifier Zero indicates that drive regards Password as User Password. One indicates that drive regards Password as Master Password.

7.34 ERASE UNIT (F4)

	7	6	5	4	3	2	1	0
BYTE 0	Command Code = F4h							
BYTE 1	LUN			Reserved = 0				
BYTE 2 : BYTE 8	Reserved = 0							
BYTE 9	VU = 0		Reserved = 0				FLAG	LINK

Figure 88. Erase Unit (F4)

This command requests to transfer 34 bytes data from the host including information specified in Figure 89. This command executes erase all user data. It will take about 5 minutes to complete erasure.

This command is not available in drive frozen mode.

If password is not matched, drive rejects this command with Check Condition status.

If host sets Maximum level and User password is forgotten, only Erase Unit command is available.

	7	6	5	4	3	2	1	0
BYTE 0	Reserved = 0							Identifier
BYTE 1	Reserved = 0							
BYTE 2 : BYTE 33	Password							

Figure 89. Erase Unit information

Identifier Zero indicates that drive regards Password as User Password. One indicates that drive regards Password as Master Password.

7.35 FREEZE LOCK (F5)

	7	6	5	4	3	2	1	0
BYTE 0	Command Code = F5h							
BYTE 1	LUN			Reserved = 0				
BYTE 2 : BYTE 8	Reserved = 0							
BYTE 9	VU = 0		Reserved = 0				FLAG	LINK

Figure 90. Freeze Lock (F5)

The Freeze Lock Command make the drive enter drive frozen mode. And after this command completion, following commands which can update drive lock condition terminate with Check Condition status. This command is also not available in drive frozen mode.

- Set Password
- Unlock
- Erase Unit
- Freeze Lock
- Disable Password

Drive cannot quits frozen mode until power off.

7.36 DISABLE PASSWORD (F6)

	7	6	5	4	3	2	1	0
BYTE 0	Command Code = F6h							
BYTE 1	LUN			Reserved = 0				
BYTE 2 : BYTE 8	Reserved = 0							
BYTE 9	VU = 0		Reserved = 0				FLAG	LINK

Figure 91. Disable Password (F6)

Disable Password command requests to transfer 34 bytes data from host including information specified in Figure 92. Then the drive compares transferred password. If User Password or Master Password is matched, the drive disables drive lock function. This command does not affect to User Password or Master Password.

This command is not available in drive frozen mode.

If password is not matched, drive rejects this command with Check Condition status.

This command will NOT allow Master Password if security level is maximum.

	7	6	5	4	3	2	1	0
BYTE 0	Reserved = 0							Identifier
BYTE 1	Reserved = 0							
BYTE 2 : BYTE 33	Password							

Figure 92. Password Information for Password disable command

Identifier Zero indicates that drive regards Password as User Password. One indicates that drive regards Password as Master Password.

8.0 PASSWORD COMMAND USAGE

8.1 Overview

8.1.1 Drive Lock

Drive Lock is powerful security feature. With a drive lock password, user can prevent unauthorized access to hard disk drive even if the drive is removed from the computer.

New commands are supported for this feature as below.

- Set Password ('F1'h)
- Unlock ('F2'h)
- Erase Unit ('F4'h)
- Freeze Lock ('F5'h)
- Disable Password ('F6'h)

8.1.2 Terminology

Term **Definition**

Drive Locked mode
In this mode, the drive disables media access commands. At powering on, automatically drive enters this mode if drive lock function is enabled. And drive quits this mode by Unlock command or Erase Unit command.

Drive Unlocked mode
In this mode, the drive enables all commands. Drive enter this mode by Unlock command.

Drive Frozen mode
In this mode, the drive enables all commands except commands which can update drive lock function. Drive enters this mode by Freeze Lock command. And drive cannot quits this mode until power off.

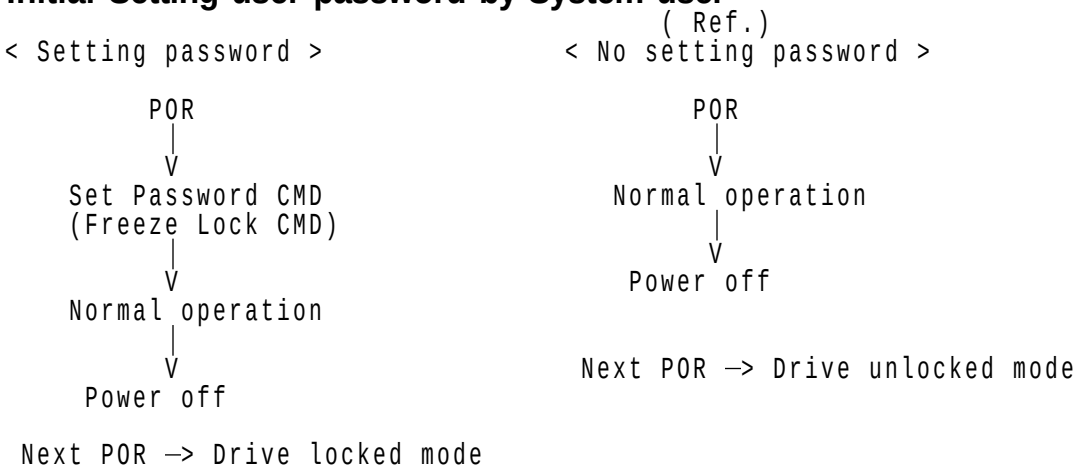
8.2 Operation

8.2.1 Default setting

Master Password is set as all ASCII blanks (20h) and the lock function is disabled on shipping from Drive MFG.

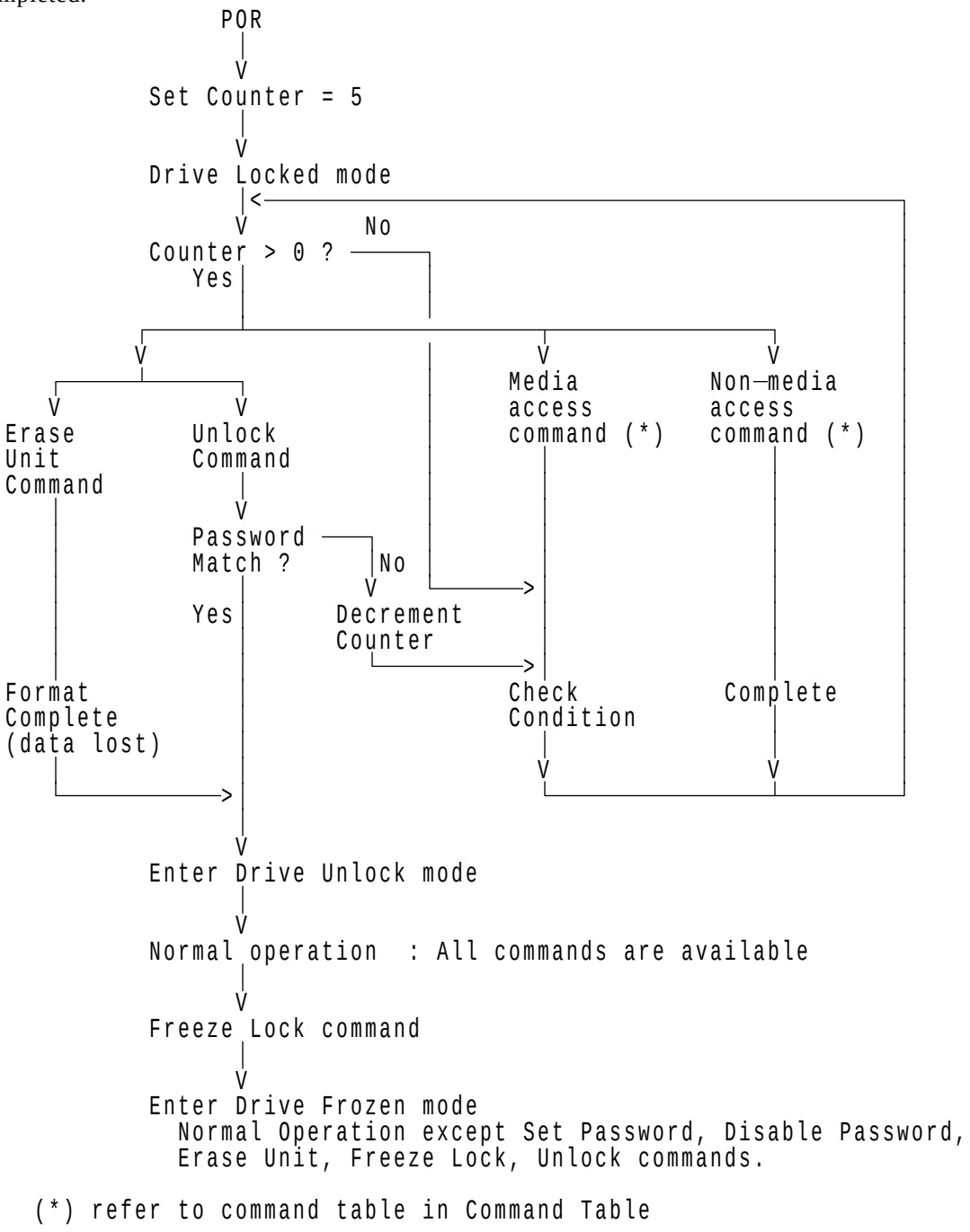
System manufacturer/dealer can set new Master Password by Set Password command, without enabling the lock function.

8.2.2 Initial Setting user password by System user



8.2.3 Operation from POR after User Password is set

When drive lock is enabled, the drive rejects media access command until an Unlock command is successfully completed.

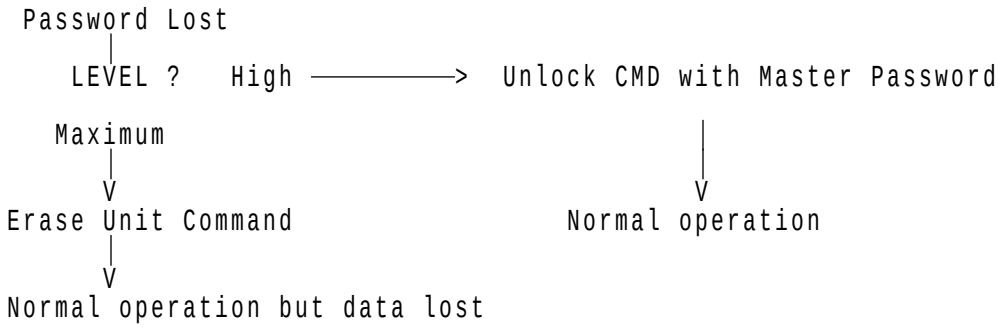


(*) refer to command table in Command Table

8.2.4 Password Lost

If the user password is forgotten and High security level is set, the user can't access any data. However the drive can be unlocked using the master password.

If a user forgets the user password and Maximum security level is set, data access is impossible. However the drive can be unlocked using the Erase Unit command to unlock the drive and erase all user data.



8.2.5 Command Table

This table shows drive's response for command when Drive lock function is enabled.

Command	Drive Locked Mode Power on to Unlock	Drive Unlock Mode unlock to freeze	Drive Frozen Mode freeze to Power off
Disable Password	x	o	x
Erase Unit	o	o	x
Format Unit	x	o	o
Freeze Lock	x	o	x
Inquiry	o	o	o
Mode Select	x	o	o
Mode Sense	x	o	o
Pre–fetch	x	o	o
Read	x	o	o
Read Buffer	x	o	o
Read Capacity	x	o	o
Read Defect Data	x	o	o
Read Extended	x	o	o
Read Long	x	o	o
Reassign Block	x	o	o
Receive Diagnostics	x	o	o
Release	x	o	o
Request Sense	o	o	o
Reserve	x	o	o
Rezero Unit	x	o	o
Seek	x	o	o
Seek Extended	x	o	o
Send Diagnostics	x	o	o
Set Password	x	o	x
Start/Stop Unit	o	o	o
Synchronize Cache	x	o	o
Test Unit Ready	o	o	o
Unlock	o	o	x
Verify	x	o	o
Write	x	o	o
Write Buffer	x	o	o
Write Extended	x	o	o
Write Long	x	o	o
Write and Verify	x	o	o

o —— Drive executes command normally
x —— Drive terminates command with Check Condition

8.2.6 Inquiry Command data

The byte 96,97 of Inquiry Data indicates Drive Lock Information.

Byte	Description
96–97	Drive Lock Information Bit 0 : Capability ; 1– Support,0– Not support Bit 1 : Enable/Disable ; 1– Enable ,0– Disable Bit 2 : Lock ; 1– Locked ,0– Unlocked Bit 3 : Freeze ; 1– Frozen ,0– Not frozen Bit 4 : Expire ; 1– Expired,0– Not expired Bit 8 : Security Level ; 1– Maximum,0– High Bit 9–15 : Reserved ;

Figure 93. Inquiry Command Data (Additional)

Capability Zero indicates Not support drive lock function. One indicates support drive lock function.

Enable/Disable Zero means drive lock function is disabled. One means drive lock function is enabled.

Lock Zero means currently mode is drive unlocked. One means currently mode is drive locked mode.

Freeze Zero indicates Not drive frozen mode. One indicates drive frozen mode.

Expire Zero indicates retry count is not expired. One indicates retry count is expired.

Security Level Zero indicates High level, one indicates Maximum level.

If auto spin-up function is disabled, the drive cannot load saved parameters from the disk until Start command completes successfully. In this case, only bit 0 is available and from bit 1 to bit 15 are reserved which value is 0.

8.2.7 Command Error Table

This table shows drive's response when Drive terminates with Check Condition.

Command	Password	Security Level		Mode	
		Maximum	High	Locked	Frozen
Set Password (F1h)	Master	o	o	Err1	Err2
	User	o	o		
Unlock (F2h)	Master	Err3	o	o	Err2
	User	o	o		
Erase Unit (F4h)	Master	o	o	o	Err2
	User	o	o		
Freeze Lock (F5h)	Master	o	o	Err1	Err2
	User	o	o		
Disable Password (F6h)	Master	Err3	o	Err1	Err2
	User	o	o		

o ——— Drive executes command normally

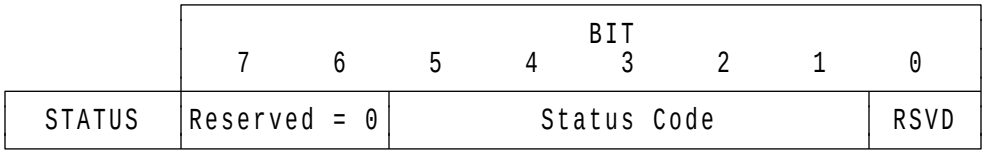
Figure 94. Command Error Table

	Sense Key	Sense Code	Description
Err1	05h	8200h	Drive is locked.
Err2	05h	8201h	Drive is frozen.
Err3	05h	8205h	Security level is maximum.
Err4	05h	8203h	Incorrect Password.
Err5	05h	8204h	Password is expired.
Err6	03h	8202h	Password table error. The drive fails to save password and lock information to disk.

Figure 95. Command Error Code List

9.0 SCSI Status Byte

Upon the completion of a command, a status byte is sent to the initiator. Additional sense information may also be available depending on the contents of the status byte. The following section describes the possible values for the status byte and sense data.



	BIT 7	6	5	4	3	2	1	0
STATUS	Reserved = 0				Status Code			RSVD

Figure 96. SCSI Status Byte. Format of the SCSI STATUS byte. All Reserved fields(R) are set to zero.

STATUS BYTE Description

00h GOOD
The command has been successfully completed.

02h CHECK CONDITION
An error, exception, or abnormal condition has been detected. The sense data is set by the file. The REQUEST SENSE command should be issued to determine the nature of the condition.

04h CONDITION MET
This status indicates that the requested operation is satisfied. (See "Pre-Fetch" Command)

08h BUSY
This condition is returned when disconnect privilege is not granted while the file is BUSY processing the other command for the other initiator. The normal initiator recovery action is to issue the command at a later time, or reissue the command and grant the disconnect privilege.

10h INTERMEDIATE/GOOD
This status is returned for every command in a series of linked commands (except the last command), unless an error, exception, or abnormal condition causes a CHECK CONDITION status or a RESERVATION CONFLICT status to be set. If this status is not returned, the chain of linked commands is broken, and no further commands in the series are executed.

14h INTERMEDIATE/CONDITION MET
This status is the combination of CONDITION MET and INTERMEDIATE /GOOD.

18h RESERVATION CONFLICT
This status is returned whenever an SCSI device attempts to access the file, but it has been reserved by another initiator. (See 7.18, “RESERVE (16)” on page 94.)

28h QUEUE FULL
This status indicates that the target's command queue is full. If tagged command queuing feature is enabled and there is no room on the command queue, this status is returned when the initiator sends a command. For this status, sense is not valid.

10.0 SCSI MESSAGE SYSTEM

This chapter details how the message system is implemented on the file. Included is a functional description of the supported messages.

10.1 Supported Messages

The message supported by the file is shows in Figure 97.

MESSAGE	CODE (hex)	Direction		Negate ATN Before last ACK
COMMAND COMPLETE	00	IN		———
SYNCHRONOUS DATA TRANSFER REQUEST	010301	IN	OUT	Yes
SAVE DATA POINTER	02	IN		———
RESTORE POINTERS	03	IN		———
DISCONNECT	04	IN		———
DISCONNECT	04		OUT	Yes
INITIATOR DETECTED ERROR	05		OUT	Yes
ABORT	06		OUT	Yes
MESSAGE REJECT	07	IN	OUT	Yes
NO OPERATION	08		OUT	Yes
MESSAGE PARITY ERROR	09		OUT	Yes
LINKED COMMAND COMPLETE	0A	IN		———
LINKED COMMAND COMPLETE (w/FLAG)	0B	IN		———
BUS DEVICE RESET	0C		OUT	Yes
IDENTIFY	80–FF	IN		———
IDENTIFY	80–FF		OUT	No

Key: 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.
——— = Not applicable
XX = Queue Tag

Figure 97. Supported Messages

If an unsupported message is received, the file will send the *MESSAGE REJECT* message to the initiator. If at the time the unsupported message is received a valid NEXUS exists then the file will continue with the command. If no valid NEXUS exists then the file will go to Bus Free.

10.1.1 COMMAND COMPLETE (00)

The file sends this message to the initiator to indicate that the execution of a command has terminated and that valid status has been sent to the initiator. After successfully sending this message, the file releases all bus signals and goes to BUS FREE phase.

10.1.2 SYNCHRONOUS DATA TRANSFER REQUEST (01,03,01H)

Byte	Value	Description
0	01H	Extended message
1	03H	Extended message length
2	01H	SYNCHRONOUS DATA TRANSFER REQUEST code
3	M	Transfer period (M times 4 nanoseconds)
4	X	REQ/ACK offset

Figure 98. Synchronous Data Transfer Request.

A pair of Synchronous Data Transfer Request (SDTR) messages shown in Figure 98 are exchanged between an initiator and a Target to establish the synchronous data transfer mode between the two devices. The message exchange establishes the permissible transfer period and REQ/ACK offset for a synchronous data transfer between the two devices. The initiator may initiate a synchronous data transfer negotiation at any time after the LUN has been identified. A Synchronous Data Transfer Request(SDTR) message 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;*

1. after a Power-on Reset
2. after a SCSI Bus "hard" reset condition
3. after a Bus Device Reset message

In addition, a SCSI device may initiate a SDTR message exchange whenever it is appropriate to negotiate a new data transfer agreement(either synchronous or asynchronous).

M The transfer period(M above) 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 file supports transfer period in the range 100 nSec to 475 nSec in 25 nSec increments.

REQ/ACK Offset

The ACK/REQ offset(X above) is the maximum number of REQ pulses allowed to be outstanding before the leading edge of its corresponding ACK pulses is received at the file. A REQ/ACK offset value of zero indicate asynchronous data transfer mode. The file supports REQ/ACK offset values in the range 0 through 15.

If ATN is negated before all bytes of a multiple-byte extended message is received, the file will go to **BUS FREE** to signal a catastrophic error.

10.1.2.1 Synchronous Negotiation Started by the Initiator

The file responds to each Initiator requested transfer period as shown in the following figure Figure 99:

Initiator Request	Target Response	Target Transfer Period	Maximum Burst Rate
0 <= Mi <= 25	Mt = 25	100 nSec	10.00 MT/s
26 <= Mi <= 31	Mt = Mi	125 nSec	8.00 MT/s
32 <= Mi <= 37	Mt = Mi	150 nSec	6.67 MT/s
38 <= Mi <= 43	Mt = Mi	175 nSec	5.71 MT/s
44 <= Mi <= 50	Mt = Mi	200 nSec	5.00 MT/s
51 <= Mi <= 56	Mt = Mi	225 nSec	4.44 MT/s
57 <= Mi <= 62	Mt = Mi	250 nSec	4.00 MT/s
63 <= Mi <= 68	Mt = Mi	275 nSec	3.64 MT/s
69 <= Mi <= 75	Mt = Mi	300 nSec	3.33 MT/s
76 <= Mi <= 81	Mt = Mi	325 nSec	3.08 MT/s
82 <= Mi <= 87	Mt = Mi	350 nSec	2.86 MT/s
88 <= Mi <= 93	Mt = Mi	375 nSec	2.67 MT/s
94 <= Mi <= 100	Mt = Mi	400 nSec	2.50 MT/s
101 <= Mi <= 106	Mt = Mi	425 nSec	2.35 MT/s
107 <= Mi <= 112	Mt = Mi	450 nSec	2.22 MT/s
113 <= Mi <= 118	Mt = Mi	475 nSec	2.11 MT/s
119 <= Mi <= 255	Mt = Mi	(Asynchronous mode)	N/A

Figure 99. Initiator Request/Target Response

10.1.2.2 Synchronous Negotiation Started by the Target

If the file recognizes that negotiation is required, the file sends a SDR message to the initiator with transfer period equal to 200 nSec (M = 50). The file interprets the Initiator corresponding transfer period as shown in the following figure Figure 100:

Initiator's Response	Target Transfer Period	Maximum Burst Rate
0 <= Mi <= 24	Send Message Reject(Async mode)	N/A
25 <= Mi <= 25	100 nSec	10.00 MT/s
26 <= Mi <= 31	125 nSec	8.00 MT/s
32 <= Mi <= 37	150 nSec	6.67 MT/s
38 <= Mi <= 43	175 nSec	5.71 MT/s
44 <= Mi <= 50	200 nSec	5.00 MT/s
51 <= Mi <= 56	225 nSec	4.44 MT/s
57 <= Mi <= 62	250 nSec	4.00 MT/s
63 <= Mi <= 68	275 nSec	3.64 MT/s
69 <= Mi <= 75	300 nSec	3.33 MT/s
76 <= Mi <= 81	325 nSec	3.08 MT/s
82 <= Mi <= 87	350 nSec	2.86 MT/s
88 <= Mi <= 93	375 nSec	2.67 MT/s
94 <= Mi <= 100	400 nSec	2.50 MT/s
101 <= Mi <= 106	425 nSec	2.35 MT/s
107 <= Mi <= 112	450 nSec	2.22 MT/s
113 <= Mi <= 118	475 nSec	2.11 MT/s
119 <= Mi <= 255	Send Message Reject(Async mode)	N/A

Figure 100. Target Response to Initiator's Transfer Period

10.1.3 SAVE DATA POINTER (02)

This message is sent from the file to direct the initiator to copy the active data pointer to the saved data pointer. The SAVE DATA POINTER message is only sent if the initiator has previously indicated the ability to accommodate disconnection and reconnection via the IDENTIFY message .

The file will send the SAVE DATA POINTER message to the initiator prior to sending a DISCONNECT message to the initiator if a data phase has occurred and another data phase is required to successfully complete the command.

10.1.4 RESTORE POINTERS (03)

This message is sent from the file to direct an initiator to copy the most recently saved pointers to the corresponding command, data, and status pointers. Command and status pointers should be restored to the beginning of the present command and status areas. The data pointer should 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. Also see 10.4, “SCSI Bus Related Error Handling Protocol” on page 136.

10.1.5 DISCONNECT (04)

This message is sent from the file to inform an initiator that the present connection is going to be broken. A later reconnect will be required in order to complete the current command. The disconnection is to free the SCSI bus while the file performs a relatively long operation that does not require the bus. These messages are only sent if the initiator previously indicated (via the IDENTIFY message) the ability to accommodate disconnection and reconnection.

The DISCONNECT message may also be sent from the initiator to the file to disconnect from the SCSI bus. If the file supports disconnecting at the time the DISCONNECT message is received from the initiator, the file will switch to the MESSAGE IN phase, send a DISCONNECT message to the initiator (possibly preceded by a SAVE DATA POINTER message), and then go to the BUS FREE phase. The file will not participate in another ARBITRATION phase for at least a disconnection delay. If the file does not support disconnecting at the time the Disconnect message is received from the initiator, the file will respond by sending a MESSAGE REJECT message to the initiator.

10.1.6 INITIATOR DETECTED ERROR (05)

This message is sent from an initiator to inform the file that an error has been detected that does not preclude the file from retrying the previous COMMAND, DATA and STATUS phase. The source of the error may be either related to previous activities on the SCSI bus or may be internal to the initiator and unrelated to any previous SCSI bus activity

If the initiator intends to send this message, the initiator must assert the ATN signal prior to its release of ACK for the last byte transferred in the information phase that is to be retried. This provides an interlock so the file can determine which information phase to retry.

After receiving this message, the file may retry the previous phase by sending a RESTORE POINTERS message to the initiator and then repeating the previous COMMAND, DATA, or STATUS phase.

10.1.7 ABORT (06)

This message is sent from the initiator to direct the file to clear the present operation for this initiator and logical unit, including queued command(s). If a logical unit has been identified, then all pending data and status for the issuing initiator and this logical unit will be cleared and the file will go to the BUS FREE phase. Pending data and status for other logical unit and initiators will not be cleared. If a logical unit has not been identified, the file will go to the BUS FREE phase without affecting an operation on any logical unit for this initiator or any other initiator. In either case, no status or ending message will be sent to the initiator for this operation. It is not an error to send the ABORT message to a logical unit that is not currently performing an operation for the initiator.

Note: It is permissible for an initiator to select the file/LUN after the file has disconnected from the initiator, for the purpose of sending an IDENTIFY message followed by an ABORT message. This will abort the command on the specified logical unit.

10.1.8 MESSAGE REJECT (07)

This message is sent from either the initiator or the file to indicate that the last message received was inappropriate or has not been implemented.

If the initiator intends to send this message, the initiator must assert the ATN signal prior to its release of ACK for the REQ/ACK handshake of the message byte that is to be rejected. This provides an interlock so the file can determine which message is rejected.

If the file intends to send this message, the file will change to the MESSAGE IN phase and send the MESSAGE REJECT message to the initiator prior to transferring any additional message bytes (or any other information phase bytes) from the initiator regardless of ATN signal. This provides an interlock so the initiator can determine which message is rejected. After the file sends a MESSAGE REJECT message and if 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.

10.1.9 NO OPERATION (08)

This message is sent from the initiator to the file when the initiator does not currently have any other valid message to send. This message is ignored by the file and will not affect any operation.

10.1.10 MESSAGE PARITY ERROR (09)

This message is sent from the initiator to inform the file that the last message byte received had a parity error.

If the initiator intends to send this message, the initiator must assert the ATN signal prior to its release of ACK for the REQ/ACK handshake of the message byte that has the parity error. This provides an interlock so the file can determine which message byte has the parity error.

If the file receives this message under any other circumstance, the file will change to BUS FREE to signal a catastrophic error. After receiving this message, the file will retry sending the previous message to the initiator.

10.1.11 LINKED COMMAND COMPLETE (0A)

The file sends this message to the initiator to indicate that execution of a linked command (with flag bit equal to zero) has completed and that valid status has been sent to the initiator. After successfully sending this message, the file goes to COMMAND phase to receive the next command.

10.1.12 LINKED COMMAND COMPLETE WITH FLAG (0B)

The file sends this message to the initiator to indicate that the execution of a linked command with flag bit set to one has completed and that valid status has been sent to the initiator. After successfully sending this message, the file goes to COMMAND phase to receive the next command.

10.1.13 BUS DEVICE RESET (0C)

This message is sent from an initiator to direct the file to clear all current commands. This message forces a hard reset condition which will reset the file to an initial state with no operations pending for any initiator. After receiving this message, the file will go to the BUS FREE phase.

10.1.14 IDENTIFY (80 - FF)

This message is set by either the initiator or the file to establish the logical path connection between the two devices.

The IDENTIFY message is defined as follows:

Bit 7 This bit is always set to one to distinguish the IDENTIFY message from other messages.

Bit 6 This bit is only set to one by the initiator to grant the file the privilege of disconnecting. If this bit is zero, the file will not disconnect, unless the initiator instructs the file to disconnect by sending a DISCONNECT Message to the file. This bit is set to zero when the file sends an IDENTIFY message to the initiator.

Bits 5-3 These bits are reserved and must be zero for an IDENTIFY message.

Note: If an invalid Identify message is received with these bits not equal to zero, then the file sends a MESSAGE REJECT message to the initiator and goes to the Bus Free phase to signal a catastrophic error condition.

Bits 2-0 These bits specify the logical unit number (LUN).

Only one LUN may be identified for any one selection sequence. If the file receives an IDENTIFY message with a new LUN after the LUN had previously been identified, the file will go to the BUS FREE phase to signal a catastrophic error. The initiator may send more than one Identify message during a selection sequence in order to toggle disconnect/reconnect permission if the specified LUN remains the same.

When the IDENTIFY message is sent from the file to the initiator during reconnection, an implied RESTORE POINTERS message must be performed by the initiator.

10.2 Supported Message Functions

The implementation of the supported messages will also include the following functions.

- Retry SCSI Command, DATA IN, DATA OUT, or STATUS phase
  The retry will be caused by the following error condition.
  - The file detected SCSI bus parity error(Command phase)
  - The file receives INITIATOR DETECTED ERROR MESSAGE during or at the conclusion of an information transfer phase (Command, Data In, Data Out or Status Phase)

    Note: The initiator may send the INITIATOR DETECTED ERROR message as a result of an initiator detected SCSI Bus parity error or an internal error.
- Retry MESSAGE IN phase
  - The retry will be caused by the receipt of a MESSAGE PARITY ERROR message immediately following a MESSAGE IN phase.

    Note: The Initiator may send the MESSAGE PARITY ERROR message as a result of an Initiator detected SCSI Bus parity error during the Message In phase.
- Receipt of multiple Identify message
  - The initiator is allowed to send multiple IDENTIFY messages out in order to toggle the disconnect/reconnect permission bit. This may be used to selectively enable or disable disconnect/reconnect permission during portions of a command. Note that this function does not effect the operation of the Forced Disconnect function.
- MESSAGE REJECT during Target Disconnection
  - If the Initiator rejects the SAVE DATA POINTER message, the file will disable disconnect/reconnect permission. This is equivalent to receiving an IDENTIFY message with bit 6 equal to zero. This will cause to file to inhibit the pending disconnection.
  - If the initiator rejects the DISCONNECT message, the file will not disconnect but may attempt to disconnect at a later time. This function may be used to selectively disable disconnection during portions of a command.

10.3 Attention Condition

The attention condition allows an initiator to inform the file that a MESSAGE OUT phase is desired. The initiator may create the attention condition by asserting the ATN signal at any time except during the ARBITRATION or BUS FREE phases.

The initiator must create the attention condition by asserting the ATN signal least two deskew delays before releasing ACK for the last byte transferred in a bus phase to guarantee that the attention condition will be honored before transition to a new bus phase. This will guarantee a predictable file response to message received during the MESSAGE OUT phase for this attention condition. If the ATN signal is asserted later, it might be honored in the current bus phase or the next bus phase and then may not result in the expected action.

After the initiator asserts the ATN signal, the file will respond with the MESSAGE OUT phase as follows:

Current Phase	Response
COMMAND	Message Out phase will occur after part or all of the Command Descriptor Block has been transferred to the file. The initiator must continue REQ/ACK handshakes during the Command phase until the file enters the MESSAGE OUT phase.
DATA	The MESSAGE OUT phase will occur after part or all of the data bytes have been transferred and not necessarily on a logical block boundary. The initiator must continue REQ/ACK handshakes (asynchronous transfer) until it detects the phase change. **Note:** In synchronous transfer, the initiator must continue sending ACK pulses to reach an offset of zero.
STATUS	The MESSAGE OUT phase will occur after the REQ/ACK handshake of the status byte has been completed.
MESSAGE IN	The MESSAGE OUT phase will occur before the file sends another message.
SELECTION	If ATN occurs during a SELECTION phase and before the initiator releases the BSY signal, the MESSAGE OUT phase will occur immediately after that SELECTION phase.
RESELECTION	The MESSAGE OUT phase will occur after the file has sent its IDENTIFY message for that RESELECTION phase. (First the file tries to complete the reselection.)

The initiator must keep the ATN signal asserted if more than one message byte is to be transferred during the MESSAGE Out phase. The file will process each message byte (multiple-bytes for an extended message) prior to receive the next message from the initiator. The file will continue to handshake and process byte(s) in the MESSAGE OUT phase until ATN goes false unless one of the following condition occurs:

1. The file receives an illegal or inappropriate message and goes to the MESSAGE IN phase to send a MESSAGE REJECT message.
2. The file detects a catastrophic error condition and goes to the BUS FREE phase.

10.4 SCSI Bus Related Error Handling Protocol

This protocol is used to handle error that threaten the integrity of a connection between the Target and an Initiator.

10.4.1 Unexpected BUS FREE Phase Error Condition

There are several error conditions that will cause the file to immediately change to the BUS FREE phase, regardless of the state of the ATN signal. The file will not attempt to reconnect to the initiator to complete the operation that was in progress when the error condition was detected. The initiator should interpret this as a catastrophic error condition.

If the LUN was identified by the file prior to the error condition, then the file will abort the active command for this initiator/LUN and generate sense data for this initiator/LUN to describe the cause of the catastrophic error. The initiator may retrieve this sense data by issuing a REQUEST SENSE command to this LUN. Note however, that the REQUEST SENSE command may fail if the catastrophic error condition persists.

If the LUN was not identified by the file prior to the error condition, then the file will not affect the sense data or the operation of any currently executing command for this initiator or any other initiator.

10.4.2 MESSAGE OUT Phase Parity Error

If the file detects a parity error during the MESSAGE OUT phase, the file will retry the MESSAGE OUT phase one time as follows:

1. Continue the REQ/ACK handshakes until the initiator drops ATN. The file will ignore all the remaining MESSAGE OUT phase bytes received after the parity error.
2. Assert the REQ signal prior to changing to any other phase. After detecting this condition, the initiator must resend all of the previous message byte(s) sent during this MESSAGE OUT phase.
3. Repeat the transfer of the MESSAGE OUT phase bytes(s). If the file receives all of the message byte(s) successfully, the file will change to:
   - Any other information transfer phase and transfer at least one byte.
   - BUS FREE phase if the message received was ABORT or BUS DEVICE RESET.

   If a second parity error is detected, the target will abort the current command with CHECK CONDITION status and sense data of ABORTED COMMAND / SCSI PARITY ERROR .

10.4.3 MESSAGE IN Phase Parity Error (Message Parity Error)

If the file receives a MESSAGE PARITY ERROR message, it is considered a retrievable error. The file will do the following one time if no previous retrievable error and if a MESSAGE IN phase has just occurred:

1. Change phase to MESSAGE IN.
2. Send the last message again.

If this is the second retrievable error, the file will terminate the current command as follows:

1. Change to the BUS FREE phase, regardless of the state of the ATN signal.
2. Abort the active command for this initiator/LUN and set the sense data to ABORTED COMMAND / SCSI PARITY ERROR.

10.4.4 COMMAND Phase Parity Error

1. Change phase to MESSAGE IN and send a RESTORE POINTERS message.
2. If RESTORE POINTERS message is accepted, then change phase to COMMAND OUT and receive the command again.

If a second parity error is detected, the file will abort the current command with CHECK CONDITION status and sense data of ABORTED COMMAND / SCSI PARITY ERROR .

10.4.5 DATA OUT Phase Parity Error

If the file detects a parity error during DATA OUT phase, the file will abort the current command with CHECK CONDITION status and sense data of ABORTED COMMAND / SCSI PARITY ERROR.

10.4.6 INITIATOR DETECTED ERROR Message

An INITIATOR DETECTED ERROR message is valid after a COMMAND, DATA IN/OUT or STATUS phase has occurred. If another phase has occurred, the message is rejected.

The recovery for COMMAND and STATUS phase consists of:

1. Change phase to MESSAGE IN and send a RESTORE POINTERS message
2. Repeat previous information phase .

If a second INITIATOR DETECTED ERROR message is received in the same selection, the target will abort the current command with CHECK CONDITION status and a Sense key of ABORTED COMMAND with additional sense code of INITIATOR DETECTED ERROR.

If a INITIATOR DETECTED ERROR message is received during a DATA IN/OUT phase, the target will abort the current command with CHECK CONDITION status and a Sense key of ABORTED COMMAND with additional sense code of INITIATOR DETECTED ERROR.

10.4.7 MESSAGE REJECT Message

The file will take the following actions after receiving the MESSAGE REJECT message in response to messages listed below.

DISCONNECT The file will not disconnect but remains connected.

COMMAND COMPLETE No error, continue to bus free.

IDENTIFY Command aborted - bus freed - Sense data set to MESSAGE REJECT ERROR.

LINKED CMD CMPLT Command aborted - link broken - bus freed - sense data set to MESSAGE REJECT ERROR.

MESSAGE REJECT Command aborted - STATUS phase executed with CHECK CONDITION - sense data set to MESSAGE REJECT ERROR.

RESTORE POINTERS Command aborted - status set to CHECK CONDITION - sense will be set with the error that caused the RESTORE POINTERS message to be issued. (Assuming that error recovery is in progress)

SAVE DATA POINTER The file will not disconnect from the SCSI bus. It will not be considered an error.

No previous Msg The command is aborted, the bus freed, and Sense data is set to MESSAGE REJECT ERROR. This occurs when the file has not sent a message, but gets a MESSAGE REJECT from the initiator.

11.0 Additional Information

This chapter provides additional information or descriptions of various functions, features, or operating models supported by the Target that are not fully described in previous chapters.

11.1 SCSI Protocol

There are various operating conditions that prevent the Target from executing a SCSI command. This section describes each of these operating conditions and their relative priority.

11.1.1 Invalid LUN in Identify Message

There are three different circumstances defined within the SCSI protocol when the response to an invalid LUN will occur. Each of these result in a different response.

11.1.1.1 Case 1 - Selection message sequence with Inquiry command

The INQUIRY command is a special case in SCSI. It is used to configure the bus when file IDs and LUNs are not known. The proper response is to return the inquiry data with a peripheral drive type of 1Fh which indicates that the specified LUN is not supported.

11.1.1.2 Case 2 - Selection message sequence with any other command

Any other commands, except REQUEST SENSE, return CHECK CONDITION status when an invalid LUN is specified in the message sequence following selection. In response to a REQUEST SENSE command the target shall return sense data. The sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to LOGICAL UNIT NOT SUPPORTED.

11.1.1.3 Case 3 - After selection message sequence

It is permissible for the initiator to issue multiple IDENTIFY messages during a single command sequence provided to LUN remains the same. If the LUN is altered, the file goes to a Bus Free Phase.

11.1.2 Incorrect Initiator Connection

It is an Incorrect Initiator Connection error if any of the following occurs:

- an Initiator attempts to establish an I_T_L nexus when an I/O process (either queued or active) with an I_T_L nexus already exists from a previous connection with the same initiator.

If any of the above errors occur, all queued I/O processes and active I/O processes associated with the issuing Initiator on the specified logical unit are terminated. The current I/O process is ended with a CHECK CONDITION status, the sense key is set to ABORTED COMMAND and the additional sense code is set to OVERLAPPED COMMANDS ATTEMPTED. Status is only returned for the current I/O process.

11.1.3 Command Processing During Execution of Active I/O process

When the Target is not executing any active I/O processes, a new I/O process is permitted to execute (unless execution is prevented by another internal Target condition. See 11.2, “Priority Commands” on page 148).

If an active I/O process does exist when the Target receives a new command, then the Target determines if:

- Check Condition Status with Sense Key = Aborted Command is returned for an Overlapped Commands Attempted error
- the command is permitted to execute
- the command is added to the command queue
- Queue Full Status is returned
- Busy Status is returned

If an active I/O process does exist when the Target receives a new command, then the Target determines how the new command should be handled based on the following rules:

- Check Condition Status is returned with Sense Key set to Aborted Command for an Overlapped Commands Attempted error if:
  - See 11.1.2, “Incorrect Initiator Connection” on page 141
- the command is permitted to execute if
  - the command is an Inquiry or Request Sense command
- Check Condition Status is returned with Sense Key set to Logical Unit Not Ready if:
  - the start-up operation or format operation is an active process.
- the command is permitted to execute if
  - the conditions to execute concurrently are met. (See 11.3, “Concurrent I/O Process” on page 148)
- the command is added to the command queue for an I_T_L nexus if:
  - no Queue Tag message was received during the connection which established the I/O process,and
  - Untagged Queuing is enabled(UQE = 1),and
  - disconnection is allowed for the current I/O process, and
  - there is no queued I/O process or active I/O process corresponding to the I_T_L nexus for the current I/O process, and
  - the command is not linked to a previous command.
- the command is added to the command queue for an I_T_L_Q nexus if:
  - a Queue Tag message was received during the connection which established the I/O process, and
  - Tagged Queuing is enabled(DQue = 0), and
  - an I/O process(either active or queued) exists at the Target for this Initiator, and
  - disconnection is allowed for the current I/O process, and
  - there is no queued I/O process or active I/O process corresponding to the I_T_L_Q nexus for the current I/O process, and
  - the command is not linked to a previous command.

  Note: Both Tagged and Untagged Queuing must be enabled(DQue = 0 and UQE = 1) for the Target to the queue tagged I/O processes from multiple Initiators.
- Queue Full Status is returned if:

- the command would otherwise be queued(according to the rules described above)but the command queue is full and all slots are utilized, or
- the command would otherwise be queued(according to the rules described above)but all of the available command queue slots not reserved for use by another initiator are utilized, or
- Tagged Queuing is enabled(DQue = 0) and a Format Unit command was previously queued but has not yet begun execution, or
- Tagged Queuing is enabled(DQue = 0) and a Start Unit command was previously queued but has not yet begun execution.

- Busy Status is returned if:
  - Tagged Queuing is disabled(DQue = 1) and a Format Unit command was previously queued but has not yet begun execution, or
  - Tagged Queuing is disabled(DQue = 1) and a Start Unit command was previously queued but has not yet begun execution, or
  - the command would otherwise be queued(according to the rules described above)but disconnection is not allowed for the current I/O process, or
  - the command would otherwise be queued(according to the rules described above)but Untagged Queuing is disabled(UQE = 0) and an I/O process (either active or queued) exists at the Target from a different Initiator.

If a command is queued, command execution may still be prevented at a later time when the command is dequeued to become an active I/O process. This occurs if command execution is prevented by another internal Target condition at the time the command is dequeued. See 11.2, “Priority Commands” on page 148

11.1.4 Unit Attention Condition

The file will generate a unit attention condition for each initiator whenever:

- The file has been reset.
  This includes Power On Reset, SCSI Bus Reset, SCSI BUS DEVICE RESET message.
- The mode parameters in effect for this initiator has been changed by another initiator.
- The microcode has been changed.
  WRITE BUFFER command has been executed to download microcode. In this case, a unit attention condition is generated for all initiators except the one that issued the command.
- Commands are cleared by another initiator.
  This condition is generated against the initiator that has queued commands, if ...
  - Clear Queue Message is received.
  - Contingent Allegiance Condition is cleared when QERR (in Mode Page 0A) is 1.
  - DQue is set to 1 while queued command exist.

The unit attention condition persists for each initiator until that initiator clears the condition as described in the following paragraphs.

If the file receives a command from each initiator before reporting a CHECK CONDITION status for a pending unit attention condition for that initiator , the file's response varies with the command as follows.

INQUIRY The file executes the command with GOOD status and preserves the unit attention condition.

REQUEST SENSE

If the file has an available pending sense data for the initiator, the file sends the pending sense data and preserves the unit attention condition for the initiator.

If the file does not have an available pending sense data for the initiator, the file sends sense data for the unit attention condition and clears the unit attention condition for the initiator.

ALL OTHER The file terminates the command with a CHECK CONDITION status and preserves the unit attention condition.

If the file receives a command from each initiator after reporting a CHECK CONDITION status for a pending unit attention condition for that initiator , the file's response varies with the command as follows.

REQUEST SENSE The file sends the sense data for a pending unit attention condition and returns GOOD status. And the file clears the unit attention condition for the initiator.

ALL OTHER The file executes the command with GOOD status and clears the unit attention condition unless another unit attention condition exists. And then the sense data for the unit attention condition is lost.

11.1.5 Command Processing During Start-up and Format Operations

If the Target receives a command from an Initiator while the Target is executing a start-up or format operation, The Target's response varies with the command as follows:

INQUIRY The file sends inquiry data and returns appropriate status.

REQUEST SENSE Executes the command, returns a Sense key of NOT READY and an Additional Sense Code of LOGICAL UNIT NOT READY and returns GOOD STATUS.

The Additional Sense Code Qualifier that is returned depends on type of I/O processes that are active:

For the START/STOP UNIT and the Auto-start operation, the qualifier returned is LOGICAL UNIT IS IN PROCESS OF BECOMING READY. For the FORMAT UNIT command, the qualifier returned is LOGICAL UNIT NOT READY,FORMAT IN PROGRESS, and the Sense key specific bytes are set to return the progress indication.

START/STOP UNIT If Untagged Queuing is enabled(UQE = 1), and the start-up operation is an active process and a Start/Stop Unit command(either active or queued) does not exist at the Target from this initiator, and disconnection is allowed for the current I/O process then: The command is added to the command queue.

Otherwise: Do not execute the command and return Check Condition Status. The Sense data generated is described in Request Sense above.

ALL OTHER The file terminates the command with CHECK CONDITION status. The Sense data generated is described in Request Sense above.

11.1.6 Internal Error Condition

The Target generates an Internal Error condition for all Initiators when:

- an internally initiated operation ends with an unrecoverable error. The following is a list of internally initiated error conditions:
  - The start-up sequence for Auto Start enabled terminates after the SCSI bus has been enabled and prior to completion of the bring-up sequence.
  - Following a SCSI H/W reset or a SCSI Bus Device Reset message if the reset was received during a start-up sequence with the Auto Start function enabled. The start-up sequence is executed if it has not been previously executed and completed.
- an recoverable error occurs during an internal Target idle time function

An Internal Error condition causes Sense data to be generated and saved for all Initiators. The Error Code field of the Sense is set for a Current Error(70h) and the Sense Key is set to HARDWARE ERROR. Recovered errors are not reported. Any outstanding Deferred Error condition is cleared for all initiators and the associated Sense data is lost.

The Internal Error condition persists for each Initiator until that Initiator clears the condition from the logical unit as described below. Several commands are handled as special cases during an Internal Error condition. These cases are also discussed.

If the Target receives a command from an Initiator while an Internal Error condition exists for that Initiator, the Target's response varies with the command as follows:

INQUIRY The file executes the command with GOOD status and do not clear the Internal Error condition.

REQUEST SENSE The file executes the command, return the sense data generated by the Internal Error condition, return Good Status, and clear the Internal Error condition for that Initiator.

ALL OTHER The file terminates the command with a CHECK CONDITION status and clear the Internal Error condition.

11.1.7 Deferred error

Error code (71h) of sense data indicates that the Check Condition status returned is the result of an error or exception condition that occurred during execution of a previous command for which Good status has already been returned.
The drive creates an Deferred Error condition when :

- Execution of a Start/Stop Unit command with the immediate bit of one ends with an error.
- Execution of a Format Unit command with the immediate bit of one ends with an error.
- Execution of a Write command with WCE (write cache enable) bit of one ends with an error.

11.1.8 Degraded Mode

There are certain errors or conditions which may impair the file's ability to function normally. Rather than fail hard, the file is designed to be as responsive as possible. Also, in most cases, some action on the part of the initiator may be used to restore normal operation. This mode of limited operation is called Degraded Mode.

11.1.9 Degraded mode handling

If any degraded mode condition occurs an initiator will receive a sense key of Hardware error (4h) in the next sense data requested. After clearing the sense key, the drive accepts commands according to the status of the degraded mode.

The following table shows the degraded mode status with acceptable commands and additional sense codes. If a degraded mode exists, the Hardware error condition caused by the degrade mode will be recreated after every POR, SCSI Reset or Bus Device Reset message. The following list shows the various operation modes.

11.1.9.1 Degraded Mode Entry Condition/Consequence State

Degraded Mode	Entry Reason	Accepting Request	Description and sense code
Power on Self Test fail	• Failure of a Send Diagnostic self-test • Failure of a start-up sequence	• Request Sense • Inquiry • Start/Stop unit • Write Buffer(except download and save)	The integrity of the drive is questionable. Sense code = 4080 (diagnostic fail), 4081 (HDC fail), 4082 (HIC fail), 4083 (other failure), 4084 (RAM error)

Degraded Mode	Entry Reason	Accepting Request	Description and sense code
Spin-up	Can not start up motor	• Request Sense • Inquiry • Start/Stop unit • Write Buffer(except download and save)	Return Spin-up Degraded Mode. Sense code = 0400
U-code	Can not read u-code	Same as Spin-up Degrade	Return U-code Degraded Mode. Sense code = 4085 (u-code download fail)
Reserved Area	• Fail to read Push Table • Fail to read saved Mode Parameter • Fail to read Defect list	All commands.	Reserved area sector valid check failed. Defective sector found in reserved area. (Hard Error) The integrity of the drive is questionable. Sense code = 4080 (diagnostic fail), 1900 (Defect list error),
Config	Fail to read Drive Configuration Table	All commands	Configuration sector valid check failed. The integrity of the drive is questionable. May return blanks in Inquiry Command. Sense code = 4C00 (Self configuration fail)

11.1.10 Command Processing While Reserved

A logical unit is reserved after successful execution of the Reserve command. Each time a Reserve command is executed successfully, the Target records the SCSI ID of the Initiator that made the reservation and the SCSI ID of the Initiator that is to receive the reservation. This information is needed to determine whether subsequent commands should be permitted or if the Reservation Conflict Status should be reported. The Initiator that made the reservation is the Initiator that issued the Reserve command. The Initiator to receive the reservation may be either the same or a different Initiator(third-party reservation).

If the logical unit is reserved when a new command is received, the Target examines the command opcode and the SCSI ID of the issuing Initiator to determine whether a Reservation Conflict Status should be returned based on the following rules:

1. If the issuing Initiator is the one that made the reservation and also the one to receive the reservation then:
   - All commands are permitted.

2. If the issuing Initiator is neither the one that made the reservation nor the one to receive the reservation then:
   - A Request Sense or Inquiry command is permitted.
   - A Release command is permitted but is ignored.
   - Any other command results in a Reservation Conflict Status.
3. If the issuing Initiator is the one that made the reservation but is not the one to receive the reservation then:
   - An Inquiry, Request Sense, Reserve, or Release command is permitted.
   - Any other command results in a Reservation Conflict Status.
4. If the issuing Initiator is not the one that made the reservation but is the one to receive the reservation then:
   - An Reserve command results in a Reservation Conflict Status.
   - A Release command is permitted but is ignored.
   - Any other command is permitted.

If a Reservation Conflict Status is not reported and the command is permitted, then the Target checks the next highest priority internal condition to determine whether execution is allowed. See 11.2, “Priority Commands”

11.2 Priority Commands

Certain SCSI commands always execute without returning a Busy Status, Reservation Conflict Status in response to the command. These commands are:

- Inquiry
- Request Sense

These commands do not disconnect from the SCSI bus prior to completion. They are executed prior to attempting to complete the execution of any other pending command that has disconnected from the SCSI bus. Therefore, a second priority command cannot be received during the execution of a priority command. The rule for an Incorrect Initiator Connection apply to priority commands.(see 11.1.2, “Incorrect Initiator Connection” on page 141)

11.3 Concurrent I/O Process

The Concurrent I/O process is that plural I/O processes are active on the same logical unit at the same time. The target may start the data phase of an I/O process while another I/O process is not completed. The following I/O processes are allowed to executed concurrently.

- Unlinked Request Sense and Inquiry during execution of other commands.
- When CPE (Concurrent process enable) bit is 1, one of the following commands can be executed during another one or the same one of the following commands is being executed.
  - Read(6), Read extend(10)
  - Write(6), Write extend(10)

When an I/O process ends in Check Condition Status, the drive enters the Contingent Allegiance Condition and other queued I/O processes from all initiators on the same logical unit will not reconnect and will not complete the execution until the sense data is cleared. See 11.14, “Contingent allegiance Condition” on page 156 for details. If an I/O process (P-1) encounters an error while another I/O process (P-2) is active, the drive returns Check Condition to P-1 and P-2. The drive may continue P-2 until its convenient point to suspend, but may not send a Status. After the initiator clears the Contingent Allegiance condition, the drive will resume or terminate P-2 according to QErr bit of Control mode page.
If the drive gets an error of P-2 before suspending the execution of P-2, it will keep the sense data separately from the sense data for P-1. The sense data for P-2 will be set after the Contingent Allegiance condition caused by P-1 is cleared.

11.4 Back to Back Write

Back to Back Write allows plural write commands requesting sequential LBAs to be written without losing a motor revolution.

11.5 Write Cache

If the WCE (Write cache enable) bit is 1, the drive returns Good Status and Command Complete message and goes to Bus Free immediately after receiving the data of the last sector before actually writing the data onto the media. The drive will accept and queue a command, but it can not start to execute the command after sending a Good Status except under the following conditions.

- The incoming command is one of priority commands.
- The CPE (Concurrent process enable) is 1 and the incoming command is Read(6), Read extend(10), Write(6) Write extend(10).

The drive behavior according to the mode parameter.

When Write Cache is enabled and Concurrent I/O process is enabled,

the drive may start and complete following Read/Write commands before the actual write operation (writing on the media) is completed. So, any following Read/Write or priority command returning a Good Status does not guarantee the completion of the Write command.
Under the current implementation, a command except Read/Write commands or priority commands returning a Good Status following a Write command can guarantee that the data is written to the media.
A Synchronize Cache command always performs this function regardless of the current implementation.

When Write Cache is enabled and Concurrent I/O process is disabled,

the drive may not start any following commands except priority commands before a previous Write command is completed and the drive sends a Status. So, under the current implementation, any following commands except priority commands returning a Good Status guarantees that the data is written to the media.
A Synchronize Cache command always performs this function regardless of the current implementation.

When Write Cache is disabled and Concurrent I/O process is enabled,

the drive may start and complete following Read/Write commands before a previous Write command is completed. But the Write command will not be completed before the data is written to the media.
A Synchronize Cache command is not needed in order to assume that the data is written to the media.

When Write Cache is disabled and Concurrent I/O process is disabled,

the drive may not start any following commands except priority commands before a previous Write command is completed and the drive sends a Status. And the Write command will not be completed before the data is written to the media.

A Synchronize Cache command is not needed in order to assume that the data is written to the media.

If the drive detects an error after it returns a Good Status, the drive sets a Differed Error (Error Code of sense data = 71h) and a following command will be returned with Check Condition and the Contingent allegiance condition is established. Under the Contingent allegiance condition, all queued processes including commands from other initiators are suspended.

11.6 Power Saving Mode

Power save function will save power consumption while the drive is idle. The drive automatically transfers its operating mode according to the event and timer.

11.7 Automatic Rewrite/Reallocate

The target supports Auto and Recommended Reallocate for READ, WRITE, WRITE VERIFY and VERIFY.

Automatic and Recommend Reallocate operate from within the read/write command. When an automatic reallocation occurs, the read or write command takes longer to complete.

This operation is sometimes referred to as autoreassignment due to it's similarity to the operation performed by the reassign command. During this time, the target disconnects from the SCSI bus, if allowed, and reconnects before ending the command.

Following is a description of the target behavior for each setting of ARRE. ARRE setting effects all data errors.(No Sector Found, Data Sync Byte Errors and Data ECC Errors.)

ARRE=1 : An error site determined to need rewriting or reallocation during a read is automatically rewritten or reallocated at the conclusion of the read and prior to sending the status. If the site cannot be automatically rewritten or reallocated, then a recommendation for reassignment is given. The site will be automatically rewritten or reallocated only if the data has been successfully read.

ARRE=0 : An error site determined to need rewriting or reassignment during a read is recommended for rewriting or reassignment at the conclusion of the read.

The setting of the ARRE bit is checked and the target will automatically rewrite/reallocate or recommend rewrite/reassign for the following commands.

- Read(6)
- Read(10)

Target will recommend rewrite/reallocate but will not auto rewrite/ reallocate for the following commands.

- Verify
- Verify Portion of Write and Verify

For all other commands the ARRE setting is ignored and the target will not automatically rewrite/reallocate or recommend rewrite/reassign.

Following is a description of the target behavior for each setting of AWRE. AWRE setting effects only No Sector Found Errors on writes.

AWRE=1 : An error site determined to need reassignment during a write is automatically reallocated at the conclusion of the write and prior to sending the status. If the site cannot be automatically reallocated, then a recommendation for reassignment is given. The site will be automatically reallocated only if the write recovery succeeded at the conclusion of the write.

AWRE=0 : An error site determined to need reassignment during a write is recommended for reassignment at the conclusion of the write.

The setting of the AWRE bit is checked and the target will automatically reallocate or recommend reassign for the following commands.

- Write(6)
- Write(10)
- Write portion of Write and Verify

For all other commands the AWRE setting is ignored and the target will not automatically reallocate or recommend reassign.

Auto/Recommend Reallocate information is communicated via the sense data returned following a command during which a site was determined to need rewriting or reassignment. The LBA returned in the sense data is the LBA that determined to need rewriting or reassignment.

The sense data combinations with auto/recommend rewrite/reallocate are listed below.

Key	Code	Qual	Description
1	17	00	Recovered Data without ECC.
1	17	06	Recovered Data without ECC - Auto Reallocated.
1	17	07	Recovered Data without ECC - Recommend Reassign.
1	17	09	Recovered Data without ECC - Data Rewritten.
1	18	00	Recovered Data with ECC.
1	18	02	Recovered Data with ECC - Auto Reallocated.
1	18	05	Recovered Data with ECC - Recommend Reassign.
1	18	07	Recovered Data with ECC - Data Rewritten.

11.8 Segmented Caching

11.8.1 Overview

Segmented Caching divides the data buffer into several smaller buffers. Each buffer is used as Read/Write/Read†Ahead buffer.

The size of the segmented buffer is controlled by the segmented buffer number field of read cache page (page 08h). But the file may adapt the size of the segmented buffer based on the access pattern if the Adaptive Caching bit is set in Mode Select page 0.

11.8.2 Read Ahead

The Read Ahead function consists of reading data that the Initiator has not yet requested to the file buffer. This function is intended to improve performance for an initiator that frequently accesses sequential data with successive SCSI read commands. The Read Ahead function works when RCD (the read cache disable) bit of read cache page (page 08h) is set to 0.

The file will continue to read subsequent logical blocks following the rules below.

1. At least the same number of sectors succeeding the sectors requested by the last Read command will be read automatically if they are not available on the sector buffer.
2. The drive has at least 2 segmented buffers. Data stored by the most recent Read ahead function will not be discarded by Write command.
3. Data in the segmented buffers will not be replaced unless it is against the rule 1.
4. The Read Ahead operations continue across all physical boundaries (such as tracks and cylinders).

The drive initiates the Read ahead function when

- RCD is 0, and
- Read(6), Read extended(10), Read Verify, and Write and Verify is received, and
- The consecutive LBA of the requested LBA is not available on the buffer.

The action of each command for previously started Read ahead function is listed below. If SCSI reset or bus device reset message is received, all contents of segmented buffer is flushed.

Code	Command	Action
00h	Test Unit Ready	No Effect
01h	Rezero Unit	Abort Read Ahead
03h	Request Sense	No Effect
04h	Format Unit	Abort Read ahead and flush all segments
07h	Reassign Blocks	Abort Read ahead and flush all segments
08h	Read(6)	Abort Read ahead if data not in active segment

Code	Command	Action
0Ah	Write(6)	Abort Read ahead and flush the LRU segment
0Bh	Seek(6)	Abort Read Ahead
12h	Inquiry	No Effect
15h	Mode Select(6)	Abort Read ahead and flush all segments
16h	Reserve	No Effect
17h	Release	No Effect
1Ah	Mode Sense(6)	Abort Read ahead and flush all segments
1Bh	Start/Stop Unit	Abort Read ahead and flush all segments
1Dh	Send Diagnostic	Abort Read ahead and flush all segments
25h	Read Capacity	No Effect
28h	Read extended(10)	Abort Read ahead if data not in active segment
2Ah	Write extended(10)	Abort Read ahead and flush the LRU segment
2Bh	Seek extended(10)	Abort Read Ahead
2Eh	Write and Verify	Abort Read ahead and flush the LRU segment
2Fh	Verify	Abort Read ahead and flush the LRU segment
34h	Pre-Fetch	Abort Read ahead if data not in active segment
35h	Synchronize Cache	Abort Read ahead and flush all segments
37h	Read Defect Data	Abort Read ahead and flush all segments
3Bh	Write Buffer	Abort Read ahead and flush all segments
3Ch	Read Buffer	Abort Read Ahead
3Eh	Read Long	Abort Read ahead and flush the LRU segment
3Fh	Write Long	Abort Read ahead and flush the LRU segment
4Dh	Log sense	Abort Read ahead and flush all segments

Figure 101. Read Ahead handling per each command

Even if an error occurs during Read ahead, the error will not be reported to the Initiator. The data read before the error occurs will be stored as a valid data by Read ahead.

11.9 Reselection

A reselection timeout error occurs when the target attempts to reselect an initiator and the initiator does not respond within a Selection Timeout delay(250 mSec). If this occurs, the target releases the SCSI bus going to the bus free phase and waits 250ms. It will then retry the reselection up to 16 times. If the initiator still does not respond the command is terminated and the target generates sense data with a Sense Key of Aborted Command and an Additional Sense code of Select/Reselect failure(45h). If any of the reselection attempts is successful then the command is resumed.

11.10 Single Initiator Selection

For single initiator systems, it is not an error to have only the target ID bit present during selection. Disconnection is not allowed for Single Initiator Selection with only one ID bit present during selection. The initiator must not send an Identify message with the disconnect permission bit(6) on.

11.11 Non-arbitrating systems

The Target cannot detect whether other SCSI devices on the SCSI bus use arbitration prior to selection. As a consequence, the Target allows disconnect permission to be enabled by the Identify message independent of the initiators use of arbitration prior to selection. A non-arbitrating initiator must ensure that disconnect permission in the Identify message is disabled (bit 6=0)for proper operation.

11.12 Selection without ATN

If the target is selected without ATN signal active, no Identify message is received from the initiator. In this case, the LUN is identified from the CDB and disconnect permission is disabled. The target does not perform any phase retries. The target still responds to a subsequent attention condition. However, the LUN is not considered to be known if a fatal error is detected during the Command phase. That is a Command phase parity error or a fatal message error in response to attention condition during Command phase is handled as a Bus Free error with no sense data. The target also knows the use of linked commands if selected without ATN. The target does not initiate synchronous data transfer negotiation if selected without ATN.

Phase retries and target initiated negotiations may be allowed if a subsequent Identify message is received.

11.13 Multiple Initiator Environment

11.13.1 Initiator Sense Data

Separate sense data is reserved for each initiator. Each initiator's sense data is maintained independent of commands from other initiators.

11.13.2 Initiator Mode Select/Mode Sense Parameters

A single shared copy of the Mode Select/Mode Sense parameters is maintained by the file. This includes both the current and saved parameters.

11.13.3 Initiator Data Transfer Mode Parameter

A separate data transfer mode parameters area is reserved and maintained for each initiator.

11.14 Contingent allegiance Condition

The contingent allegiance condition shall exist following the return of Check Condition, except Check Condition caused by Invalid LUN. Execution of all queued commands shall be suspended until the contingent allegiance condition is cleared.

The contingent allegiance condition can be cleared by the initiator in one of the following ways:

- By issuing a REQUEST SENSE command to the Target and receiving the sense data. This is most recommended way.
- By issuing any other command to the I_T_x nexus that reported the fault.
- By issuing an Abort message to the I_T_x nexus that reported the fault. This will also abort the current and queued I/O process from that initiator.
- By issuing a Bus Device Reset message to the Target. This will also abort all current and queued I/O processes.
- By generating a RESET condition on the bus. This MUST be the last resort.

11.15 Reset

The Reset condition is used to clear all SCSI devices from the bus. This condition takes precedence over all other phases and conditions. After a reset condition is detected and the reset actions completed, the target returns to a 'SCSI bus enabled' state that allows the target to accept SCSI commands.

This device uses the Hard reset option as defined in the SCSI-2 standard.

11.15.1 Reset Sources

There are four sources of resets detected by the target:

Reset Name	Reset Source
Power-On Reset	This is the signal generated by the hardware at initial power-on
Self-Initiated reset	This is a software-generated reset that occurs when a catastrophic error is detected by the microcode.
SCSI Bus Reset	This is a reset generated when the SCSI bus control line RST goes active.

SCSI Bus Device Reset Message This is the reset generated by the SCSI Bus Device Reset Message(0Ch).

11.15.2 Reset Actions

The action taken by the Drive following a reset is dependent on the source of the reset.

11.15.2.1 Power-On reset and Self-Initiated reset

These two reset conditions cause the following to be performed in the order shown.

1. A power-up sequence
2. A start-up sequence is necessary to put the Drive in a ready state

11.15.2.2 SCSI Bus reset and SCSI Bus Device Reset message

These two reset conditions cause the following to be performed.

- If reset goes active while the power-up sequence is in progress, the power-up sequence is started over.
- If the Auto Start pin is grounded and a start-up sequence has not yet completed, a start-up sequence will be re-attempted from the beginning.

  Note: The power-up sequence, having already completed, is not rerun.
- If reset occurs while a physical sector is being written, the write operation is disabled after the current physical sector is written. Data is not lost as long as power stays valid until the physical sector being written is completed.

11.16 Diagnostics

The file will execute a self test at power on or when a Send Diagnostics command is issued with the self test bit set.

The diagnostics are to assure the correct operation of the file and to verify that the check circuits detect fault conditions.

11.16.1 Power on Diagnostics

At power on time the following tests are executed:

1. Test the microprocessor's:
    a. Internal Timers.
    b. Internal RAM.
2. Do a sum check on the microprocessor's external ROM.
3. Test the adapter section of the file as follows:
    a. Test the registers.
    b. Test HDC.
4. Do a read/write test on the microprocessor's external RAM.
5. Do a read/write test on sector buffer RAM.
6. Initialize and check the servo system is functioning correctly.
7. Check the spindle's RPM.
8. Seek to a correct cylinder.

11.16.2 Diagnostics Command

The tests executed as a result of the Send Diagnostics command with the self test bit set to a one differs from the tests executed at power on. The spindle motor must be at the correct speed for the Diagnostics command to be executed. If the motor is not at the correct speed, a NOT READY status will be returned in the sense byte.

The Diagnostics command will execute the following tests:

1. Test the adapter section of the file as follows:
    a. Test the registers.
    b. Assure the ECC circuits work correctly.
    c. Do a read/write test on sector buffer RAM.
2. Check the spindle's RPM.
3. Seek to a correct cylinder.
4. Write the CE cylinder.
5. Read from the CE cylinder.

11.16.3 Diagnostics Fault Reporting

Faults detected before successful completion of the adapter section could prevent the file from responding to a selection.

Faults detected after the successful completion of the adapter section will be reported as Check Condition status to the initiator on the first command issued after a fault is detected except for the Inquiry command. The Inquiry command will always respond with good status. Detecting a fault during power on will not terminate execution of the diagnostics nor will it terminate the power on process.

Faults detected during a Send Diagnostics command will report a Check Condition as end status.

12.0 SCSI SENSE DATA

12.1 SCSI Sense Data Format

Format of the sense data returned by the file in response to the REQUEST SENSE command.

	BIT 7	6	5	4	3	2	1	0
BYTE 0	Valid	Error Code (70h or 71h)						
BYTE 1	RSVD = 0							
BYTE 2	0			ILI	0	Sense Key		
BYTE 3 — 6	(MSB) Information Bytes (LSB)							
BYTE 7	Additional Sense Length							
BYTE 8 —11	(MSB) Reserved (LSB)							
BYTE 12	Additional Sense Code							
BYTE 13	Additional Sense Code Qualifier							
BYTE 14	FRU = 0							
BYTE 15	SKSV	Sense—Key Specific Bits						
BYTE 16 BYTE 17	Sense—Key Specific Bytes							
BYTE 18 —19	Reserved = 0							
BYTE 20 BYTE 21	Unit Error Code							
BYTE 22 BYTE 23	Reserved = 0							
BYTE 24 —27	Physical Error Code							
BYTE 28 —31	Reserved = 0							

Figure 102. Format of Sense Data. Format of the Sense Data returned by the file in response to the REQUEST SENSE command

12.1.1 Sense Data Description

12.1.1.1 Valid Bit

Bit 7 of byte 0

0 The Information Bytes are not defined.
1 The Information Bytes contain a valid logical block address.

12.1.1.2 Error Code

Bit 6 - 0 of byte 0.

70h Current Error. This indicates an error for the current command.
71h Deferred Error. This indicates that the error is for a previous command that has already returned a GOOD status. Such commands are associated with the immediate bit, or write caching. FORMAT UNIT command is an example of a command that may return a deferred error.

12.1.1.3 Sense Key

Bit 3 - 0 of byte 2.

The sense key provides generic categories in which error and exception conditions can be reported. Initiators would typically use sense keys for high level error recovery procedures.

0 NO SENSE
There is no sense key information to be reported for the logical unit.

1 RECOVERED ERROR
The last command completed successfully with some recovery action performed by the file. More detailed information is available in the Additional Sense Code.

2 NOT READY
The logical unit addressed cannot be addressed. More detailed information is available in the Additional Sense Code.

3 Medium Error
The command terminated with an unrecoverable error condition caused by a flaw in the media or an error in the recorded data. More detailed information is contained in the Additional Sense Code.

4 HARDWARE ERROR
The file detected a unrecoverable hardware error while performing a command or during a diagnostic test. More detailed information is contained in the Additional Sense Code.

5 ILLEGAL REQUEST
There was an illegal parameter in the command descriptor block or additional parameter supplied as data. If an invalid parameter is found in the CDB, then the command is terminated without altering the medium. If an invalid parameter is found in parameters supplied as data, then the file might have altered the medium.

6 UNIT ATTENTION
Indicates that the file entered in the 'Unit Attention Condition'. (See 11.1.4, “Unit Attention Condition” on page 144.)

7-8 Not used

9 Vendor Specific

A Not used

B ABORTED COMMAND
The file aborted the command.

C-D Not Implemented

E Not Used

F Reserved

12.1.1.4 Information Bytes

Byte 3 - 6
This field is only valid when Valid Bit is one, and contains the unsigned LBA associated with the sense key.

12.1.1.5 Additional Sense Length

Byte 7
Indicates the remaining number of bytes in the sense data. (It is set to 18h in the file.)

12.1.1.6 Reserved

Byte 8 - 11

12.1.1.7 Additional Sense Code/Qualifier

Byte 12 / 13

Key	Code	Qual	Description
0	00	00	No error.
1	01	00	Recovered write error no index
1	02	00	Recovered no seek comp
1	03	00	Recovered write error - write fault
1	14	01	Recovered write error Id not found
1	16	00	Recovered write error DAM not found
1	17	00	Recovered read error without ECC applied.
1	17	01	Recovered read error with retries.
1	17	06	Recovered read error without ECC applied. Auto reallocated.
1	17	07	Recovered read error without ECC applied. Recommended reassign. This value can be returned only when ARRE = 0.
1	17	09	Recovered read error without ECC applied. Data re-written. This value can be returned only when ARRE = 1.
1	18	00	Recovered read error with ECC applied. This value can be returned only when ARRE = 0.
1	18	02	Recovered read error with ECC applied. Auto reallocated. This value can be returned only when ARRE = 1.
1	18	05	Recovered read error with ECC applied. Recommended reassign. This value can be returned only when ARRE = 0.
1	18	07	Recovered read error with ECC applied. Data Rewritten. This value can be returned only when ARRE = 1.
1	1C	01	Primary Defect list Not Found. Requested Defect List Format is not supported. Default Lsi Format is returned.(Read Defect Data Only)
1	1C	02	Grown Defect list Not Found. Requested Defect List Format is not supported. Default Lsi Format is returned.(Read Defect Data Only)
1	44	00	Internal target failure
2	04	00	Not ready. Start spindle motor fail.
2	04	01	Not ready. In process of becoming ready.
2	04	02	Not ready. Initializing command required. (Start Unit)
2	04	04	Not ready. Format in progress.
2	31	00	Not ready. Media format corrupt. A format operation was interrupted (power down, reset) prior to completion of a Format Unit command. The Format Unit command should be re-issued and must complete successfully for this error condition to be removed.
2	40	80	Diag Fail - Bring-Up Fail
2	40	85	Diag Fail - RAM Microcode Not Loaded

Key	Code	Qual	Description
2	4C	00	Degraded Mode - Self Configuration Fail Configuration/RAM Microcode not loaded
3	10	00	Medium error. ID CRC error.
3	11	00	Medium error. Unrecovered read error.
3	14	01	Medium error. Record not found.
3	16	00	Medium error. Data synchronization mark error. (DAM error)
3	19	00	Medium error. Defect list error. A defect list error occurs when a data error is detected while reading the manufacturing defect list or while reading or writing the grown defect list.
3	31	01	Medium error. Medium Format Corrupted Reassign Failed
4	01	00	H/W error. No index or sector.
4	02	00	H/W error. No seek complete.
4	03	00	H/W error. Write fault.
4	09	00	H/W error. Track following error.
4	11	00	H/W error. Unrecovered read error in reserved area.
4	31	00	Degrade mode. Format corrupt.
4	32	00	H/W error. No defect spare location available. A no defect spare location available sense code indicates that the Reassign Block command can not proceed the process because all spare sectors have been used, or it will exceed implementation limitation of defect handling of the file.
4	40	80	Degrade Mode. Diagnostic Fail. Configuration sector valid check fail. Reserved area sector valid check fail.
4	40	81	Degrade mode. HDC error.
4	40	82	Degrade mode. HIC error.
4	40	83	Degrade mode. Other LSI error.
4	40	84	Degrade mode. RAM error.
4	40	85	Degrade Mode. RAM Microcode Not Loaded
4	44	00	H/W error. Internal target failure
4	47	00	H/W error. SCSI parity error.
5	1A	00	Illegal request. Parameter list length error. The number of parameters supplied is not equal to the value the expected.
5	20	00	Illegal request. Illegal command operation code. This command is also returned when an unsupported command code is received.
5	21	00	Illegal request. Logical block address out of range.
5	24	00	Illegal request. Invalid field in CDB.
5	25	00	Illegal request. Invalid lun.
5	26	00	Illegal request. Invalid fields in the parameter list.
6	28	00	Unit attention. Not ready to ready transition.(Format completed)
6	29	00	Unit attention. Power on reset or Bus device reset occurred.

Key	Code	Qual	Description
6	2A	01	Unit attention. Mode select parameter changed.
6	2F	00	Unit attention. Command cleared by another initiator.
6	3F	01	Unit attention. Micro code has been changed.
B	1B	00	Aborted command. Synchronous data transfer error. (Extra ack detected)
B	25	00	Aborted command. Unsupported LUN. The drive supports LUN 0 only.
B	43	00	Aborted command. Message reject error. A message reject error occurs when an inappropriate or unexpected message reject is received from the initiator or the initiator rejects a message twice.
B	45	00	Aborted command. Selection/Reselection failed. A selection/reselection error occurs when the initiator fails to respond to a reselection within 250 milliseconds after the drive starts reselection. The reselection is attempted a second time before setting selection/reselection failed sense code.
B	47	00	Aborted command. SCSI parity error.
B	48	00	Aborted command. Initiator detected error message received. An initiator detected error occurs when the initiator detects an error, sends a message to retry, detects the error again, and sends the retry message a second time. The drive then sets check condition status with Initiator Detected Error.
B	49	00	Aborted command. Inappropriate/illegal message. An inappropriate or illegal message occurs when the initiator sent a message that either is not supported or is not in a logical sequence.
B	4E	00	Aborted command. Overlapped commands attempted.

12.1.1.8 FRU (Field Replaceable Unit)

Byte 14
The FRU (Field Replaceable Unit) field value will always be zero.

12.1.1.9 Sense Key Specific

Byte 15 - 17
The definition of this field is determined by the value of the sense key field.

12.1.1.9.1 Illegal Request Case: Error filed pointer is returned.

	BIT 7	6	5	4	3	2	1	0
BYTE 15	SKSV	C/D	Reserved		BPV	Bit Pointer		
BYTE 16 BYTE 17	(MSB)	Field Pointer						(LSB)

Figure 103. Field Pointer Bytes

SKSV Sense-key specific valid

C/D Command/Data

0 Indicates that the illegal parameter is in the data parameters sent by the initiator during DATA OUT phase

1 Indicates that the illegal parameter in the command descriptor block.

BPV Bit Pointer Valid

0 Indicates the bit pointer field is not valid.

1 Indicates the bit pointer field is significant.

Bit Pointer Bit Pointer indicates which bit of the byte number reported in Field Pointer is the bit in error. When a multiple-bit field is in error, the pointer point to the most significant bit of the field.

Field Pointer Indicates which bytes of the command descriptor block or of the parameter data was in error. Bytes are numbered starting from zero, as shown in the tables describing the commands and parameters. When a multiple-byte field id in error, the pointer point to the most significant byte of the field.

12.1.1.9.2 Recovered, Hardware or Medium Error Case: Actual Retry Count is reported.

	BIT 7	6	5	4	3	2	1	0
BYTE 15	SKSV	Reserved						
BYTE 16 BYTE 17	(MSB) Actual Retry Count (LSB)							

Figure 104. Actual Retry Count Bytes

SKSV Sense-key specific valid

0 Indicates that Actual Retry Count is not valid.

1 Indicates that Actual Retry Count is valid.

Actual Retry Count Actual number of retries used in attempting to recover from the error condition.

12.1.1.9.3 Not Ready Case: Progress indication is returned. These fields are only defined for the FORMAT UNIT command with the Immediate bit set to one.

	BIT 7	6	5	4	3	2	1	0
BYTE 15	SKSV	Reserved						
BYTE 16 BYTE 17	(MSB) Progress Indication (LSB)							

Figure 105. Format Progress Indication Bytes

SKSV Sense-key specific valid

0 Indicates that Progress Indication is not valid.

1 Indicates that Progress Indication is valid.

Progress Indication Indicates a percent complete in which the returned value is the numerator that has 10000h as its denominator.

12.1.1.10 Reserved

Byte 18 - 19

12.1.1.11 Unit Error Code(UEC)

Byte 20 - 21
The UEC gives detailed information about the error. It contains a unique code which describes where the error was detected and which piece of hardware or microcode detected the error.

12.1.1.12 Reserved

Byte 22 - 23

12.1.1.13 Physical Error Record

Byte 24 - 27

- ILI = 1 - This field contains zeros.
- ILI = 0 - These bytes contain the physical location of the error in cylinder, head and sector. Byte 24 and 25 are Cylinder high and cylinder low respectively. Byte 26 is the head number and byte 27 is the sector. If the head and/or sector is undetermined, the value is set to FFh. If the Cylinder value is undetermined, both bytes 24 and 25 are set to FFh. This field is valid with Sense Key 1, 3 and 4 only.

12.1.1.14 Reserved

Byte 28 - 31

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