SMO-E501 Magneto Optical Disk Drive

Specifications and Operating Instructions

SONY Corporation

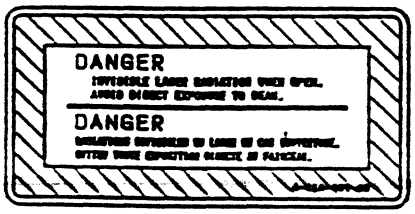
WARNING

To prevent fire or shock hazard, do not expose the unit to rain or moisture.

To avoid electrical shock, do not open the unit. Opening the unit by unauthorized personnel voids the warranty. Refer servicing to qualified personnel only.

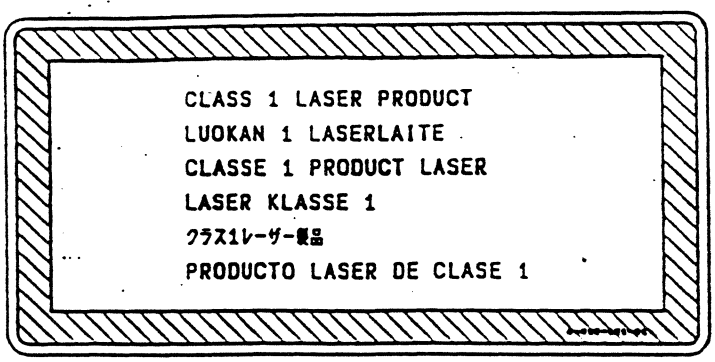
CAUTION

As the laser beam used in the SMO-E501-XX is harmful to the eyes, do not attempt to disassemble the unit



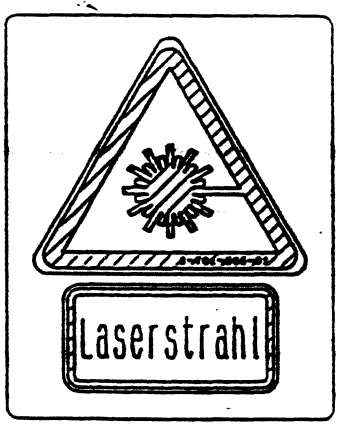
This label is affixed both on the top cover and, internally, on the cartridge tray of this unit.

The export of this product is subject to the authorization of the government of the exporting country.



This MO unit is classified as a CLASS 1 LASER PRODUCT.

The CLASS 1 LASER PRODUCT label is located at the top cover of the unit.



This label is affixed, internally, on the cartridge tray of this unit.

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1. INTRODUCTION

The Sony SMO-E501 is an embedded SCSI, rewritable optical direct access mass storage device. Unlike conventional magnetic storage devices and due to the utilization of magneto optical effects this drive can access a vast amount on information within a few seconds. This drive complies with the ISO/IEC DIS 10089 format A (Continuous-Composite Format) proceedings for 130mm Rewritable Optical Disk cartridges.
This International Standard specifies the characteristics of 130mm rewritable optical disk cartridges of the type providing for information to be written, read and erased many times using magneto optical effects.

The SMO-E501 utilizes, ISO/IEC DIS 10089 complying, 5.25 inch (130mm) magneto-optical (M.O.) disk cartridges. Each such disk cartridge can store approximately either 650 megabytes or 594 megabytes of data. Information stored in MO disks can be archived for at least ten years with no maintenance whatsoever. Since MO media are removable the storage capacity of the SMO-E501 is virtually unlimited. Removability allows not only for portability but security as well since each disk can be safely locked up.

MO disks are pregrooved and formatted either with 1024 bytes per sector and 17 sectors per track, or 512 bytes per sector and 31 sectors per track, using a spiral track configuration.

The SMO-E501 contains mechanical and optical components, analog circuitry for data separation, servo systems, digital circuitry for drive control, formatting and interfacing, and interfacing circuitry for communication with other devices.

Communications with a host system is performed via SCSI (Small Computer System Interface) which complies with ANSI X3.131-1986 and the Common Command Set (CCS) Rev. 4B. The SMO-E501 can be accessed by SCSI commands much as a conventional magnetic disk drive. The use of new digital LSIs has resulted in a compact drive with a high degree of reliability. The inclusion of buffered memory allows the drive to achieve a high speed burst transfer rates through SCSI.

2.1 Location Requirements

Place the SMO-E501 in a well air-conditioned room. The recommended environmental conditions are approximately 25°C (77°F) temperature and 60% relative humidity.
Forced-air cooling is required through the drive, and is critical to preventing overheating of the mechanism and electronics residing in the drive. Forced-air cooling must be provided by the integrated system package. Refer to the drive specification section for the said cooling specifications.

Place the SMO-E501 drive horizontally or vertically on a flat plane. Mounting tilt is specified as less or equal to 5 degrees from each mounting position.

Do not place either the drive and/or the media in environments that are normally subject to heavy dirt or dust contamination, or where continuous vibration and/or shock may occur.

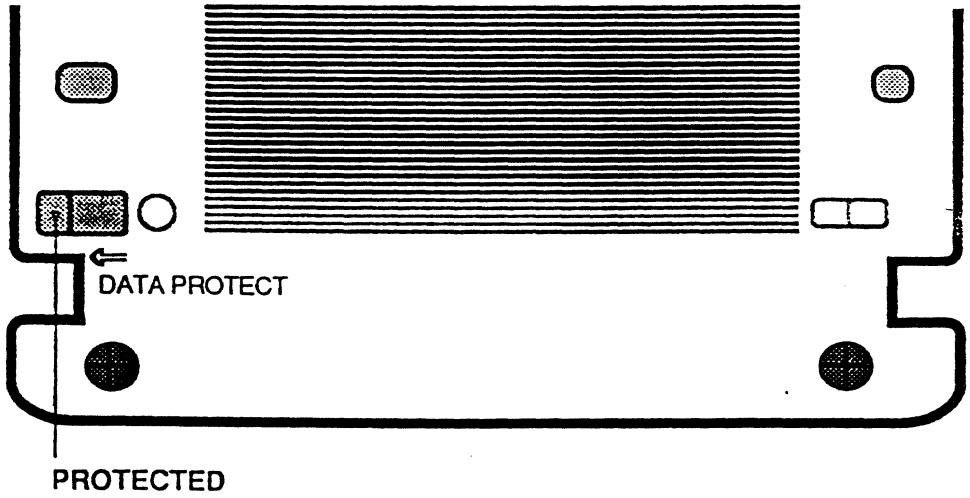
Do not use the drive and/or the media in environments that are normally subject to strong external magnetic fields.

Do not place the drive and/or the media at locations exposed to direct sunlight or sudden changes in temperature and humidity generated by air conditioners.

Always eject the media before moving the drive to a new location.

2.2 Precautions on Handling Disks

- Do not drop the disk or subject it to vibration.
- The disk cartridge is designed so that the shutter automatically opens when it is installed in the drive unit. Do not open the shutter manually or touch the disk inside.
- Do not disassemble the disk cartridge. Precise adjustments are made at the factory prior to shipping.
- An erase protection tab is provided on the cartridge. To protect the disk, slide the tab in the direction of the arrow; to write on the disk, slide the tab in the opposite direction.



- Moisture condensation caused by a sudden temperature change or high humidity may impair writing or reading capabilities.

Notes on storage

- Keep cartridges in their cases.
- Keep cartridges away from heat sources, such as radiators, or places subject to direct sunlight, excessive dust and/or moisture.

2.3 Front Panel

The front panel of SMO-E501 has a BUSY indicator, EJECT button and emergency eject hole at the positions shown in the figure below.

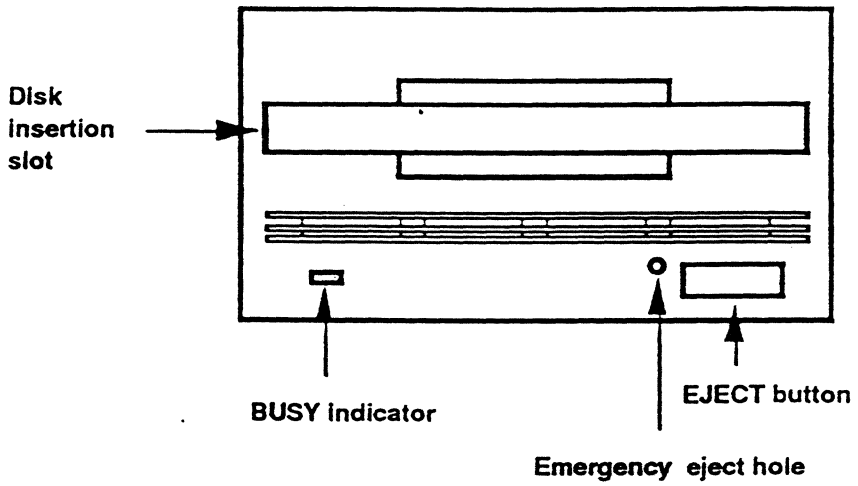


Fig. 2.1 : Front View of SMO-E501

2.2.1 BUSY Indicator

Lights up when read, write, erase or seek operations are performed. Do not eject the disk when the this indicator is lit.

2.2.2 EJECT Button

Press this button to eject any disk existing in the drive. You can also eject the disk using the software on the host computer. Please note that the disk will not be ejected in the event that the "Lock Cartridge" software command had been issued from the host system.

2.2.3 Emergency Eject Hole

In the event the disk can not be ejected the normal way, insert a paper clip, or other similar object in this hole to eject the disk.

2.2.4 Disk Insertion Slot

Insert disks in this slot.

2.4 Rear Panel

The SMO-E501 has a frame ground as well as three connectors; One for the power supply, an options jumper block and a SCSI connector. These connectors are located on the rear panel of the disk drive as shown in the figure below.

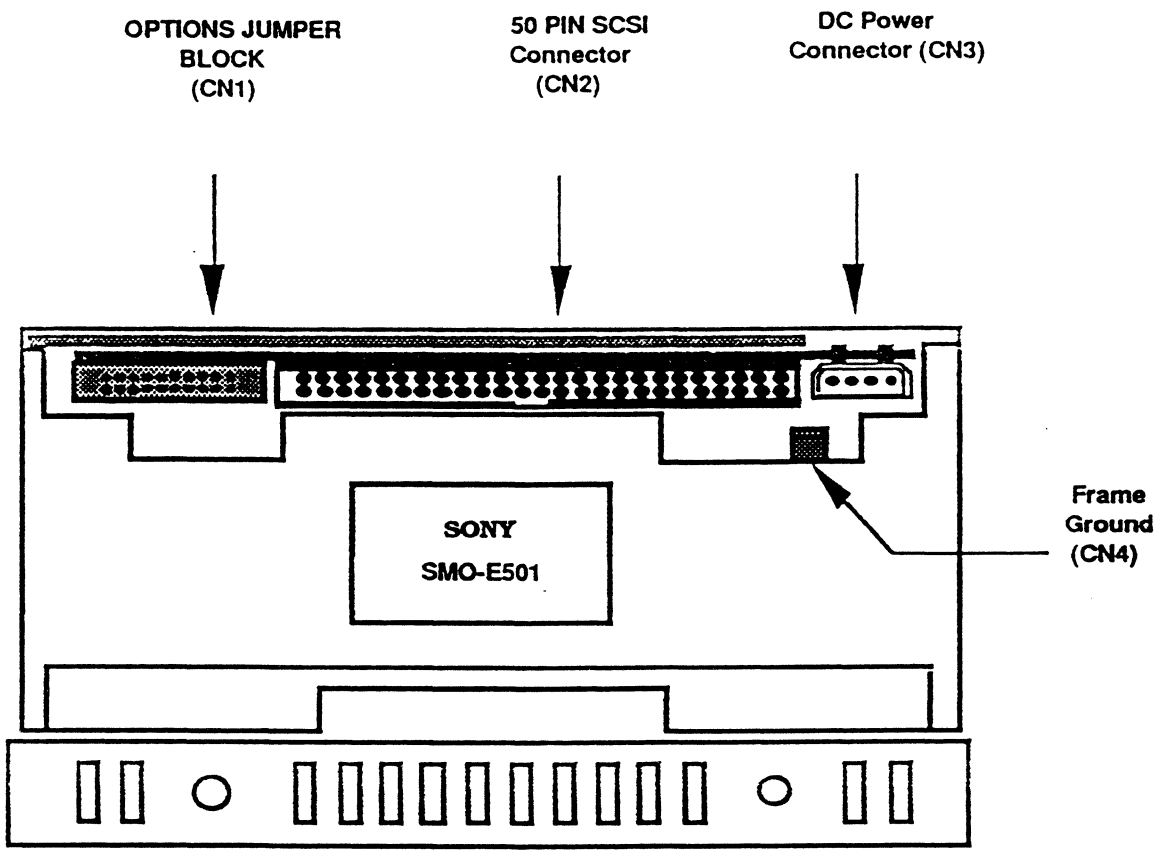
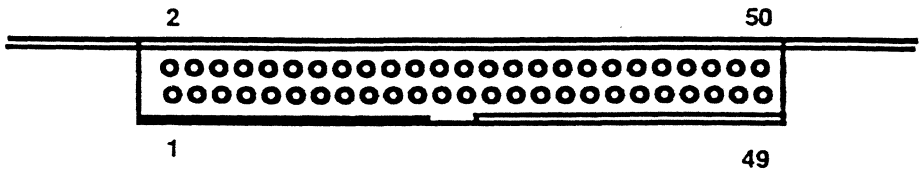


Fig 2.2 : Rear View of SMO-E501

2.5 SCSI Connector (CN2)

The SCSI connector is located in the upper side of the SMO-E501 and between the Options Block and the DC power connectors, as seen from the rear. Information on SCSI termination is available in succeeding section 2.8. Setting of the SCSI ID is described in section 2.7.

The SMO-E501 uses a 50-pin header socket, 3M part type7950-5002SC, and is designed for use with a 3M type number 7950-6500SC connector.



Signal Name	Pin No.		Signal Name
GND	1	2	$\overline{DB0}$
GND	3	4	$\overline{DB1}$
GND	5	6	$\overline{DB2}$
GND	7	8	$\overline{DB3}$
GND	9	10	$\overline{DB4}$
GND	11	12	$\overline{DB5}$
GND	13	14	$\overline{DB6}$
GND	15	16	$\overline{DB7}$
GND	17	18	$\overline{DBP}$
GND	19	20	GND
GND	21	22	GND
GND	23	24	GND
OPEN	25	26	(TERM PW)
GND	27	28	GND
GND	29	30	GND
GND	31	32	$\overline{ATN}$
GND	33	34	GND
GND	35	36	$\overline{BSY}$
GND	37	38	$\overline{ACK}$
GND	39	40	$\overline{RST}$
GND	41	42	$\overline{MSG}$
GND	43	44	$\overline{SEL}$
GND	45	46	$\overline{C/D}$
GND	47	48	$\overline{REQ}$
GND	49	50	$\overline{I/O}$

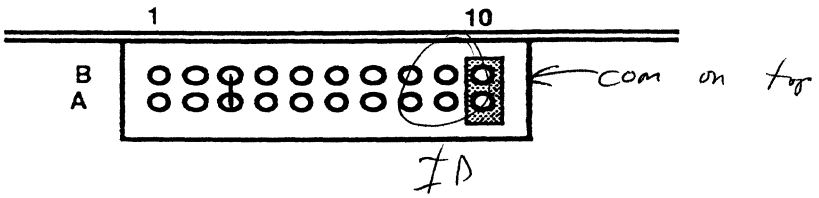
The bar "-" above the signal indicates active low

Table 2.1 : Pin Assignments of SCSI Connector

2.6 Options Jumper Block (CN1)

The Options Jumper Block, located in the upper left corner of the SMO-E501 and under the upper circuit board , as seen from the rear, is for setting the SCSI drive number and other configurations as shown in the table below. Information on SCSI termination is described in section 2.8. Setting of the SCSI ID is described in section 2.7.

The SMO-E501 uses a 20-pin header socket, JAE part type PS-20PE-D4LT1 or equivalent header socket, and is designed for use with a JAE type number PS-20SM-D4P1 or 3M type number 7920-6500SC or equivalent connector.



Signal Name	Pin No.		Signal Name
RESERVED	A1	B1	RESERVED
RESERVED	A2	B2	GROUND
TERM POWER to connector	A3	B3	TERM POWER from PCB
MANUAL EJECT	A4	B4	GROUND
RESERVED	A5	B5	GROUND
RESERVED	A6	B6	GROUND
SCSI PARITY	A7	B7	GROUND
SCSI ID (2)	A8	B8	GROUND
SCSI ID (1)	A9	B9	GROUND
SCSI ID (0)	A10	B10	GROUND

Table 2.2 : Options Block signal allocation

In the example illustrated in table 2.1 directly above, SCSI ID 1 is selected, SCSI parity is enabled, the manual (media) eject mode is enabled, and terminator power is not provided to pin 26 of the CN-2, 50 pin SCSI connector.

The options block setting assignment is described as follows.

Bit 1 : Not used (internal use only)

Factory setting = OFF position.

Bit 2 : Not used (internal use only)

Factory setting = OFF position.

Bit 3 : SCSI Terminator Power Selection

ON : Terminator power enabled.

OFF : Terminator power disabled (factory setting).

Bit 4 : Manual Eject Mode Selection

ON : Manual eject disabled.

OFF : Manual eject enabled (factory setting).

Bit 5 : Not used (internal use only)

Factory setting = OFF position.

Bit 6 : Not used (internal use only)

Factory setting = OFF position.

Bit 7 : SCSI Parity Check Mode Selection

ON: Parity check disabled.

OFF : Parity check enabled (factory setting).

Bit 8,9,10 : SCSI ID Setting

Factory setting = ID = 0.

NOTE: OFF means that no jumper(s) is/are present over the corresponding pin numbers (both A and B rows). The factory jumper setting is SCSI ID 0, as illustrated in the example in section 2.7.A number of jumpers are included with the drive as an accessory.

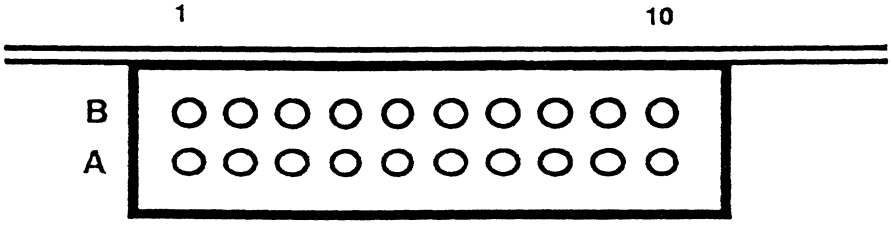
2.7 SCSI ID Setting

The SCSI ID number of the SMO-E501 is selected by setting the appropriate SCSI ID jumpers on the Options Jumper Block. The table below shows the required bit (jumper position) configuration for each of the possible SCSI IDs. For termination and parity jumpers settings refer to section 2.6 in this manual.

SCSI ID	Bit 8	Bit 9	Bit 10
0	OFF	OFF	OFF
1	OFF	OFF	ON
2	OFF	ON	OFF
3	OFF	ON	ON
4	ON	OFF	OFF
5	ON	OFF	ON
6	ON	ON	OFF
7	ON	ON	ON

Table 2.3 : SCSI ID Setting

NOTE: OFF means that no jumper(s) is/are present over the corresponding pin numbers (both A and B rows). The factory jumper setting is SCSI ID 0, as illustrated in the example below.



No jumpers on the block

2.8 SCSI Terminator

The SMO-E501 drive has no internal SCSI bus terminators. The user is responsible for proper termination and powering of the SCSI bus in the host system.

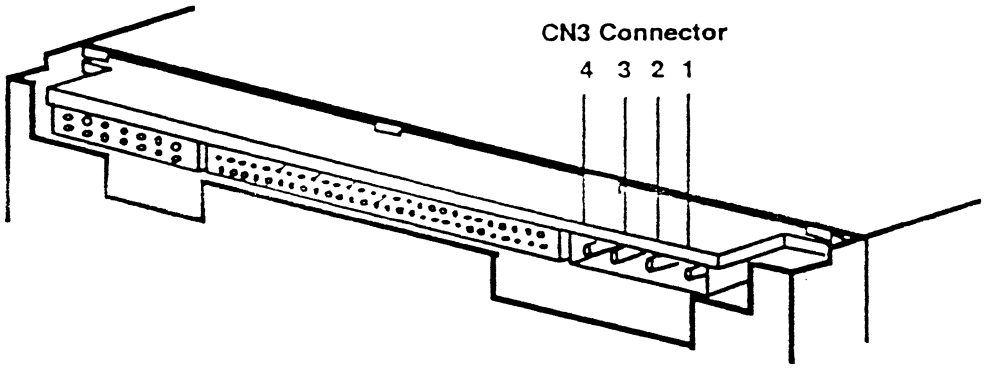
AMP #88-4163-081-1 or DATA MATE DM500-06-8 or equivalent external terminators can be used for drive termination purposes.

For a single ended cable, a 50 signal conductor flat cable or a 25 signal twisted cable can be used. The maximum length should be maintained at 6.0 meters.

2.9 DC Power Connector (CN3)

The 4 pin DC voltage power supply connector is located at the upper right corner of the SMO-E501 and under the upper circuit board, as seen from the rear. The pin assignments of the connector are illustrated in the figure below.

The connector is a female MATE-N-LOCK contact socket AMP type number 61173-4 and is designed for use with MATE-N-LOCK connector plug AMP type number 1-480824-0.



Pin No.	Voltage
1	+12 V DC ±5%
2	12V Return
3	5V Return
4	+5V DC ±5%

Fig 2.3 : Pin Assignments of DC Power Connector (CN3)

2.10 Cooling Requirements

The drive should be cooled such that the conditions listed below are met under all environmental conditions specified in this document.

MEASURING POINTS	MAXIMUM TEMPERATURE (deg C)
Above Disk	45
Below Disk	50

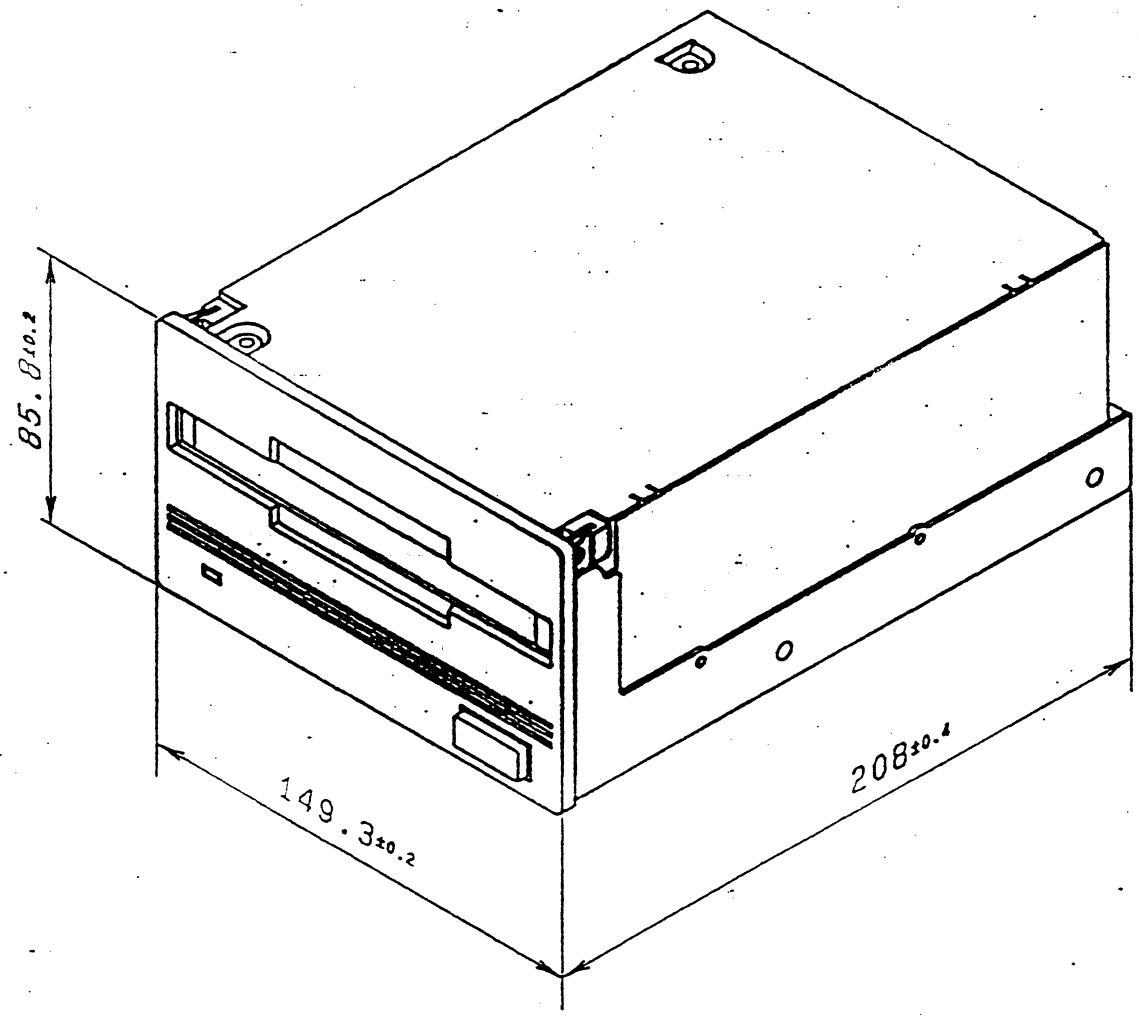
NOTE: A fan with a minimum of 0.7 m^3/min. free air, air specification, located less than 80 mm behind the drive is required in order to maintain the specifications described in this document. The airflow direction should be from the front towards the back of the unit.

The drive must always be operated under the cooling conditions specified above.

2.11 Mechanical Dimensions

All dimensions are shown in mm.

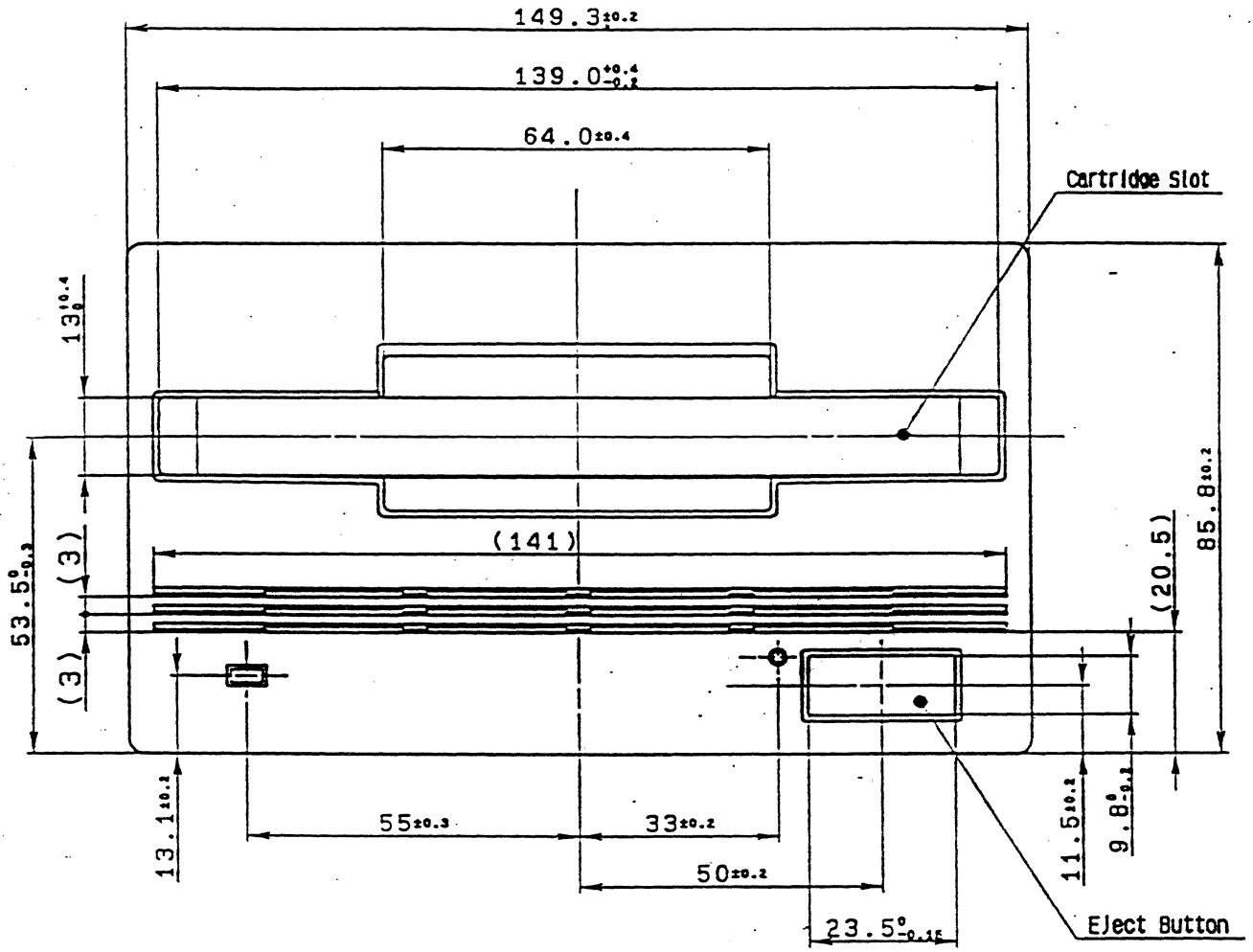
Fig 2.4 - OVERVIEW -



2.11a Mechanical Dimensions

All dimensions are shown in mm.

Fig 2.5 - FRONT VIEW -



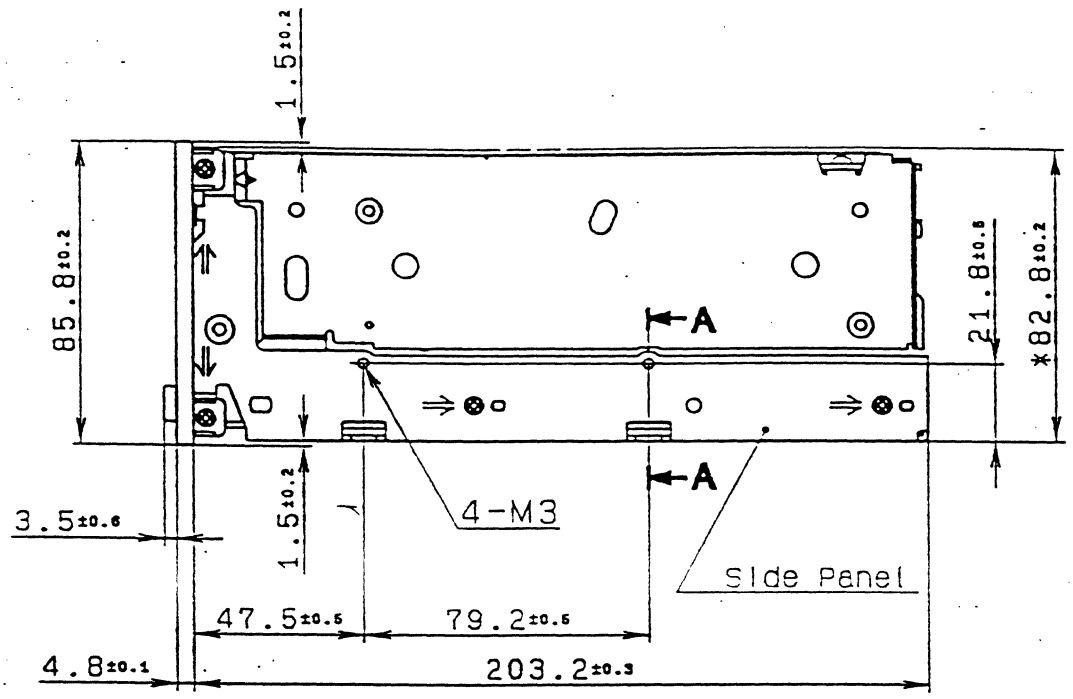
NOTES:

1. The eject button protrudes from the front panel by 3.5 mm.
2. The media cartridge slot is centered with respect to the front panel.

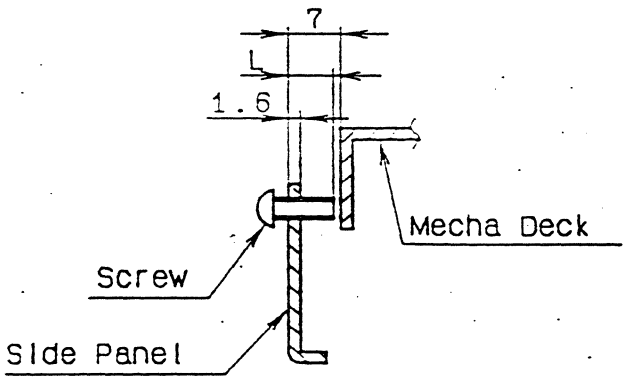
2.11b Mechanical Dimensions

All dimensions are shown in mm.

Fig 2.6 - SIDE VIEW -



*This dimension includes a 1.3mm moving clearance for insulation.



SECTION **AA**

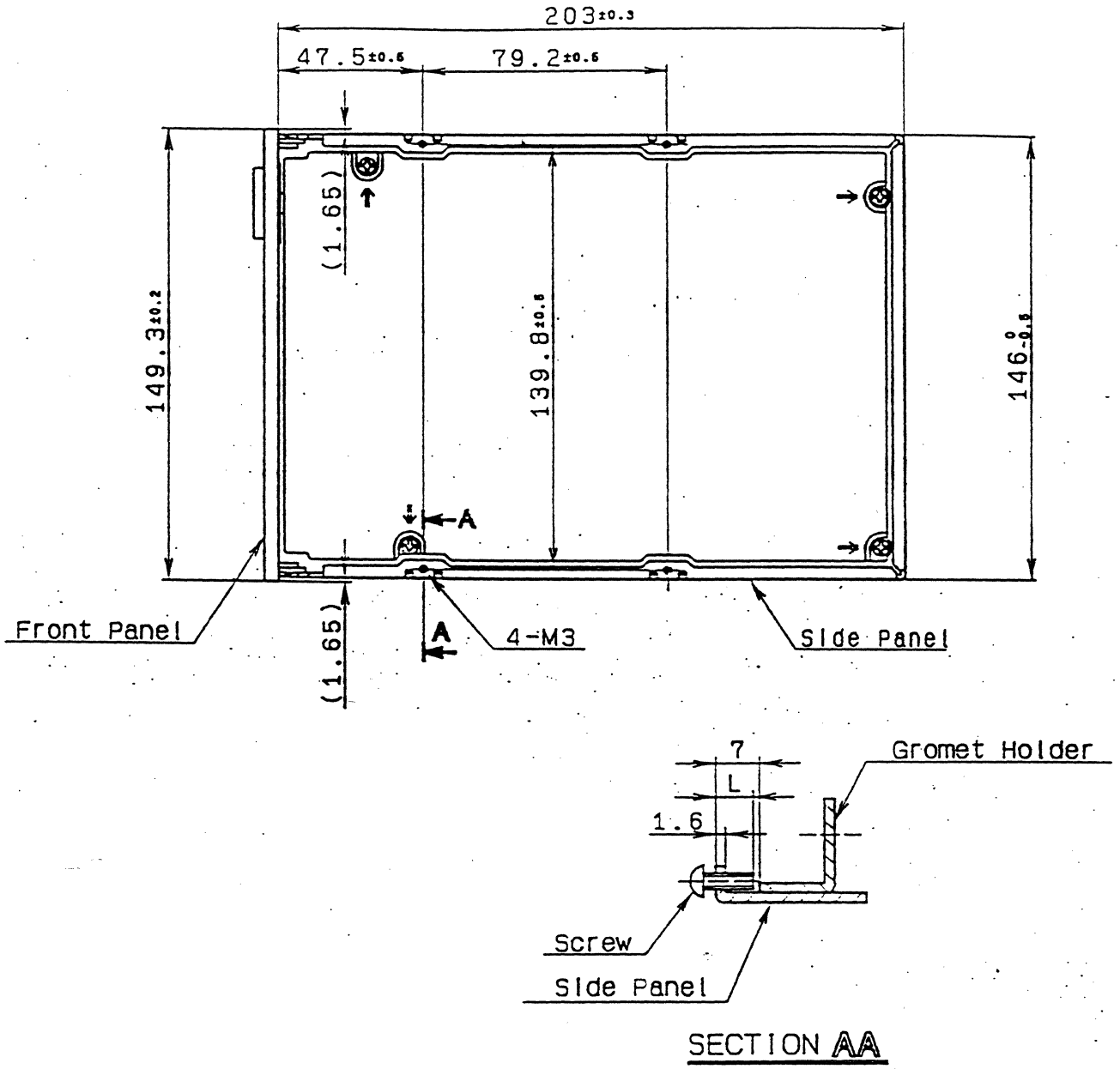
NOTES:

1. The interface connectors protrude from the rear panel of the drive.
2. The four (4) M3 taps are provided to stabilize the position of the mounted drive. (CAUTION: The length-L must be kept to less than 5.5 mm)

2.11c Mechanical Dimensions

All dimensions are shown in mm.

Fig 2.7 - BOTTOM VIEW -



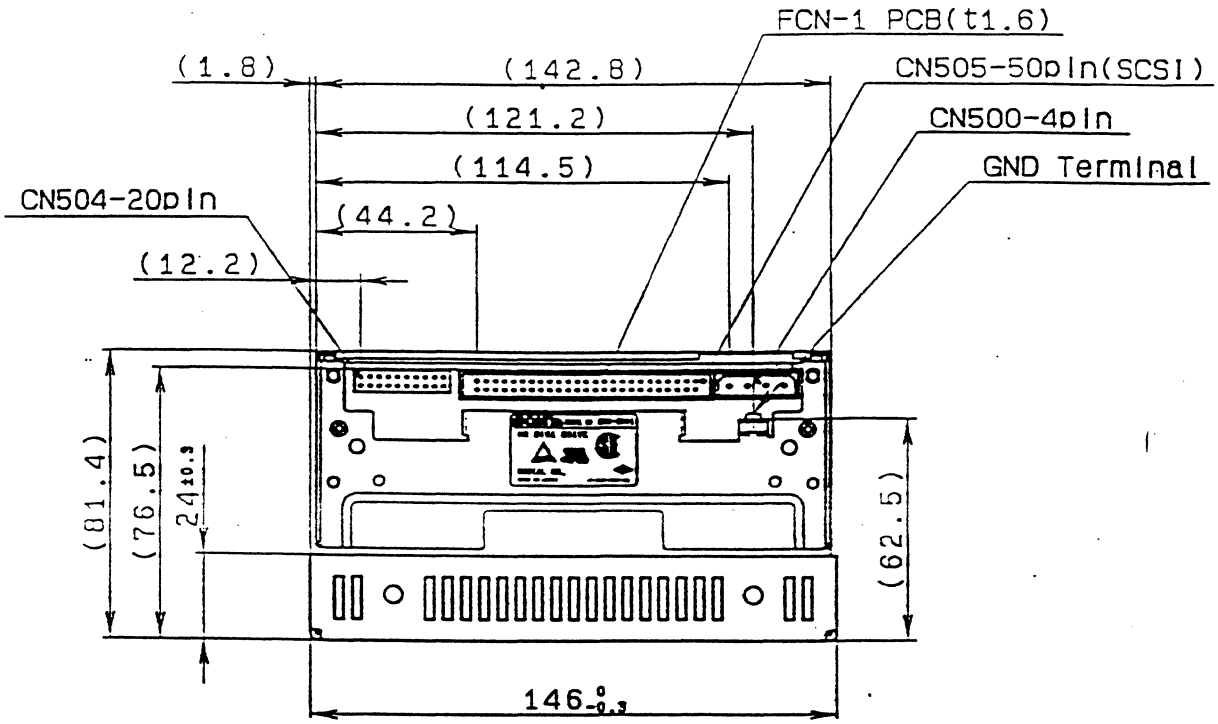
NOTES:

1. The four (4) M3 taps are provided to stabilize the position of the mounted drive. (CAUTION: The length L must be kept to less than 5.5 mm)
2. The front panel and the mounting holes on the bottom are centered with respect to the chassis.

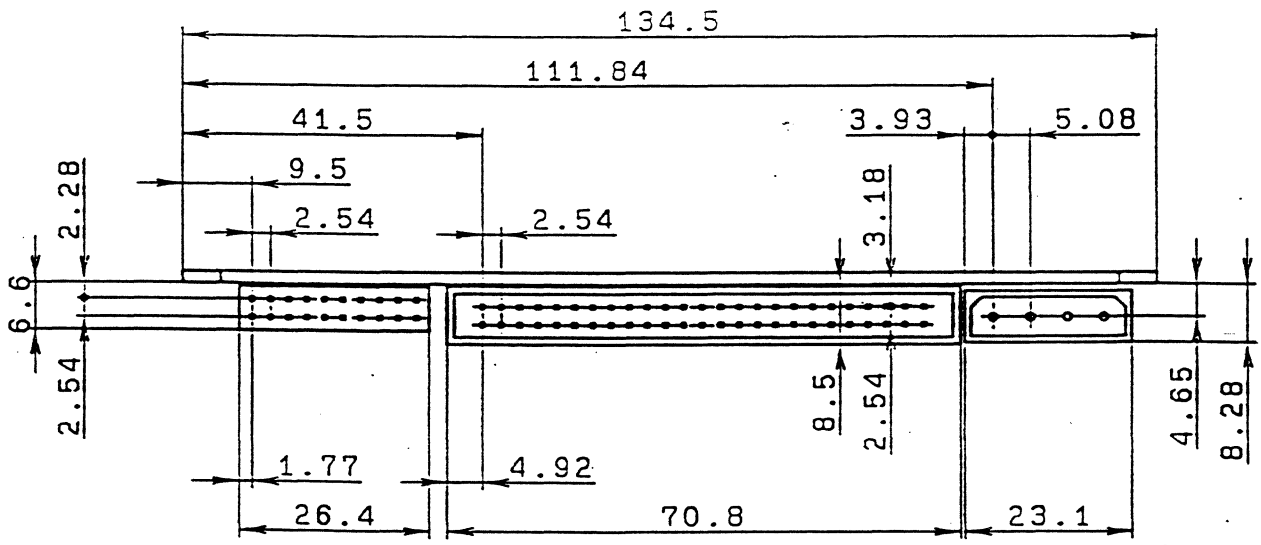
2.11d Mechanical Dimensions

All dimensions are shown in mm.

Fig 2.8 - REAR VIEW -



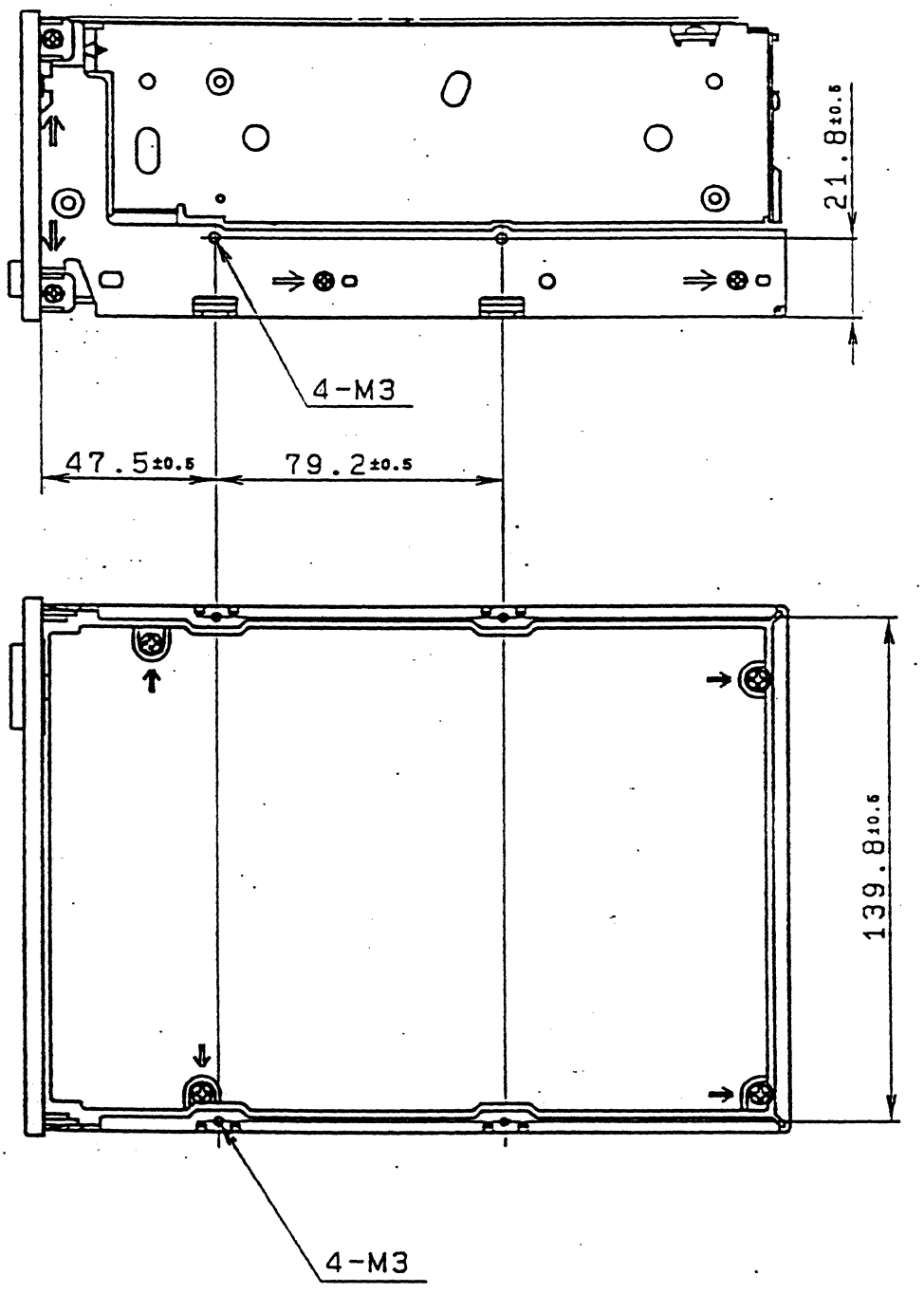
FCN-1 PCB



2.12 Mounting

The figure below illustrates the mounting holes available on the unit. All dimensions are shown in mm. Dimensions in inches are shown in parentheses. For additional information on mounting and cooling requirements see the appropriate sections.

Fig 2.9 - MOUNTING -

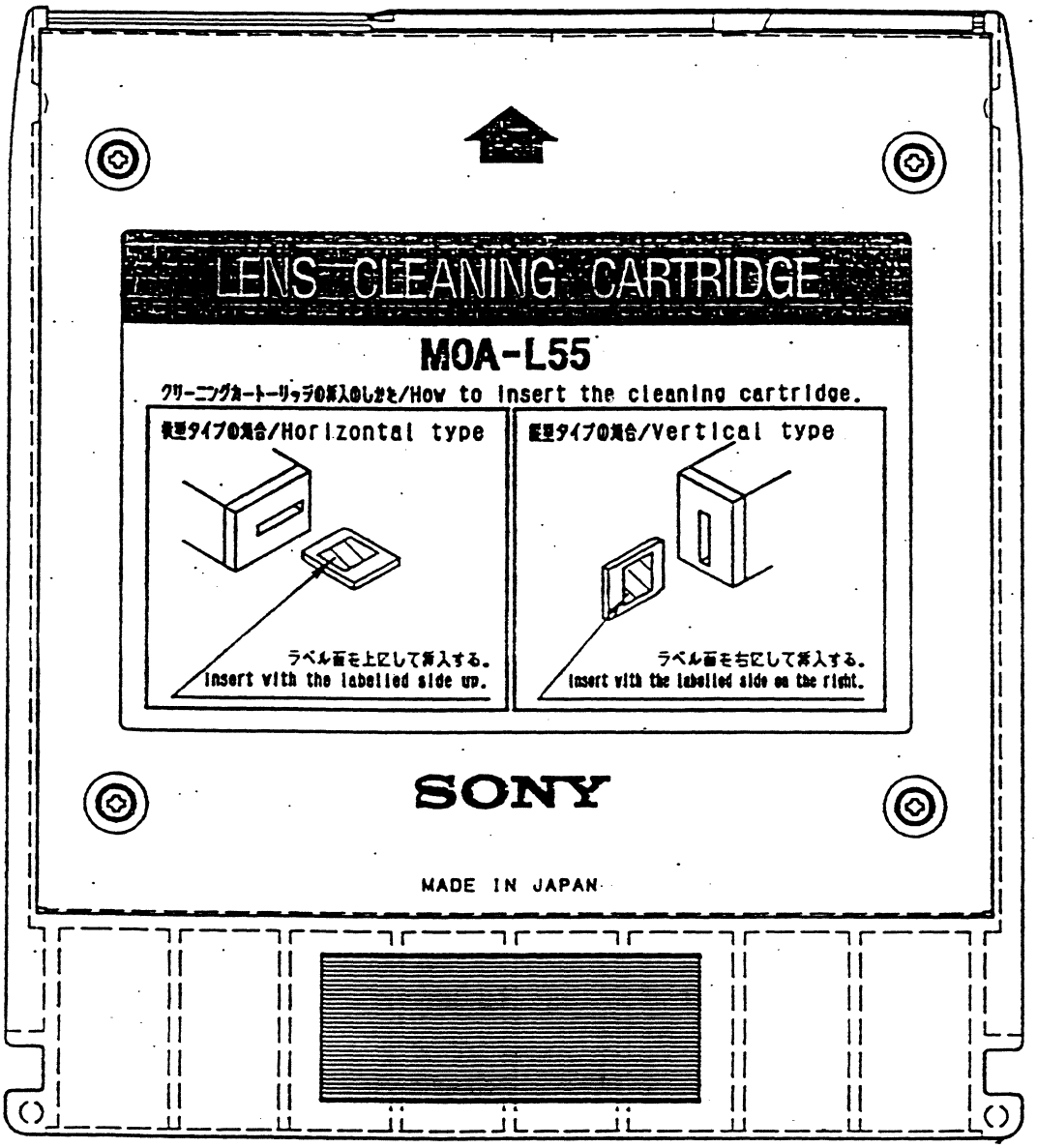


2.13 Maintenance

In order to avoid dust build-up in the unit, which might result to errors, periodical cleaning of the optical unit's lens is required as means of preventive maintenance.

Lens cleaning should be performed by means of inserting to the unit a lens cleaning cartridge, shown below (SONY model number MOA-L55) once a month, at a frequency of four (4) to five (5) insertions per cleaning time. Lens cleaning maintenance must be performed when the unit power turned off. Additional lens cleaning procedures are described in the MOA-L55 user's manual.

Fig 2.10 - LENS CLEANING CARTRIDGE -



3. SPECIFICATIONS

Item	Specification	Remarks
Disk	130mm (5.25 inch) double sided MO Disk with a cartridge	Formatted Address : Track 0 Sector 0 to Track 18750 Sector 16 or 30
Capacity		1M = 10^6
Formatted (per disk)	650Mbytes	(1024 bytes/sector)
	594Mbytes	(512 bytes/sector)
(per side)	325Mbytes	(1024 bytes/sector)
	297Mbytes	(512 bytes/sector)
Unformatted (per side)	433.5Mbytes	
Disk Format	Continuous/Composite	complied with ISO/IEC DIS 10089 format A
Rotational Mode	CAV	CAV: Constant Angular Velocity
Bytes per Sector	1024 or 512	
Sectors per Track	17 or 31	
Total Tracks per Side	18751	
Host Interface	SCSI (Small Computer System Interface)	ANSI X3.131-1986 (Asynchronous. single ended)
Transfer Rate		
User Data Transfer Rate	680Kbytes/sec	(1024bytes/sector, 1K = 1024)
	620Kbytes/sec	(512bytes/sector)
Burst Transfer Rate	1.2M bytes/sec (max)	
Bit Error Rate	less than 10^{-12}	after error correction and defect management
Error Correction Length	80bytes (max)	1024 bytes/sector format
	40bytes (max)	512 bytes/sector format
Buffer Memory Capacity	64Kbytes	64 blocks (1024 bytes/sector) 128 blocks (512 bytes/sector)
Rotational Speed	2400rpm	CAV
Average Latency	12.5msec	
Seek Time		
Single Track	10msec(avg)	Measured at SCSI level
Short Stroke (±64 Tracks)	22msec(avg)	excluding SCSI communication overhead
Average (1/3 full stroke)	95msec(avg)	
Full Stroke	185msec(avg)	

Table 3.1 : DRIVE SPECIFICATIONS

Item	Specification	Remarks
Loading Time	6.4sec (avg)	Including spin-up time
Spin-up Time	2.5sec (avg)	
Unloading Time	3.6sec (avg)	Including spin-down time
Spin-down Time	1.8sec (avg)	
Bias Magnet Rotation Time	18msec (avg)	
Mechanical Dimension	82.5 (H) x 146.0 (W) x 203.2 (D) mm 3.25 (H) x 5.75 (W) x 8.00 (D) inch	Without front panel and connector
Weight	2.5 Kg (5.5 lbs)	
Power Requirements		
Power Dissipation	17W (typ)	
DC Voltage	+5V ± 5%	Ripple voltage < 50mVpp
	+12V ± 5%	Ripple voltage < 100mVpp
DC Current		
+5 V	1.2A (max) 1.0A (typ)	
+12 V	3.0A (max) 1.0A (typ)	Max. at spin-up
Power Supply Delay (Sequencing)	< 0.5sec	90% of the final value for both power on and power off
Operating Mount	Horizontal or Vertical	
Mounting Tilt	<±5°	
Environmental		
Operating		
Temperature	5 - 40°C (41 - 104°F)	See cooling requirement
Relative Humidity	10 - 90%	Not condensing
Max. Wet-bulb Temp.	29°C (84.2°F)	
Temperature Gradient	10°C / Hour (18°F / Hour)	
Non-operating		No disk
Temperature	-30 - 60°C (-22 - 140°F)	
Relative Humidity	5 - 90%	Not condensing

Table 3.2 : DRIVE SPECIFICATIONS

Item	Specification	Remarks
Laser Diode		Laser Product Classification: Class 1 (IEC. 825)
Type	Semiconductor Laser	GaAlAs
Wavelength	785nm, Continuous	
Output Power	30mW (max)	
Vibration		
Operating	f: 5 to 350Hz PSD: 0.00015G²/Hz f: 350 to 500Hz -6db/Oct f: 500Hz PSD: 0.0001G²/Hz	No customer perceivable error PSD: Power Spectrum Density
Non-operating	f: 5 to 100Hz PSD: 0.02G²/Hz f: 100 to 137Hz -6db/Oct f: 137 to 350Hz PSD: 0.0107G²/Hz f: 350 to 500Hz -6db/Oct f: 500Hz PSD: 0.0052G²/Hz	No permanent damage
Shock		
Operating	30G 3msec Half Sine	No data loss
Non-operating	89G 3msec Half Sine 30G 28msec Trapezoidal	No permanent damage
Transportation		
Vibration	f: 5 to 200Hz PSD: 0.015G²/Hz	No permanent damage
Impact	76cm (30in)	No permanent damage

Table 3.3 : DRIVE SPECIFICATIONS

Item	Specification	Remarks
Altitude		
Operating	-305m to 2,438m (-1,000ft to 8,000ft)	770mmHg to 565mmHg
Non-operating	-305m to 7,620m (-1,000ft to 25,000ft)	770mmHg to 252mmHg
Electric Susceptibility	1V/m (14KHz to 1GHz)	
Magnetic Susceptibility	0.5Gauss (47.5 to 198Hz)	
Electromagnetic Emissions		
Magnetic Field Interference	< 10 Gauss peak to peak	
MTBF	20,000POH	POH: Power on Hours
MTTR	30min	
Life Expectancy	5 years or 30,000POH	
Regulatory	- UL 478 5th Edition	USA
	- CSA C22.2 No. 220	Canada
	- DHHS Laser Compliance 21 CFR subchapter J	USA
	-TÜV Certification according to IEC 380/VDE 0806	Europe
	- TÜV Certification according to IEC 950/EN 60 950	Europe
	- TÜV Certification according to IEC 825/VDE 0837	Europe

Table 3.4 : DRIVE SPECIFICATIONS

Item	Specification	Remarks
Acoustical Noise	55dBA (max) 45dBA (typ)	Measuring distance: 1m Measuring response: Fast
Electrostatic Discharge (ESD)	 10kV 20kV	Discharge to front panel ONLY C = 200 pF, R = 100 ohms No data loss No permanent damage
Electromagnetic Emissions Radio Frequency Interference (Tested as a subsystem)	- FCC 47 CFR Part 15 - DOC SOR/88-475 Class B - VDE 0871(B) Class B / VDE 0875 Class N - VCCI Class 2 Information Technology Equipment	 USA Subpart J Class B Canada West Germany Japan
Cooling Requirements above disk below disk	 45°C (113°F) max 50°C (122°F) max	 *Ta* = 40°C (104°F), during any operation

Table 3.5 : DRIVE SPECIFICATIONS in System Environments

3.2 Media Format Specifications

This section describes the various media format parameters that the SMO-E501 complies with and supports. The Sony SMO-E501 complies with the ISO/IEC DIS 10089, format A, standard for Continuous-Composite Format of 130mm Rewritable Optical Disks. For a complete description of the media format standard please refer to the above referenced ISO/IEC DIS document.

3.2.1 Formatted Zone

The formatted zone of the media extends from radius 29.00 mm to radius 61.00 mm and is divided as follows. Dimensions are given as references only, and are nominal locations.

- Formatted zone 29.00 - 61.00 mm
- Control track PEP zone 29.00 - 29.50 mm
- Transition zone for SFP 29.50 - 29.52 mm
- Control track SFP zone 29.52 - 29.70 mm
- Media manufacturer zone 29.70 - 30.00 mm
  - Guard band 29.70 - 29.80 mm
  - Manufacturer test zone 29.80 - 29.90 mm
  - Guard band 29.90 - 30.00 mm
- User zone 30.00 - 60.00 mm
- Manufacturer zone 60.00 - 60.15 mm
- Control track SFP zone 60.15 - 60.50 mm
- Lead out zone 60.50 - 61.00 mm

3.2.2 Modulation Code

The SMO-E501 implements RLL (2,7) as the modulation code, adopting pit-position as the recording method of the RLL (2.7) code. The RLL (2,7) code translation is shown in the table below.

Data bits	Channel bits
10	0100
010	100100
0010	00100100
11	1000
011	001000
0011	00001000
000	000100

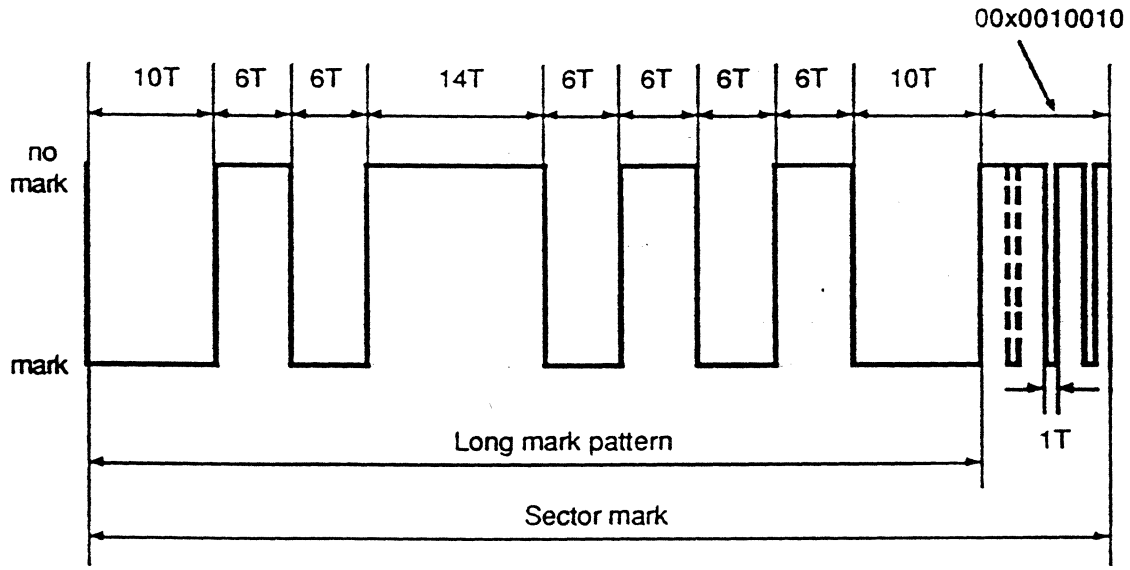
Table 3.6 : Modulation Code

3.2.3 Sector Format

The Sector Format, for 1024 and 512 byte media, is shown in figures 2.2. and 2.3 respectively. The ID Field contains the preformatted triple ID's. The Data Field contains 1024 bytes or 512 bytes of user data. Each signal in the said format(s) is defined throughout this section as follows.

SECTOR (SM):

The Sector Mark has a 5 byte length and is used for the purpose of detecting a sector header.
The Sector Mark pattern is shown below, where T corresponds to the time length of one channel bit. The signal obtained from a mark is less than a signal obtained from no mark. The long mark pattern shall be followed by the channel bit pattern: 00X0010010 where X can be ZERO or ONE.



VARIABLE FREQUENCY OSCILLATOR signals (VFO):

VFO consists of four areas designated VFO_1, VFO_2, and VFO_3. VFO_1 and VFO3 have a 12 length and VFO_2 has a 8 byte length. VFO is used for the purpose of synchronizing the PLO (Phase Locked Oscillator) with the read out signal. The continuous channel bit pattern for the VFO areas is as follows:

VFO_1: 192 Channel bits = 0 1 0 0 1 0 0 1 0 0 1 ... 0 1 0 0 1 0

VFO_2: 128 Channel bits = 1 0 0 1 0 0 1 0 0 1 0 ... 0 1 0 0 1 0 or

VFO_2: 128 Channel bits = 0 0 0 1 0 0 1 0 0 1 0 ... 0 1 0 0 1 0

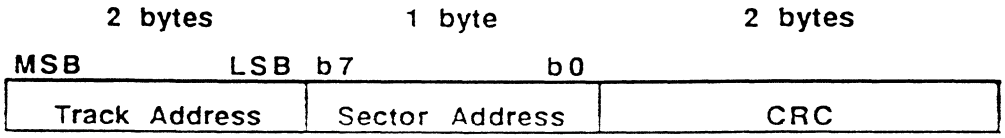
VFO_3: 192 Channel bits = 0 1 0 0 1 0 0 1 0 0 1 ... 0 1 0 0 1 0

ADDRESS MARK (AM):

The Address Mark is one byte in length and is used for the purpose of detection of ID field(s).
AM is a channel bit pattern not used in RLL (2,7) and is a run-length violation for RLL (2,7).
This 16-bit channel bit pattern is: 0 1 0 0 1 0 0 0 0 0 0 0 0 1 0 0

IDENTIFICATION (ID)+ CYCLIC REDUNDANCY CHECK CODE (CRC):

The ID consists of 2 bytes of a track address and 1 byte of a sector address followed by 2 bytes of ID field check bytes (CRC) as follows. The 2 byte CRC code is for detecting ID failure. The MSB (most significant bit) of the track address is output first.



b0-b4: Sector Number (0 ~ 16 or 30)
b5: 0 (Reserved)
b6, b7: ID number (ID0 ~ ID2)

The 2 byte CRC checks the track and sector numbers. The codes are generated using the CCITT polynomial $G(X) = X^{16} + X^{12} + X^5 + 1$ The initial value of the CRC resister is all ONEs.

POST AMBLE (PA):

The Post Amble consists of 1 byte to allow the last byte of CRC to achieve closure of a few uncertain bits in the (2,7) RLL encoding scheme.

OFFSET DETECTION FLAG (ODF) & GAPS:

The Offset Detection Flag and gaps area contains the following bytes. Please refer to figures 2.2 and 2.3 for the actual layout.

ODF: 1 byte of mirror area with neither grooves nor preformatted data.

FLAG: 5 bytes of the flag area to prevent inadvertent write operations over previously written data. The SMO-E501 does not use this area due to its rewritable operations capability.

ALPC (Automatic Laser Power Control): This area is designated as a test area for calibration of the laser power levels.

GAP: 3 bytes length to absorb the timing shift when writing a FLAG.

SYNCHRONIZATION (SYNC):

The Synchronization area consists of 3 bytes to give the data separation timing for the succeeding DATA field.

redundant sync pattern for data (triple sync pattern)

0100 0010 0100 0010 0010 0010 0100 0100 1000 0010 0100 1000

DATA FIELD:

For 1024 bytes/sector format disks:

The data field consists of 1024 bytes of user data and 223 bytes of CRC, ECC and Resync, plus 12 bytes of control information (DMP). The data format is shown in section 3.2.4, figure 2.4.

For 512 bytes/sector format disks:

The data field consists of 512 bytes of user data, 124 bytes of CRC, ECC and Resync, 2 bytes of reserved data (FFH), plus 12 bytes of control information (DMP). The data format is shown in section 3.2.4, figure 2.5.

Resynchronization Mark (RESYNC)

The purpose of the RESYNC marks is to prevent the loss of byte synchronization when the VFO must ride through defects within a data field and to limit the propagation of errors. The RESYNC consists of 1 byte pattern (16 channel code bits) of illegal RLL (2,7) modulation code.

The one byte pattern channel code is as follows: 0 0 1 0 0 0 0 0 0 0 1 0 0 1 0 0

BUFFER:

The BUFFER consists of a total of 20 (1024 bytes/sector) or 15 (512 bytes/sector) bytes of reserved space to allow for motor speed and other electrical/mechanical tolerances.

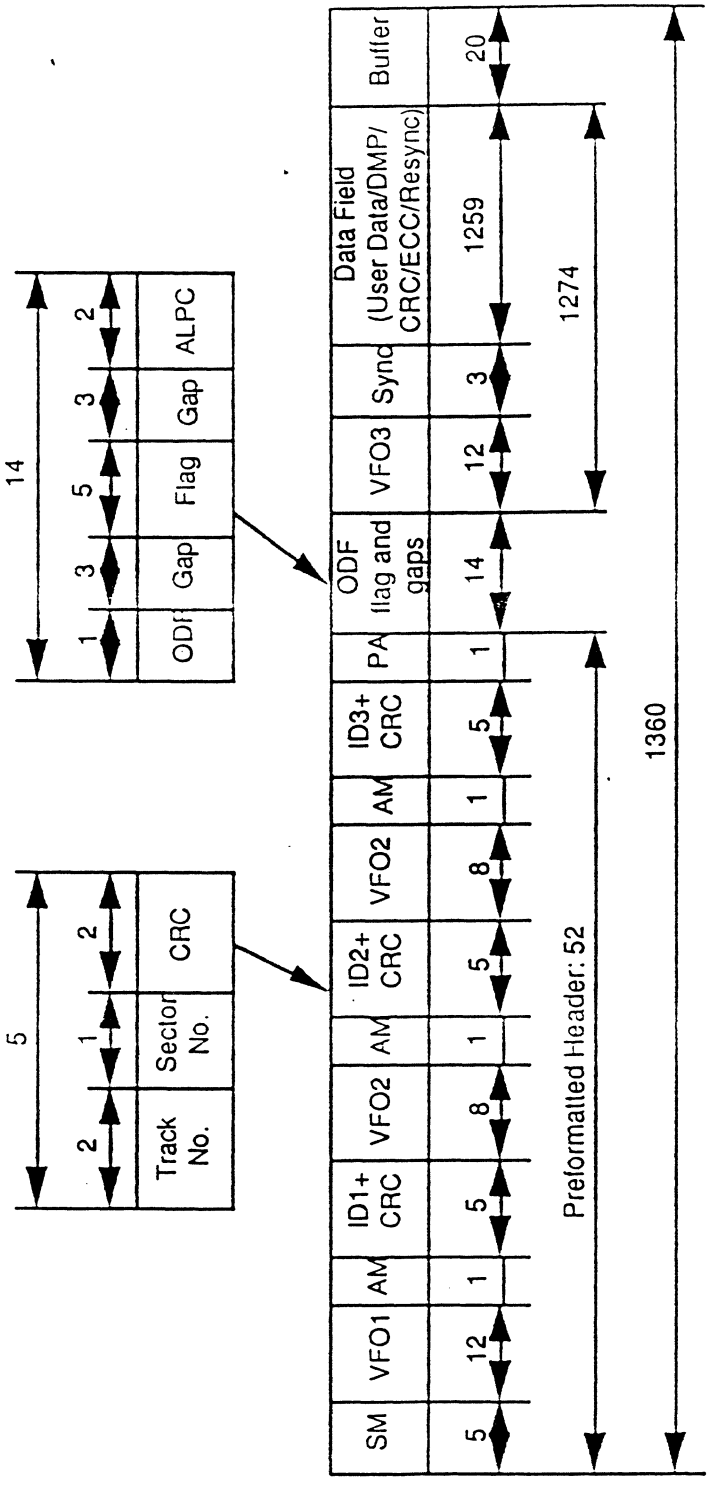


Fig 3.1 : Sector Format of 1024 Bytes/Sector

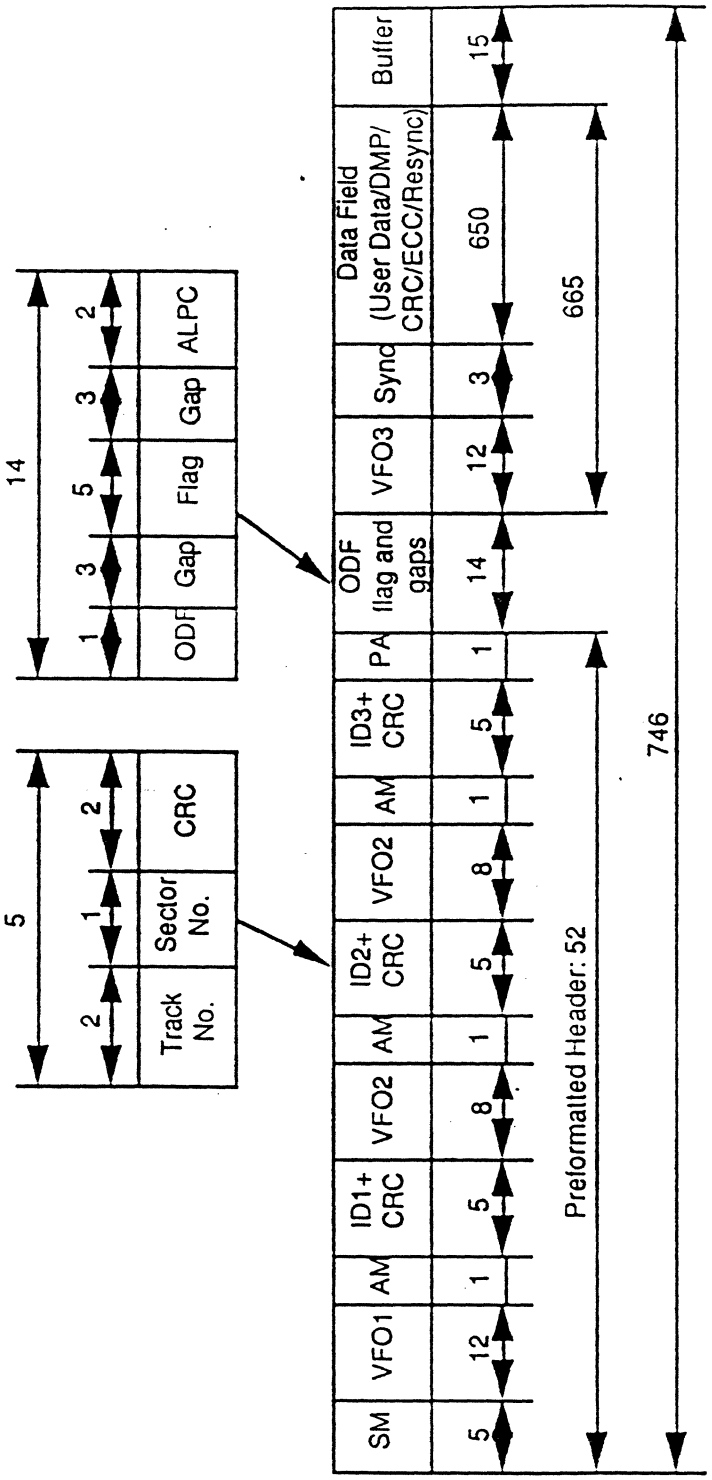


Fig 3.2 : Sector Format for 512 Bytes/Sector

3.2.4 Data Field Format

For 1024 bytes/sector format, the data field consists of 1024 bytes of user data, 12 bytes of control information, 4 bytes of CRC data, 160 bytes of EDAC (Error Detection and Correction) data and 59 bytes of RESYNC pattern. The data configuration is shown in figure 2.4. The 10 way interleave is adopted for increased error correction capability purposes.

For 512 bytes/sector format, the data field consists of 512 bytes of user data, 12 bytes of control information, 4 bytes of CRC data, 80 bytes of EDAC (Error Detection and Correction) data, 2 bytes of reserved data and 40 bytes of RESYNC pattern. The data configuration is shown in figure 2.5.
The 5 way interleave is adopted for increased error correction capability purposes.

The EDAC method utilized is the Reed-Solomon code, known as Long Distance Code (LDC), with a degree of redundancy of 16. The ECC (Error Correction Code) polynomial expression is as follows.

Primitive Polynomial:

$$G_p(X) = X^8 + X^5 + X^3 + X^2 + 1$$

Element:

$$\alpha^i = (\beta^i)^{88}$$

where β is the root of $G_p(x)$

Generator Polynomial:

$$G(X) = \prod_{i=120}^{i=135} (X+\alpha^i)$$

The initial set value of the ECC register is all ZEROs. The ECC data output to the media are inverted from that calculated.

The 4 byte CRC is calculated over the data field, including the control data. The same primitive polynomial as the ECC calculation is used. The CRC generator polynomial is as follows.

$$G(X) = \prod_{i=136}^{i=139} (X+\alpha^i)$$

Initial set value is all ZEROs. Input sequence is MSB to LSB. Output value to the media is not inverted from that calculated.

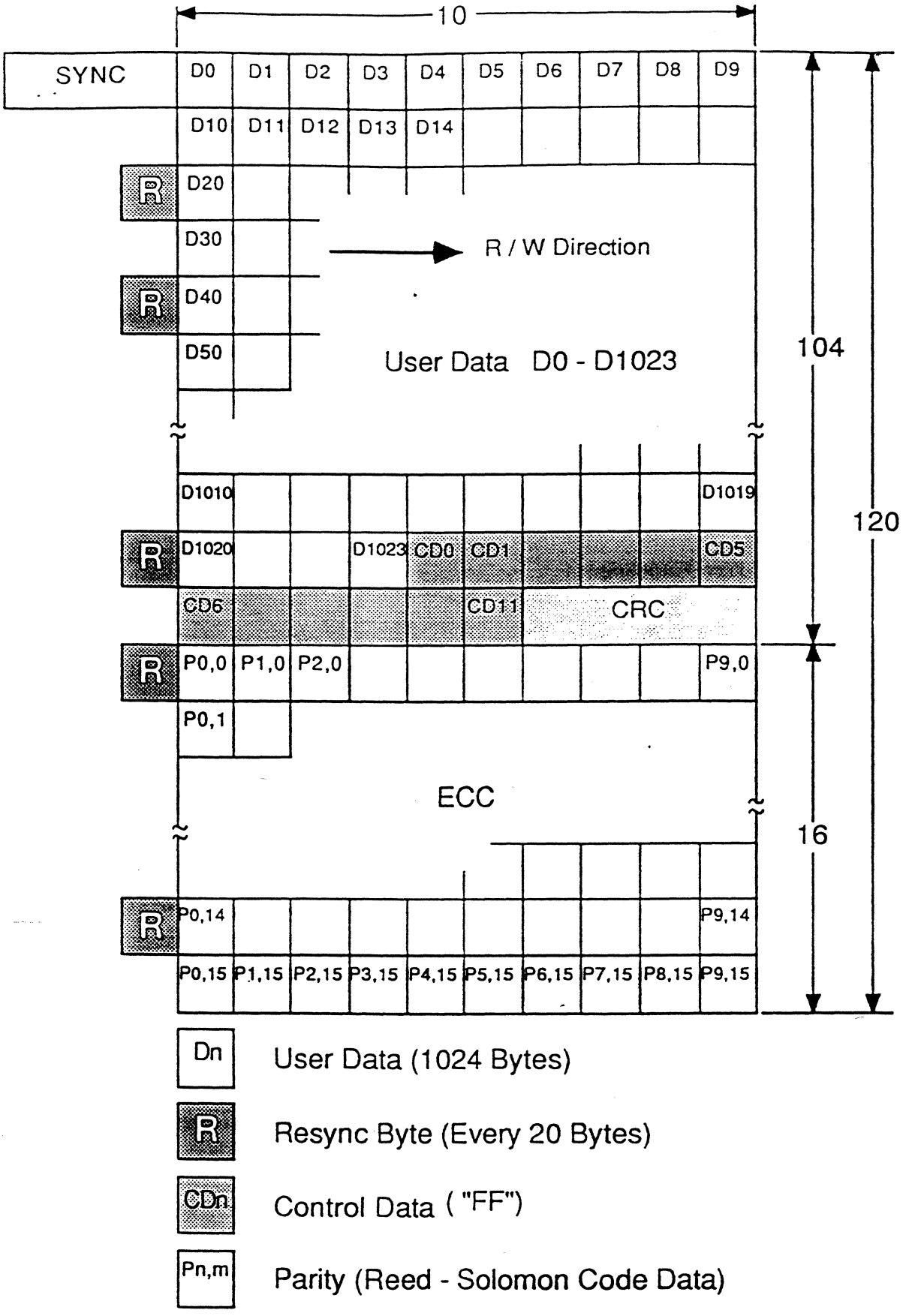


Fig 3.3 : 1024 Bytes/Sector Data Block Configuration

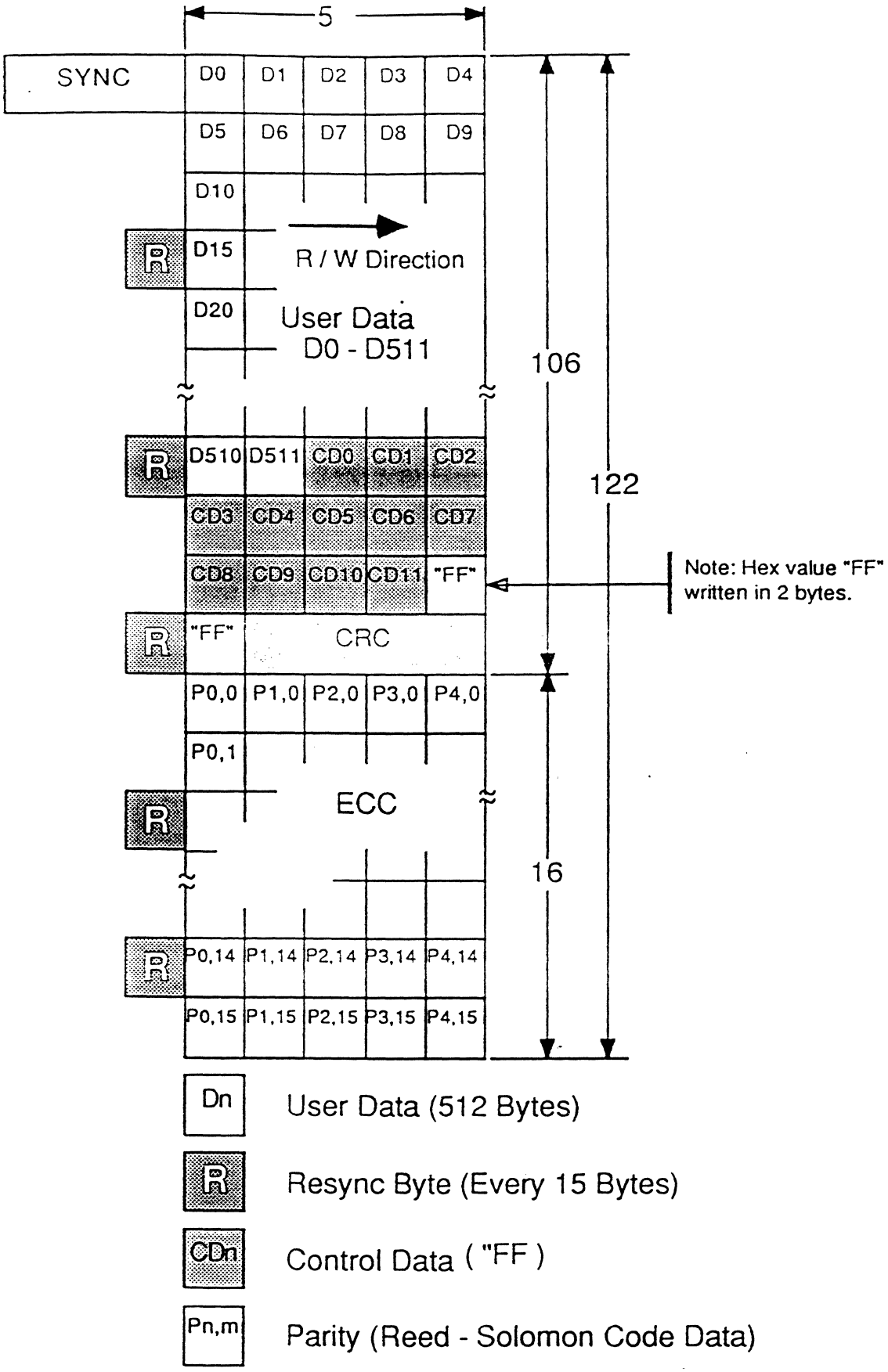


Fig 3.4 : 512 Bytes/Sector Data Block Configuration

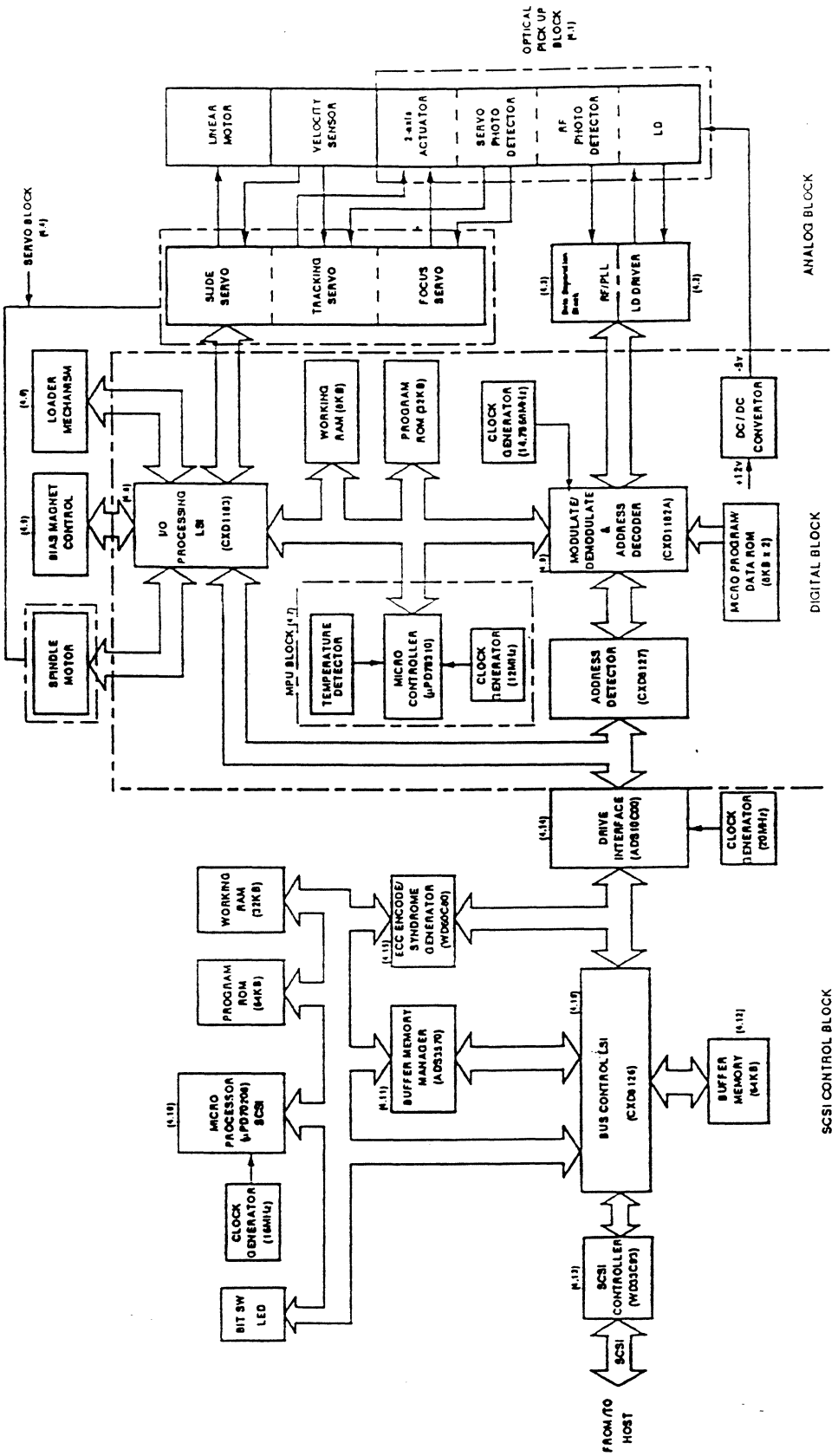
4. SYSTEM CONFIGURATION

The SMO-E501 M.O. Disk Drive consists of several mechanical blocks, an optical block, electrical blocks and SCSI control blocks . The electrical blocks contain all of the analog and digital circuitry required for the various drive functions. The analog circuitry includes the laser diode drive, RF block and the servo systems for focusing and tracking. The digital circuitry includes the analog and mechanical control logic, modulator/demodulator , drive interface logic and the SCSI control block.

The SMO-E501 can be connected to a host system through the SCSI (Small Computer System Interface) which complies with ANSI X3.131-1986 and the CCS (Common Command Set) Rev. 4B, and it employs the LDC (Long Distance Code) for the error detection and correction code as described in the previous section 3.2.4.

The block diagram of the SMO-E501 drive is shown in Fig.4.1.

Fig 4.1 : SMO-E501 Block diagram



4.1 Optical Head

Erasing, writing and reading are performed via a laser diode and photo detectors residing in the optical head housing. The laser diode driver and RF/servo pre-amplifiers are built in this optical head as well.

4.2 Laser Diode Drive Block

This block drives the laser diode at the correct power in each mode for reading, writing and erasing using an Automatic Power Control (APC) circuit. APC is performed by means of measuring the read power at the GAP area, and the write and erase power at the ALPC area in the recording format and holding these levels.

4.3 Data Separation Block

The read-out signal from the photo-detectors is divided into two different band-width signals for data separation and servo systems. The RF signal is amplified, equalized and differentiated for peak data detection. The PLO (Phase-Locked Oscillator) generates a phase-locked clock in order to separate the data correctly. The demodulator decodes the RLL (2,7) in accordance with this PLO clock.

4.4 Servo Blocks

The SMO-E501 contains the following four servo blocks.

(1) Spindle Servo
(2) Focus Servo
(3) Tracking Servo
(4) Slide Servo

The Spindle Servo block rotates the MO disk at a constant 2400 rpm by a digital frequency-lock servo method which uses the Frequency Generator (FG) signal.

The Focus Servo block controls a two-axis actuator to focus the laser diode beam on the disk writing surface by an astigmatism focus servo method.

The Tracking Servo block controls a two-axis actuator to follow the tracks utilizing Sony's DPP (Differential Push-Pull) servo method.

The Slide Servo block drives a slide motor (flat linear motor) for accessing the designated track(s) during seek operations.

4.5 Bias Magnet Control Block

This block rotates a permanent bias magnet and senses its polarity in order to provide an erasing bias magnetic field with opposite polarity to that of the writing bias.

4.6 Loading Block

The Loading block consists of a loading motor and the necessary switches to load and eject a cartridge.

4.7 MPU Block

The MPU block consists of an MPU (μPD78310), 32K bytes of PROM and 8K bytes of RAM. This block supervises the drive and controls the analog and mechanical blocks. In addition it supervises communications with the SCSI block of the drive. Most of the control lines are transferred via the IOP block. However, part of the servo control signal is connected directly to the MPU. A real time monitor program manages each control task.

4.8 IOP Block

The IOP (Input / Output Processor) block provides control lines to the analog , mechanical and all other blocks described in this section, with the exception of the SCSI controller block. The IOP block also handles control handshakes with the SCSI circuitry of the drive via the DRIVE INTERFACE IC (ADS10C00).

4.9 MDA Block

The MDA (Modulator, Demodulator & Address decoder) block performs encoding and decoding of the RLL (2,7) data and in addition detects the read addresses in the ID's of the disk. The encoded channel clock rate is 14.797 MHz at 2400 rpm. The SYNC and RESYNC in the format are encoded in this block. The MDA block provides the laser drive block with the control signals for laser power modes, and provides the RF block with a switch signal for the equalizer.

4.10 Microprocessor (SCSI)

The MPU for SCSI is the V40 (μPD70208), and it has a 64KB Program ROM and 32KB of working RAM on the MPU bus. Another main function of this MPU is error correction of read out data. This module performs the following functions:

1. Management of SCSI modules.
2. Management of SCSI communication.
3. Control of the drive via the SCSI interface.
4. DMA of ECC syndrome data and error correction.
5. Defect Management.
6. Error Recovery and Management.
7. Diagnostic Functions.

The RAM is divided into 4 areas; program working area, defect management information area, control information area and ECC syndrome buffer area.

4.11 Buffer Memory Manager

This module performs the internal data bus management and generates addresses for Buffer Memory. The data from/to the Buffer Memory is transferred in the DMA mode. The Buffer Memory Manager arbitrates DMA requests according to the priority of each channel.

4.12 Buffer Memory

Buffer Memory is composed of a 64K bytes of static RAM. Only the user data (1024 bytes or 512 bytes) are stored in both the read and write modes.

4.13 SCSI Controller

The SCSI Controller controls the SCSI bus and transfers the data from/to the internal bus. This SCSI implementation conforms to ANSI X3.131-1986. User data from/to the Buffer Memory are transferred in the DMA mode.

4.14 Drive Interface Controller

This module is composed of the Internal Interface and Address Detector. The internal Interface controls handshaking for transfering commands and status. The read/write data are converted into serial-parallel/parallel-serial data streams in this module. The Address Detector (CXD8127) checks the IDs by computing CRC.

4.15 ECC Encoder/Syndrome Generator

This module encodes the Reed-Solomon Long Distance Code and the CRC on the fly during write operations, and generates the syndrome during read operations. Corrections are performed by the SCSI microprocessor.

4.16 Bus Control Logic (SCSI)

This module performs two functions. One is to switch either the MPU bus or the Buffer Memory Data bus to the SCSI Controller bus. It's second function is to select the designated bus data among the user, control and ECC/CRC data.

5. HOST INTERFACE EXPLANATION

The SMO-E501 is connected to a host systems via the SCSI (Small Computer System Interface) which complies with ANSI X3.131-1986. In this section, only a summary of the Sony Rewritable Optical Disk SCSI specification is described. For a detailed explanation of the drive interface please refer to the *SMO-E501 Magneto Optical Disk Drive SCSI Implementation manual.*

5.1 Data Bus and Signal Lines

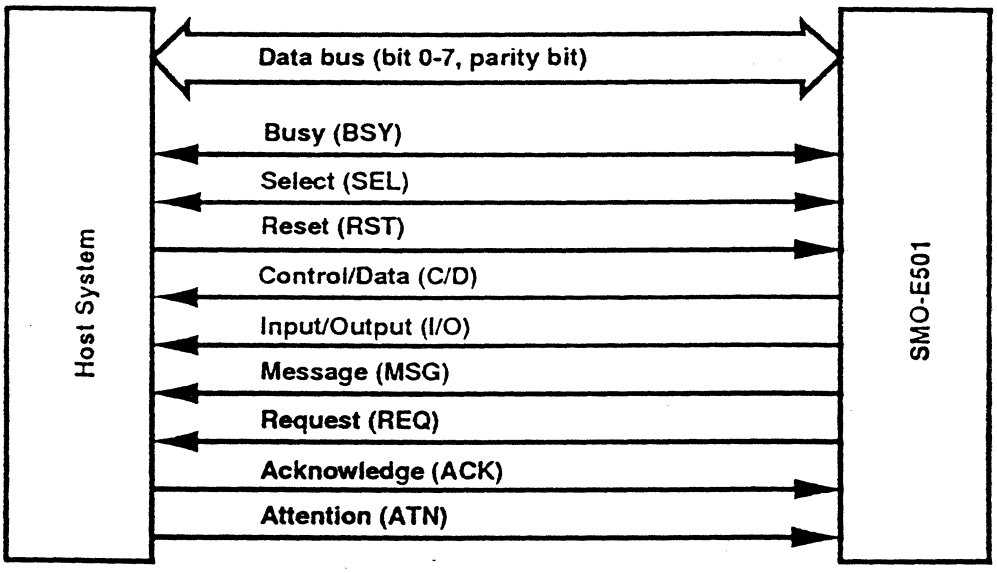


Fig 5.1 : SCSI Data Bus and Signal Lines

The SCSI interface uses the 18 signal lines indicated in figure 5.1 above. Nine of the signals are used for control and the rest for data. (Data signals include the parity signal option.)

These signals are described as follows:

BSY (BUSY) : An "OR-tied" signal that indicates whether the bus is being used.

SEL (SELECT) : A signal used either by the initiator to select a target or by a target to reselect an initiator.

C/D (CONTROL/DATA) : A signal driven by a target that indicates whether CONTROL or DATA information is on the DATA BUS. True indicates CONTROL.

I/O (INPUT/OUTPUT) : A signal driven by a target that controls the direction of data movement on the DATA BUS with respect to an initiator. True indicates input to the initiator. This signal is also used for distinction between SELECTION and RESELECTION phases.

MSG (MESSAGE) : A signal driven by a target during the MESSAGE phase.

REQ (REQUEST) : A signal driven by a target to indicate a request for a REQ/ACK data transfer handshake.

ACK (ACKNOWLEDGE) : A signal driven by the initiator to indicate an acknowledgement for a REQ/ACK data transfer handshake.

ATN (ATTENTION) : A signal driven by an initiator to indicate the ATTENTION condition.

RST (RESET) : A "OR-tied" signal that indicates the RESET condition.

DB(7-0,P) (DATA BUS) : Eight data-bit signals, plus a parity-bit signal form the DATA BUS. DB(7) is the most significant bit and the highest priority during the ARBITRATION phase. Bit number, significance, and priority decrease downward to DB(0). A data bit is defined as ONE when the signal value is true and is defined as ZERO when the signal value is false. Data parity DB(P) is odd.

For the status of the signals relating to control of the drive and details of the timing of the SCSI bus, refer to the ANSI X3.131-1986 document. Single-ended drivers have been adopted for the bus drive. Use a device which satisfies the standards for the drive and receiving circuits.

5.2.1 General

The SMO-E501 interfaces with a host system via SCSI (Small Computer System Interface). This section provides an overview of the control phases supported, in addition to a listing of the SCSI commands that the drive supports. For the materials not described in this section, refer to ANSI X3.131-1986 (SCSI) and the *SMO-E501 Magneto Optical Disk Drive SCSI Implementation manual.*

The SMO-E501 SCSI implementation provides the unit with a standard set of features and functions.

- Asynchronous communication mode
- Single ended configuration
- Full implementation of mandatory commands
- Full support of all the phases specified in the SCSI standard
- Provision of terminator power

DEFINITIONS

The role of the host computer and the controller and the addresses of a disk are defined in the SCSI specifications as follows.

Initiator and target device: The unit which issues the drive control commands is called the initiator. This term usually refers to the host computer. The device which controls the drive with initiator's command is called as a target device. In this case the SMO-E501.

Physical and logical addresses on disk: With SCSI, all data on a disk are handled in blocks, regardless of the type of media. Commands are executed by specifying the address assigned to each of these blocks. One block corresponds to one sector on the MO disk. When the disk drive is under control, all disk addresses are specified as Logical Block Addresses (LBA). Physical Addresses are defined as the preformatted track and sector addresses on the disk.

5.2.2 Control Method and Procedures

The following flowchart is an example of the procedure for controlling the drive through the built-in SCSI interface. Each step of the procedure is referred to as a phase. The role of each phase and SCSI command is described in the *SMO-E501 Magneto Optical Disk Drive SCSI Implementation manual*..

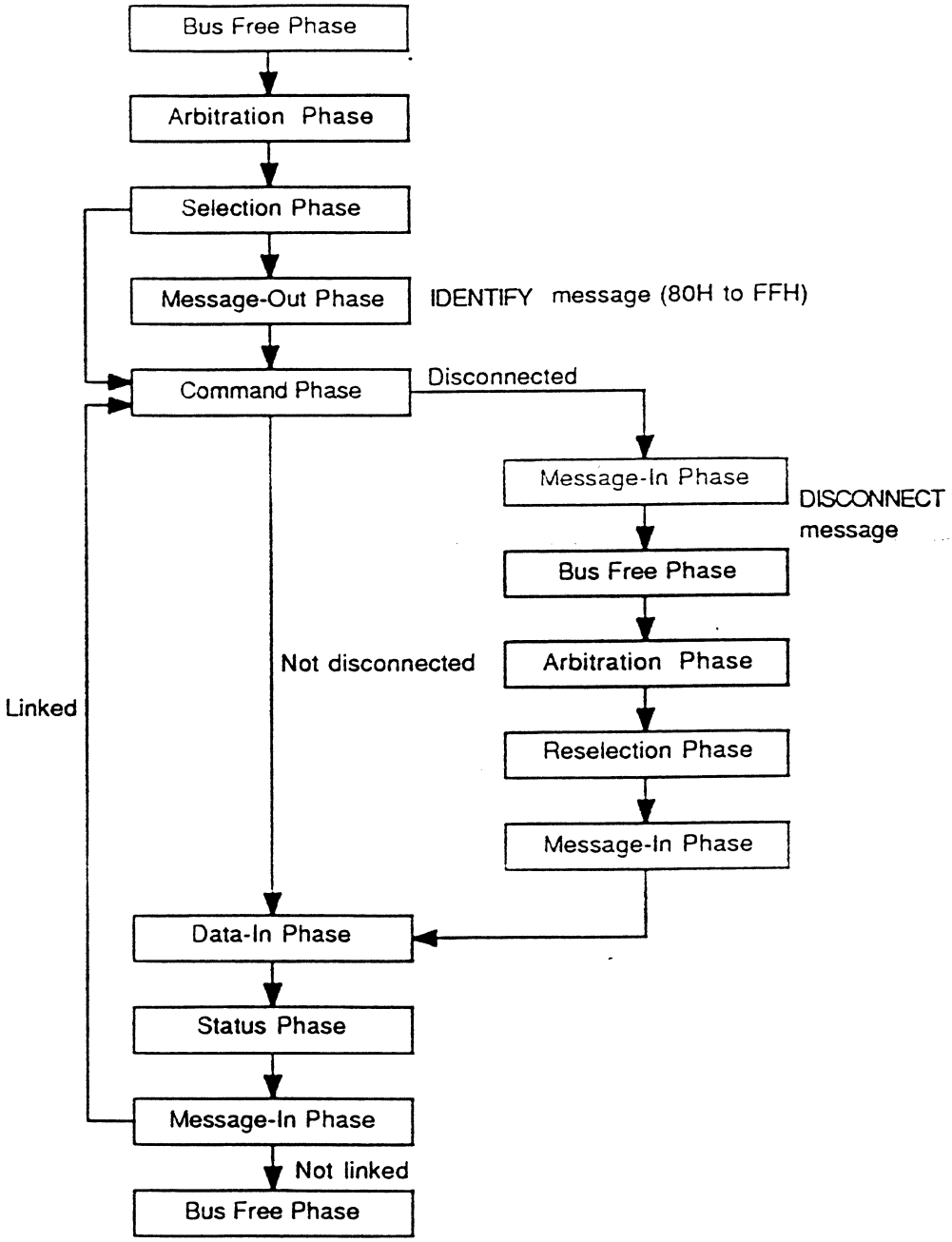


Fig.5.2 : Drive Control Flowchart through SCSI

5.2.3 Phases

The SMO-E501 supports the following SCSI 1 phases.

- ARBITRATION phase
- SELECTION phase
- RESELECTION phase
- DATA phase
- COMMAND phase
- MESSAGE phase

  Command complete
  Save data pointer
  Restore pointers
  Disconnect
  Initiator Detected Error
  Abort
  Message reject
  No operation
  Message parity error
  Linked command complete
  Linked command complete (with FLAG)
  Bus device reset
  Identify

- STATUS phase

5.2.4 Command Summary

The SMO-E501 supports the following group 0 and group 1 commands.

GROUP 0 (6-byte commands)

Code	Description
00H	**TEST UNIT READY** Provides a means to check if the logical unit is ready.
01H	**REZERO UNIT** Moves the optical head to the physical track 0.
03H	**REQUEST SENSE** Requests the detailed error information.
04H	**FORMAT UNIT** Initializes the medium.
07H	**REASSIGN BLOCKS** Reassigns the defective sectors.
08H	**READ** Reads data from the specified logical block address.
09H	**ERASE** Executes erase operation from the specified logical block address.
0AH	**WRITE** Writes data to the specified logical block address.
0BH	**SEEK** Moves the optical head to the physical track where the specified logical block exists.
12H	**INQUIRY** Reads information related to the drive unit.
15H	**MODE SELECT** Sets medium or drive unit parameters.
16H	**RESERVE** Gains the exclusive control of a specified logical unit.
17H	**RELEASE** Releases a specified logical unit from the reservation state.
18H	**COPY** Copies data from a specified area of the logical unit (medium) to another area of the same logical unit.
1AH	**MODE SENSE** Reads medium and drive parameters.
1BH	**START/STOP UNIT** Starts or stops rotating the medium, and/or ejects the medium from the drive unit.
1CH	RECEIVE DIAGNOSTIC RESULTS Requests analysis data be sent to the initiator.
1DH	**SEND DIAGNOSTIC** Requests the drive to perform diagnostic tests.
1EH	**PREVENT/ALLOW MEDIUM REMOVAL** Prevents or allows removal of the medium in the logical unit.

GROUP 1 (10-byte command)

Code	Description
25H	**READ CAPACITY** Reads the capacity of the medium.
28H	**READ** Reads data from the specified logical block address.
29H	**ERASE** Executes erase operation from the specified logical block address.
2AH	**WRITE** Writes data to the specified logical block address.
2BH	**SEEK** Moves the optical head to the physical track where the specified logical block exists.
2EH	**WRITE AND VERIFY** Writes data to the medium and then verifies the written data by checking the error correction code.
2FH	**VERIFY** Verifies the data starting from the specified logical block address by checking the error correction code.
37H	**READ DEFECT DATA** Reads the medium defect information.
3AH	**COPY AND VERIFY** Copies data from a specified area of the logical unit (medium) to another area of the same logical unit and then verifies the written data by checking the error correction code.
3BH	**WRITE BUFFER** Writes data to the data buffer of the SMO-E501.
3CH	**READ BUFFER** Reads data form the data buffer of the SMO-E501.
3EH	**READ LONG** Reads data from the specified logical block address with ECC data.
3FH	**WRITE LONG** Writes data to the specified logical block address without using the ECC generation circuitry.

SMO-E501

Magneto Optical Disk Drive

SCSI Specification
Disk Management Explanation

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REFERENCES

- SMO-E501 Specifications and Operating Instructions.
- Small Computer System Interface (SCSI-1), ANSI X3.131-1986.
- Common Command Set of the Small Computer Interface (SCSI) ANSI X3T9.2-85-82 (rev. 4B)
- ISO/IEC JTC1 DIS 10089, Format A, 130mm rewritable Optical Disk Cartridges for Information Interchange.

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EDITION I

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SECTION 1 INTRODUCTION

This document describes how the SONY SMO-E501 Magneto Optical Disk Drive implements the SCSI specification, defined by the American National Standard for Information Systems in the documents *Small Computer Systems Interface ANSI X3.131-1986* and *Common Command Set (CCS) of the Small Computer Interface (SCSI) ANSI X3T9.2-85-82, revision 4B.*

For the materials not described in this documents, refer to the *ANSI X3.131-1986 Small Computer Systems Interface* , the *Common Command Set (CCS) of the Small Computer Interface Rev. 4B*, the Sony *SMO-E501 Magneto Optical Disk Drive - Specifications and Operating Instructions* and the *ISO/IEC JTC1 - Format A - 130mm Rewritable Optical Disk Cartridges for Information Interchange.*

SECTION 1 describes all the SCSI specifications with the exception of the command description of the SMO-E501. SECTION 2 describes, in detail, the command specification of the SMO-E501.

SECTION 2 SCSI SPECIFICATION

2.1 PHASES

The SMO-E501 supports all the phases specified in SCSI standard. The following paragraphs describe each phase:

2.1.1 ARBITRATION phase

When the SMO-E501 tries to reconnect to an initiator for the purpose of continuing command operation, it waits for the BUS FREE phase to occur, and then enters the ARBITRATION phase.

2.1.2 SELECTION phase

The SMO-E501 detects that it is selected when SEL and its SCSI ID bit are true and BSY and I/O are false for at least a bus settle delay. The SMO-E501 examines the DATA BUS in order to determine the SCSI ID of the selecting initiator and if it cannot detect the SCSI ID of the initiator, the SMO-E501 treats this selection as single initiator option. In case of single initiator option, the SMO-E501 handles the SCSI ID of the initiator as that of the SMO-E501 internally. In this case, IDENTIFY message with disconnect bit set is rejected by MESSAGE REJECT message.

The SMO-E501 responds to the selection from an initiator even before the completion of the previous command. However, as the SMO-E501 does not support command queuing, it rejects the command for the same logical unit (for which the previous command was issued) and returns the BUSY status.

2.1.3 RESELECTION phase

When the SMO-E501 tries to reconnect to an initiator for the purpose of continuing command operation, after winning the arbitration, it reselects the initiator. If the initiator does not respond to the RESELECTION within the Selection Timeout Delay (250ms), the SMO-E501 releases the SCSI BUS and after a short period of time (about 100 µs), retries the RESELECTION after winning the arbitration. The SMO-E501 repeats this sequence up until the RESELECTION succeeds.

The SMO-E501 always generates parity during RESELECTION.

2.1.4 INFORMATION TRANSFER phase

When the information is transferred from an initiator to the SMO-E501, the SMO-E501 performs a parity check if the SCSI parity checking Options Jumper Block is enabled. When

the information is transferred from the SMO-E501 to the initiator, parity is always generated by the SMO-E501. Refer to the *Magneto Optical Disk Drive SMO-E501 Specification and Operating Instructions* for detailed information about Options Jumper Block setting.

2.1.5 DATA phase

The SMO-E501 supports asynchronous data transfer only. Synchronous data transfer is not supported.

If the parity error detection is enabled by the Options Jumper Block, the SMO-E501 checks the parity during the DATA OUT phase. When a parity error is detected, the SMO-E501 may send RESTORE POINTERS message and retry the data transfer. If the data transfer is not executed properly, the SMO-E501 returns the CHECK CONDITION status and sets the Sense Key/Additional Sense Code to HARDWARE ERROR/SCSI Interface Parity Error.

When an INITIATOR DETECTED ERROR message is sent from an initiator during the data transfer from the SMO-E501 to the initiator, the SMO-E501 may send a RESTORE POINTERS message to the initiator and retry the data transfer.

2.1.6 COMMAND phase

If the parity error detection is enabled by the Options Jumper Block, the SMO-E501 checks the parity during the COMMAND phase. When a parity error is detected, the SMO-E501 returns the CHECK CONDITION status and sets Sense Key/Additional Sense Code to HARDWARE ERROR/SCSI Interface Parity Error.

See SECTION II for a detailed description of the commands supported in the SMO-E501.

2.1.7 MESSAGE phase

If the parity error detection is enabled by Options Jumper Block, the SMO-E501 checks the parity during the MESSAGE OUT phase. When a parity error is detected, the SMO-E501 retries the MESSAGE OUT phase according to the following sequence:

1. Continue the REQ/ACK handshakes until the initiator negates ATN (all message bytes received).
2. Notify the initiator to resend all previous MESSAGE OUT message bytes within the current phase, by not changing the phase and by asserting REQ.

If the message is not received correctly, the SMO-E501 terminates the present command with a CHECK CONDITION status and sets the Sense Key/Additional Sense Code to HARDWARE ERROR/SCSI Interface Parity Error.

The SMO-E501 supports following messages:

Code	Direction	Description
00H	IN	COMMAND COMPLETE
02H	IN	SAVE DATA POINTER
03H	IN	RESTORE POINTERS
04H	IN	DISCONNECT
05H	OUT	INITIATOR DETECTED ERROR
06H	OUT	ABORT
07H	IN/OUT	MESSAGE REJECT
08H	OUT	NO OPERATION
09H	OUT	MESSAGE PARITY ERROR
0AH	IN	LINKED COMMAND COMPLETE
0BH	IN	LINKED COMMAND COMPLETE (WITH FLAG)
0CH	OUT	BUS DEVICE RESET
80H-7FH	IN/OUT	IDENTIFY

(IN: SMO-E501 to initiator OUT: initiator to SMO-E501)

COMMAND COMPLETE 00H

This message is sent from the SMO-E501 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 SMO-E501 goes to the BUS FREE phase by releasing BSY.

SAVE DATA POINTER 02H

This message is sent from the SMO-E501 to direct the initiator to save a copy of the present active data pointer for the currently attached logical unit. The SMO-E501 issues this message when it disconnects the SCSI BUS during data transfer or when the block of data, that of which length is specified by the Buffer Full Ratio for reading or by the Buffer Empty Ratio for writing, is transferred.

RESTORE POINTERS 03H

This message is sent from the SMO-E501 to direct the initiator to restore the most recently saved pointers to an active state. The SMO-E501 may send this message when INITIATOR DETECTED ERROR message is sent from the initiator during DATA IN or STATUS phase.

DISCONNECT 04H

This message is sent from the SMO-E501 to inform an initiator that the present physical path is going to be broken, but that a later reconnection will be required in order to complete the current operation.

INITIATOR DETECTED ERROR 05H

When the SMO-E501 receives this message during DATA IN or STATUS phase, it may retry the transfer after sending RESTORE POINTERS message.

ABORT 06H

This message is sent from the initiator to the SMO-E501 to clear the present operation. All pending data and status which was made by the current command is cleared and the SMO-E501 goes to the BUS FREE phase. Pending data and status for other initiators are not cleared. No status or ending message is sent for the operation.

MESSAGE REJECT 07H

This message is sent from either the initiator or SMO-E501 to indicate that the last message was inappropriate or has not been implemented.

When the SMO-E501 receives a MESSAGE REJECT message from the initiator, it takes the following action based on which message is rejected.

COMMAND COMPLETE: The SMO-E501 goes to the BUS FREE phase and does not consider this as an error.

DISCONNECT: The SMO-E501 does not disconnect and continues the current command.

IDENTIFY: The SMO-E501 goes to the BUS FREE phase and aborts the command. Sense Key/Additional Sense Code is set to HARDWARE ERROR/Message Reject Error.

LINKED COMMAND COMPLETE or **LINKED COMMAND COMPLETE (WITH FLAG)**: The SMO-E501 goes to BUS FREE phase and sets the Sense Key/Additional Sense Code to HARDWARE ERROR/Message Reject Error.

MESSAGE REJECT: The SMO-E501 terminates the command with CHECK CONDITION status and set the Sense Key/Additional Sense Code to HARDWARE ERROR/Message Reject Error.

RESTORE POINTERS: The SMO-E501 goes to the BUS FREE phase and sets the Sense Key/Additional Sense Code according to the error condition.

SAVE DATA POINTER: The SMO-E501 does not disconnect and continues the current command.

NO OPERATION 08H

This message is ignored by the SMO-E501.

MESSAGE PARITY ERROR 09H

When the SMO-E501 receives this message, it retries the operation by resending the original message once. If the message cannot be sent successfully, the SMO-E501 immediately goes to the BUS FREE phase and aborts the current SCSI command. No further reconnection is attempted and no status or COMMAND COMPLETE message is returned for the command. The SMO-E501 sets the Sense Key/Additional Sense Code to HARDWARE ERROR/SCSI Interface Parity Error.

LINKED COMMAND COMPLETE 0AH

This message is sent from the SMO-E501 to an initiator to indicate that the execution of a linked command has been completed and that the status has been sent.

LINKED COMMAND COMPLETE (WITH FLAG) 0BH

This message is sent from the SMO-E501 to an initiator to indicate that the execution of a linked command (with the flag bit set to 1) has been completed and that the status has been sent.

BUS DEVICE RESET 0CH

This command is sent from an initiator to reset the SMO-E501.

IDENTIFY 80H-FFH

These messages are sent by either the initiator or the SMO-E501 to establish the physical path connection between the initiator and the SMO-E501 for a particular logical unit.

Bit 7 This bit is always set to 1.

Bit 6 This bit is set to 1 by the initiator to indicate that the initiator has an ability to accommodate the disconnection and reconnection.

Bit 5-3 Reserved.

Bit 2-0 These bits specify a logical unit number.

Only one logical unit number is identified for any one selection sequence.

2.1.8 STATUS phase

A status byte is sent from the SMO-E501 to the initiator during the STATUS phase at the termination of each command unless the command is cleared by an ABORT message, by a BUS DEVICE RESET message, or by a RESET condition. The SMO-E501 supports the following status codes:

Code	Status
00H	GOOD
02H	CHECK CONDITION
08H	BUSY
10H	INTERMEDIATE/GOOD
18H	RESERVATION CONFLICT

GOOD 00H

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

CHECK CONDITION 02H

Any error, exception, or abnormal condition that causes sense data to be set, causes a CHECK CONDITION status. The REQUEST SENSE command should be issued following a CHECK CONDITION status, to determine the nature of the condition.

BUSY 08H

The SMO-E501 is busy. This status is returned when the SMO-E501 is in the spinning up sequence of the disk. This status is also returned when another command is being executed for the drive.

INTERMEDIATE/GOOD 10H

Unless an error, exception, or abnormal condition causes a CHECK CONDITION status or a RESERVATION CONFLICT status, the INTERMEDIATE/GOOD status is returned for every command in a series of linked commands, excluding the last command. If this status is not returned, the chain of linked commands is broken; no further commands in the series are executed.

RESERVATION CONFLICT 18H

This status is returned when an SCSI device attempts to access a logical unit that is reserved for another initiator.

2.2 CONDITIONS

2.2.1 ATTENTION condition

The ATTENTION condition allows an initiator to inform the SMO-E501 that the initiator has a message ready. The SMO-E501 gets this message at its convenience by performing a MESSAGE OUT phase. The SMO-E501 detects the assertion of the ATN signal when a block of information bytes is received or sent. Until the SMO-E501 performs a MESSAGE OUT phase, the initiator has to send or receive (dummy) information.

2.2.2 RESET condition

The SMO-E501 is reset when power is on, RST signal is asserted, or the BUS DEVICE RESET message is received. These three conditions have the same effect on the SMO-E501 except that the self-diagnostic sequence is performed only when the power is on. When the SMO-E501 is reset, it clears all the uncompleted commands, releases all reservations, and resets any SCSI device operating modes (MODE SELECT, PREVENT/ALLOW MEDIUM REMOVAL commands, etc) to their default conditions.

2.2.3 UNIT ATTENTION condition

An UNIT ATTENTION condition for a logical unit begins for each initiator when the medium is loaded (inserted into the drive unit), the SMO-E501 is reset, or MODE SELECT parameters are changed. The UNIT ATTENTION condition persists for each initiator until that initiator issues a command to the logical unit other than the REQUEST SENSE or INQUIRY for which the SMO-E501 returns the CHECK CONDITION status. If the next command from that initiator to the logical unit (following the CHECK CONDITION status) is REQUEST SENSE, UNIT ATTENTION sense key is returned. (If any command other than REQUEST SENSE is received, the UNIT ATTENTION condition is lost.)

If an INQUIRY command is received from an initiator with a pending UNIT ATTENTION condition (before the SMO-E501 reports CHECK CONDITION status), the SMO-E501 performs the INQUIRY command and does not clear the UNIT ATTENTION.

If a REQUEST SENSE command is received from an initiator with a pending UNIT ATTENTION condition (before the SMO-E501 reports CHECK CONDITION status), the SMO-E501 discards any pending sense data, reports UNIT ATTENTION sense key, and clears the UNIT ATTENTION condition for that initiator.

2.3 DISK FORMAT

The SMO-E501's role is to manage the 130mm Magneto Optical Drive and Disk as a direct access device through SCSI. It supports two types of defect management schemes, that are:

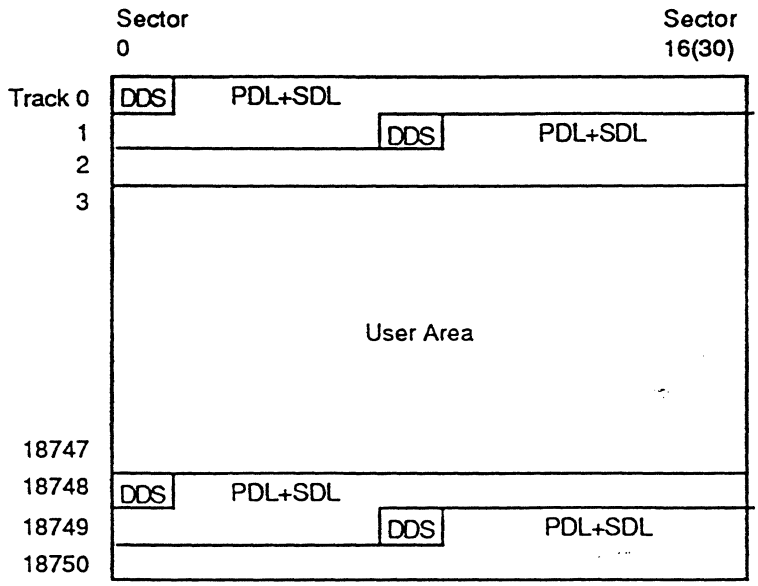
-ISO standard defect management scheme for 130mm Rewritable Optical Disk
-Sony unique defect management scheme

To manage the different defect management schemes, there are 4 disk-management modes: Format Mode 0, 1, 2 and 3. Format Mode 3 is a mode which supports the ISO defect management. Format Mode 0, 1 and 2 is a mode used to handle the Sony unique defect management.

Throughout this section, the sector number is that of 1024 bytes/sector medium. The value of the 512 bytes/sector medium is written inside the parentheses just after the value of 1024 bytes/sector medium.

ISO standard defect management scheme

The disk is divided into following areas and is managed by the SMO-E501:



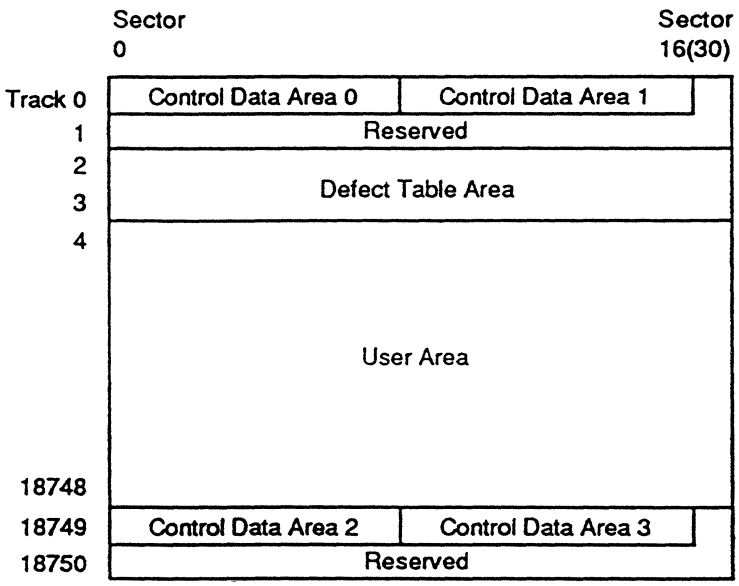
The DDS (Disk Definition Structure) defines the defect allocation algorithm and the way the user and spare area is divided into data blocks and spare blocks. The PDL (primary defect list) is established upon certification of the medium. The SDL (secondary defect list) is used to record defective sectors after the certification of the medium.

Format Mode 3

Format Mode 3 is a mode which supports the ISO standard defect management. In Format Mode 3, tracks from 0 to 2 and from 18748 to 18750 are used for DDS, PDL and SDL. And tracks from 3 to 18747 is used for user area (data blocks + spare blocks)

Sony unique defect management scheme

The disk is divided into following areas and is managed by the SMO-E501:



There are 3 disk-managing modes in the Sony unique defect management scheme: Format Mode 0, 1 and 2. Normally, format mode information is saved in the CDA (Control Data Area) and retrieved from the disk when it is spun up. The format mode can be changed by using MODE SELECT command and the information can be written onto the disk by FORMAT UNIT command.

Format Mode 0 and Format Mode 1

Format Modes 0 and 1 are Sony unique modes without defect management. These modes are for testing or such a host that can handle the defect management, requires fast access speed, etc. The difference between Format Mode 0 and 1 is that in Format Mode 0, the initiator can access the disk even when the CDA is invalid. In both modes, Logical Block Address 0 starts from the physical track 4 sector 0. In Format Mode 0, the initiator can access from track -8 to track 18843. And in Format Mode 1, it can access from track 2 to track 18748.

To access track -8 to 3, issue group 1 access type command with the negative logical block address.

Format Mode 2

Format Mode 2 is a mode which supports the Sony unique defect management. In Format Mode 2, tracks 2 and 3 are used for DTA (Defect Table Area) which includes the SDT (Skipping Defect Table) and BST (Band Sparing Table). Tracks from 4 to 18748 are used for user area (data blocks + spare blocks).

Refer to the *Magneto Optical Disk Drive SMO-E501 Disk Management Explanation* and the *ISO/130mm Rewritable Optical Disk Cartridges Standard Document (ISO/DP 10089-2A)* for details.

2.4 MISCELLANEOUS

2.4.1 LOGICAL UNIT NUMBER

After the RESET condition, the SMO-E501 examines the drive block which are connected to the SCSI controller block. If the SMO-E501 finds a drive block with an drive number 1, this drive block is treated as logical unit 0. If the SMO-E501 cannot find the drive block with an drive number 1, the commands for the logical unit 0 are rejected and the Sense Key/Additional Sense Code is set to ILLEGAL REQUEST/Invalid LUN. In this situation, INQUIRY command returns the INQUIRY data with its peripheral device type field set to 7FH (Logical unit not present). A command for LUN 1 to 7 is always rejected and Sense Key/Additional Sense Code is set to "ILLEGAL REQUEST/Invalid LUN".

2.4.2 POWER UP SEQUENCE

The SMO-E501 performs some tests automatically when the power turns on. The following table shows the power-on test sequence of the SMO-E501:

SMO-E501 Power up sequence (SCSI controller block)

Step	Action	Explanation
1	PROM Test	Checks the check sum of the PROM.
2	RAM Test	Writes FFH pattern to the entire CPU RAM and checks the data.
3	RAM Test	Writes 00H pattern to the entire CPU RAM and checks the data.
4	HIC Test	Checks Host Interface Controller chip (WD33C93).
5	BMM Test	Checks Buffer Memory Manager chip (ADS3570).
6	DIC Test	Checks Drive Interface Controller chip (ADS10C00).
7	ECC Test	Checks Error Correction processor Chip (WD60C80).
8	Buffer RAM Test	Buffer RAM test.
9	Reserved	Reserved
10	Drive Connection Test	Checks the drive block connected to the SCSI controller block.
11	Drive Configuration/ Status Access Test	Sets the drive configuration to the internal variables.

If the test fails during Step 5 through 9, SMO-E501 goes into the "Power on diag failure mode". A "HARDWARE ERROR/Power On Diagnostic Failure" status is returned instead of "Unit Attention/Power On or Reset or Bus Device Reset occurred" through SCSI. In this mode, only the following four commands are available:

- REQUEST SENSE
- INQUIRY

- RECEIVE DIAGNOSTIC RESULTS
- SEND DIAGNOSTIC

If another command is issued, SMO-E501 returns "HARDWARE ERROR/Power On Diagnostic Failure" to notify the host computer that the SMO-E501 is in the "Power on diag failure" mode.

When an SCSI RESET condition (SCSI bus reset or BUS DEVICE RESET message) happens to the SMO-E501 which is not in the "Power on diag failure" mode, Step 4 trough 7 and Step 10 through 11 will be executed. When the SMO-E501 is in the "Power on diag failure" mode and the SCSI RESET condition happens, Step 4 trough 11 will be executed.

2.4.3 DISK SPIN UP SEQUENCE

After the disk is spun up, the SMO-E501 tries to execute the following sequence. This process is performed at the time of the first spin-up after the disk is loaded. A RESET condition makes the SMO-E501 resume the following from process 2:

1. Read PEP (Phase Encoded Part) of the control track.
2. Read SFP (Standard Formatted Part) of the control track.
3. Erase/Write/Read test using the inner manufacturer zone.
4. Read the data of Sector 0 in Track 0 (DDS or DTA may be written).

If the SMO-E501 recognizes that the medium is formatted by Format Mode 3, it proceeds to the following process:

5. Read PDL
6. Read SDL

Else if the SMO-E501 can't recognize that the medium is formatted by Format Mode 3, then the next steps are followed:

5. Read format information sector in the CDA.
6. Read mode information sector in the CDA.

If Format Mode is 2

7. Read Defect Table Area (DTA).

ISO standard defect management scheme

If an error happens during process 1, 2, or 3, the access to the disk is rejected. During process 4,5 and 6, the SMO-E501 tries to read (DDS, PDL, SDL), and checks the validity of the data. At least, one set of (DDS,PDL,SDL) information sector has to contain the valid information. If the error happens during process 1, 2, or 3, or the valid information is not retrieved in the process 4, 5 and 6, medium-access commands return the CHECK

CONDITION status with its Sense Key/Additional Sense Code being set to "MEDIUM ERROR/Medium Format Corrupted".

Sony unique defect management scheme

If an error happens during process 1, 2, or 3, the access to the disk is rejected. During process 5 or 6, the SMO-E501 tries to read CDA 0 through 3 and checks the validity of the data. At least, one information sector has to contain the valid information. If the data of format information sector is not retrieved properly, access to the disk is denied unless the Format Mode is 0 (This means that if you set the Format Mode to 0 by the MODE SELECT command, you can access the disk). If the error happens during process 1, 2, or 3, or the valid information is not retrieved in the process 5 (and Format Mode is not 0), medium-access commands return the CHECK CONDITION status with its Sense Key/Additional Sense Code set to "MEDIUM ERROR/Medium Format Corrupted". When the data of mode information sector is retrieved properly, the mode select parameters are replaced by this information. If it cannot be retrieved properly, mode select parameters are not changed. In Format Mode 2, the SMO-E501 reads the skip sparing table and the band sparing table in the DTA. Each table consists of two identical information sectors, and one of them needs to be read successfully. If the retrieval is failed, the medium-access command reports CHECK CONDITION status with its Sense Key/Additional Sense Code being set to "MEDIUM ERROR/Medium Format Corrupted".

When the mode select parameters are retrieved from the disk, the target may report the UNIT ATTENTION condition with an additional sense code being set to "Mode Select Parameters Changed." This happens when the START/STOP UNIT command is executed by the other initiator after the "Medium Changed" Unit Attention has been cleared (by the initiator which will receive the "Mode Select Parameters Changed"). If "Power On or Reset or Bus Device Reset" occurred or "Medium Changed" Unit Attention is not cleared yet, "Mode Select Parameters Changed" UNIT ATTENTION will never be reported (This means that "Power On or Reset or Bus Device Reset occurred" and "Medium Changed" implies "Mode Select Parameters Changed").

SECTION 3 COMMANDS

INTRODUCTION

This section describes detailed functions of each command supported in the SMO-E501. Entries are arranged in order of the operation code.

Each entry includes:

- Command name
- Operation code
- Brief description of the command (FUNCTION)
- Command descriptor block (CDB)
- Detailed description of the command (EXPLANATION)

The following are explanations of each component:

Command name and operation code

Command name and operation code are printed at the first line of each entry in large fonts. The operation code is written in hexadecimal notation.

FUNCTION

Brief description of the command is described here.

CDB

This part shows the format of the command supported in the SMO-E501. The logical unit number field is used to specify the logical unit when the IDENTIFY message is not sent to the SMO-E501. If the logical unit is specified by IDENTIFY message, contents of this field are ignored by the SMO-E501. A link bit of 1 indicates that the SMO-E501 links to the next command upon successful completion of the current command. When the command is terminated successfully, the SMO-E501 returns the INTERMEDIATE/GOOD status and LINKED COMMAND COMPLETE or LINKED COMMAND COMPLETE (WITH FLAG) message depending on the state of the flag bit. The flag bit may be set to 1 only when the link bit is 1. If this bit is set to 1 with the link bit, the SMO-E501 returns the LINKED COMMAND COMPLETE (WITH FLAG) message upon successful completion of the command. If this bit is set to 0, it returns the LINKED COMMAND COMPLETE message. During the linked commands, the logical unit number field has to contain the same value unless the logical unit number is specified by IDENTIFY message. If the logical unit number field is different from that of the

previous CDB, the command returns the CHECK CONDITION status and sets the Sense Key/Additional Sense Code to "ILLEGAL REQUEST/Invalid LUN". Some group 1 commands have a relative address (RelAdr) bit. The RelAdr bit is set to 1 to indicate that the logical block address of the command descriptor block is a two's complement displacement. This negative or positive displacement is to be added to the logical block address last accessed on the logical unit to form the logical block address for this commands. The Reserved (or Rsrvd) field indicates that the field is reserved and has to be set to 0 by the initiator.

The SMO-E501 supports the following group 0 and group 1 commands (upper 3 bits of the operation code is called group code).

group 0 (6-byte command)

Code	Description
00H	**TEST UNIT READY** Provides a means to check if the logical unit is ready.
01H	**REZERO UNIT** Moves the optical head to the physical track 0.
03H	**REQUEST SENSE** Requests the detailed error information.
04H	**FORMAT UNIT** Initializes the medium.
07H	**REASSIGN BLOCKS** Reassigns the defective sectors.
08H	**READ** Reads data from the specified logical block address.
09H	**ERASE** Executes erase operation from the specified logical block address.
0AH	**WRITE** Writes data to the specified logical block address.
0BH	**SEEK** Moves the optical head to the physical track where the specified logical block exists.
12H	**INQUIRY** Reads the information related to the the drive unit.
15H	**MODE SELECT** Sets medium or drive unit parameters.
16H	**RESERVE** Gains the exclusive control of a specified logical unit.
17H	**RELEASE** Releases a specified logical unit from the reservation state.
18H	**COPY** Copies data from a specified area of the logical unit (medium) to another area of the same logical unit.
1AH	**MODE SENSE** Reads medium or drive unit parameters.
1BH	**START/STOP UNIT** Starts or stops rotating the medium, and/or ejects the medium from the drive unit.
1CH	**RECEIVE DIAGNOSTIC RESULTS** Requests analysis data to be sent to the initiator.
1DH	**SEND DIAGNOSTIC** Requests the SMO-E501 to perform diagnostic tests.
1EH	**PREVENT/ALLOW MEDIUM REMOVAL** Prevents or allows removal of the medium in the logical unit.

group 1 (10-byte command)

Code	Description
25H	**READ CAPACITY** Reads capacity of the medium.
28H	**READ** Reads data from the specified logical block address.
29H	**ERASE** Executes erase operation from the specified logical block address.
2AH	**WRITE** Writes data to the specified logical block address.
2BH	**SEEK** Moves the optical head to the physical track where the specified logical block exists.
2EH	**WRITE AND VERIFY** Writes data to the medium and then verifies the written data by checking the error correction code.
2FH	**VERIFY** Verifies the data starting from the specified logical block address by checking the error correction code.
37H	**READ DEFECT DATA** Reads the medium defect information
3AH	**COPY AND VERIFY** Copies data from a specified area of the logical unit (medium) to another area of the same logical unit and then verifies the written data by checking the error correction code.
3BH	**WRITE BUFFER** Writes data to the data buffer of the SMO-E501.
3CH	**READ BUFFER** Reads data form the data buffer of the SMO-E501.
3EH	**READ LONG** Reads data from the specified logical block address with ECC data.
3FH	**WRITE LONG** Writes data to the specified logical block address without using the ECC generation circuitry.

EXPLANATION

Detailed description of the command is explained here.

The Reserved (or Rsrvd) field in returned data indicates that the field contains 0.

TEST UNIT READY 00H

FUNCTION

Provides a means to check if the logical unit is ready.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (00H)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved						Flag	Link

EXPLANATION

This command is used to check if the logical unit is ready. When the logical unit is not ready to accept a medium-access command, this command returns a CHECK CONDITION status.

REZERO UNIT 01H

FUNCTION

Moves the optical head to physical track 0.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (01H)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved						Flag	Link

EXPLANATION

This command is used to recalibrate the optical head. The optical head is moved to the innermost track (physical track 0).

FUNCTION

Requests detailed error information from the drive.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (03H)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Allocation Length							
5	Reserved						Flag	Link

EXPLANATION

In the event a command ended unsuccessfully, the drive stores the error information in the internal RAM area and returns the CHECK CONDITION status. The information stored is called 'sense data' and is preserved for the initiator (which issued the command resulting in the CHECK CONDITION status) until it is retrieved via the REQUEST SENSE command or until any other command for the same logical unit has been received. Upon receipt of any subsequent command to the logical unit from the initiator receiving the CHECK CONDITION status, the SMO-E501 clears the Sense Key/Additional Sense Code to No Sense/No Additional Sense Information.

The REQUEST SENSE command requests the target to transfer the sense data to the initiator. The allocation length specifies the number of bytes that the initiator has allocated for returned sense data . If the allocation length is set to 0, the SMO-E501 returns sense data in the Nonextended Sense Data Format. In this case, 4 bytes of sense data are returned. If the allocation length is set to a nonzero value, the SMO-E501 returns sense data in the Extended Sense Data Format. The SMO-E501 transfers allocation length bytes or all available sense data (18 bytes), whichever is less.

The first byte of the sense data consists of AdValid, Error Class and Error Code field. Error Classes 0 through 6 use the Nonextended Sense Data Format and Error Class 7 uses the Extended Sense Data Format.

Nonextended Sense Data Format

.The Nonextended Sense Data format is shown in the following table.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	AdValid	Error Class			Error Code			
1	Logical Block Address (MSB)							
2	Logical Block Address							
3	Logical Block Address (LSB)							

When the address valid (AdValid) bit is set to 1, the Logical Block Address field contains valid information related to the Error Class and the Error Code. Bit 0 to 6 of byte 0 (Error Class + Error Code) contains the same value as the Additional Sense Code in the Extended Sense Data Format. Refer to the next paragraph for detailed information about the Additional Sense Code.

Extended Sense Data Format

The table below shows the format of the Extended Sense Data which consists of 18 bytes:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	AdValid	Error Class (7)			Error Code (0)			
1	Reserved							
2	Reserved				Sense Key			
3	Information Byte (MSB)							
4	Information Byte							
5	Information Byte							
6	Information Byte (LSB)							
7	Additional Sense Length (0AH)							
8	Reserved							
9	Reserved							
10	Reserved							
11	Reserved							
12	Additional Sense Code							
13	Reserved							
14	Reserved							
15	Reserved							
16	Reserved							
17	Reserved							

The Error Class is 7 and it specifies extended sense. The Error Code is 0 and it specifies the extended sense data format. The Sense Key reports the error condition. Refer to the Sense Key descriptions in the next paragraph. When the address valid (AdValid) bit is set to 1, the Information Byte field contains valid information related to the Additional Sense Code. During 'write' type commands (WRITE (0AH, 2AH), WRITE AND VERIFY, and WRITE LONG command), bytes 8 to 11 are set with non zero values.

Sense Key

The Sense Key in the Extended Sense Data reports either the nature of the detected error or the drive condition. The following Sense Keys are implemented in the SMO-E501.

Sense Key	Description
0H	**NO SENSE** Indicates that there is no specific sense key information to be reported for the designated logical unit. This sense key is returned when the command is completed successfully.
1H	**RECOVERED ERROR** Indicates that the last command was completed successfully with some recovery action performed by the SMO-E501.
2H	**NOT READY** Indicates that the logical unit cannot be accessed.
3H	**MEDIUM ERROR** Indicates that the command terminated with an unrecovered error condition caused by a medium defect.
4H	**HARDWARE ERROR** Indicates that the SMO-E501 detected a hardware error.
5H	**ILLEGAL REQUEST** Indicates that there was an illegal parameter in the command descriptor block or in the additional parameters supplied as data for some commands.
6H	**UNIT ATTENTION** Indicates that the medium has been loaded, the unit has been reset, or the Mode Select parameters has been changed.
7H	**DATA PROTECT** Indicates that a command that writes the medium has been attempted but cannot be performed due to the Write Protect setting of the medium cartridge switch.
AH	**COPY ABORTED** Indicates a COPY or COPY AND VERIFY command was aborted due to an error condition on the source device, the destination device, or both.

Additional Sense Code

The Additional Sense Code provides either detailed error information or the drive condition. The following list shows the Additional Sense Codes implemented in the SMO-E501 and the related Sense Keys.

Code	Description
00H	**No Additional Sense Information** (NO SENSE) No additional sense information to report.
02H*	**No Command Complete** (HARDWARE ERROR) The command complete signal was not returned from the drive block.
03H	**Write Fault** (HARDWARE ERROR) The Write command failed. The logical block address where the fault was detected may be returned in the Logical Block Address field or the Information Byte field of the sense data.
04H	**Drive Not Ready** (NOT READY) The READY signal from the drive block was negated. (The medium in the drive is not spun up, the focus or slide servo is unlocked.)
05H	**Drive Not Selected** (NOT READY) The drive block is not selected.
07H	**Multiple Drives Selected** (HARDWARE ERROR) Multiple drives responded for the same drive number.
08H	**Logical Unit Communication Failure** (HARDWARE ERROR) An error was detected during communication between the drive block and the SCSI controller block (e.g. parity error).
09H	**Track Following Error** (HARDWARE ERROR) Still-jump failed and the optical head could not stay on the same track.
0AH*	**No Disk** (NOT READY) A medium is not inserted into the drive unit.
0BH*	**Load/Unload Failure** (HARDWARE ERROR) A failure was detected during loading or unloading the cartridge.
0CH*	**Spindle Failure** (HARDWARE ERROR) The spindle servo was not locked with the reference signal and the medium was not rotated correctly.
0DH*	**Focus Failure** (HARDWARE ERROR) The focus servo was not activated. Issue the START/STOP UNIT command with the Start bit set to 1 to restart the drive.

* These codes are newly added or have a different meaning from that of *CCS Rev 4B.*

0EH* **Tracking Failure** (HARDWARE ERROR)

The tracking servo could not be locked.

0FH* **Bias Magnet Failure** (HARDWARE ERROR)

The bias magnet of the drive failed.

10H **ID CRC Error** (HARDWARE ERROR)

The ID field could not be read without a CRC error.

11H **Unrecovered Read Data Error** (MEDIUM ERROR)

Data errors could not be corrected by the error correction code. The logical block address where the fault was detected may be returned in the Logical Block Address field or Information Byte field of the sense data.

15H **Seek Positioning Error** (HARDWARE ERROR)

Seeking to the specified track failed despite a number of retrials.

18H **Recovered Read Data with ECC Procedure** (RECOVERED ERROR)

An interleave containing 7 or 8 error bytes was located. Error correction was successful.

20H **Invalid Command Operation Code** (ILLEGAL REQUEST)

The specified command operation code is not implemented or an invalid command is requested.

21H **Illegal Logical Block Address** (ILLEGAL REQUEST)

The specified logical block address was outside the valid area.

23H* **Illegal Function for Medium Type** (ILLEGAL REQUEST)

The format parameter is invalid for the medium type.

24H **Illegal Field in CDB** (ILLEGAL REQUEST)

There was an error in the received Command Descriptor Block (CDB). This Additional Sense Code is returned under the following situations.

- The reserved field in CDB is not zero.
- Invalid combination of parameters (e.g. Both the eject bit and the start bit are set in the START/STOP UNIT command).
- Illegal parameter at that state (e.g. A command using the relative address (RelAdr) bit is set to 1 is issued after a command who's link bit is not set to 1).

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* These codes are newly added or have a different meaning from that of *CCS Rev 4B*.

25H **Invalid LUN** (ILLEGAL REQUEST)
LUN 1 through 7 is specified or the specified LUN (0) does not respond to the selection from the SCSI controller block.

26H **Invalid Field in Parameter List** (ILLEGAL REQUEST)
There was an error in the received parameters.

27H **Write Protected** (DATA PROTECT)
Erasing or writing was aborted because the write protect switch of the cartridge is on.

28H **Medium Changed** (UNIT ATTENTION)
A medium was loaded. This Additional Sense Code is used to notify the initiator that the medium has been changed since the execution of the last command. This code implies that the Mode Select Parameters may be changed (2AH).

29H **Power On or Reset or Bus Device Reset Occurred** (UNIT ATTENTION)
This Additional Sense Code is used to notify the initiator that a RESET condition has taken place since last command. This code implies that the Mode Select Parameters may be changed.

2AH **Mode Select Parameters Changed** (UNIT ATTENTION)
This Additional Sense Code is used to notify the initiator that the mode select parameters have been changed since the execution of the last command.

30H* **Incompatible Cartridge** (MEDIUM ERROR)
The ID hole(s) location of the cartridge is/are invalid.

31H* **Medium Format Corrupted** (MEDIUM ERROR)
PEP, SFP, the format information sector in the CDA, or DDS is/are invalid.

32H **No Defect Spare Location Available** (MEDIUM ERROR)
The number of defect sectors listed in the PDL and SDL (DTA) for the format mode 3 (2) exceeded the 2048 (1024) limit, or the number of defect sectors listed in the SDL exceeded the specified value calculated by the number of groups and spare blocks per group.

38H* **Recovered with Automatic Reallocation** (RECOVERED ERROR)
Automatic write reallocation was executed successfully.

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* These codes are newly added or have a different meaning from that of *CCS Rev 4B.*

39H* **Automatic Reallocation Failure** (MEDIUM ERROR)
Automatic write reallocation failed after retrying three times.

3AH* **Defect List Update Failure** (MEDIUM ERROR)
Updating of the defect table failed after the successful sparing of the data sector.

3DH* **Defect List Not Available** (MEDIUM ERROR or RECOVERED ERROR or ILLEGAL REQUEST)
The specified defect list is not available.

42H* **Power On Diagnostic Failure** (HARDWARE ERROR)
The power on diagnostics failed.

43H **Message Reject Error** (HARDWARE ERROR)
The command was aborted because the initiator rejected the message from the SMO-E501 by issuing the MESSAGE REJECT message.

44H **Internal SCSI controller Error** (HARDWARE ERROR)
The SMO-E501 detected an error related to the SCSI controller block hardware or firmware.

47H **SCSI Interface Parity Error** (HARDWARE ERROR)
The command was aborted due to parity error on the SCSI bus.

48H **Initiator Detected Error** (HARDWARE ERROR)
The command was aborted because the INITIATOR DETECTED ERROR message was sent from the initiator.

49H **Inappropriate/Illegal Message** (HARDWARE ERROR)
The command was aborted due to an inappropriate illegal message from the initiator.

80H* **Limited Laser Life** (HARDWARE ERROR)
Over-current was detected in the laser diode or the laser power is below the lower limit.

81H* **Focus Coil Over-current Failure** (HARDWARE ERROR)
Over-current was detected in the focus coil of the optical pick up.The coil is protected by a relay.

82H* **Tracking Coil Over-current Failure** (HARDWARE ERROR)
Over-current was detected in the tracking coil of the optical pick up.The coil is protected by a relay.

83H* **Temperature Alarm** (HARDWARE ERROR)
The Internal temperature of the drive exceeded the limit (60°C).

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* These codes are newly added or have a different meaning from that of *CCS Rev 4B*.

The SMO-E501 supports the following Extended Sense Data for the COPY ABORTED(AH) . The COPY ABORTED format is as follows.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	AdValid (1)	Error Class (7)			Error Code (0)			
1	Segment Number							
2	Reserved				Sense Key (AH)			
3	Information Byte (MSB)							
4	Information Byte							
5	Information Byte							
6	Information Byte (LSB)							
7	Additional Sense Length (0AH)							
8	Relative Source Sense Data (00H or 0BH)							
9	Relative Destination Sense Data (00H or 0BH)							
10	Status Byte from Source/Destination							
11	Reserved				Source/Destination Sense Key			
12	Source/Destination Additional Sense Code							
13	Reserved							
14	Reserved							
15	Reserved							
16	Reserved							
17	Reserved							

The Segment Number contains the number of the current segment where the unusual condition is detected. Up to 256 segments are supported beginning with segment 0. The information bytes contain the difference(residue) of the requested number of blocks minus the actual number of blocks copied for the current segment descriptor. The Relative Source Sense Data specifies the byte number, relative to the first byte of sense data of the beginning of the source logical unit's sense data. A zero value indicates that there is no error information from the source logical unit. The first byte of the area pointed to by the Relative Source Sense Data contains the Sense Key from the source logical unit. The Relative Destination Sense Data specifies the byte number, relative to the first byte of sense data of the beginning of the destination logical unit's sense data. A zero value indicates that there is no error information from the destination logical unit. The first byte of the area pointed to by the Relative Destination Sense Data contains the Sense Key from the destination logical unit. The Status Byte from Source/Destination contains the status byte from the source or

destination logical unit. The Source/Destination Sense Key contains the Sense Key of the error from the source or destination logical unit. The Source/Destination Additional Sense Code reports the Additional Sense Code of the error.

FUNCTION

Initializes the medium.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (04H)							
1	Logical Unit Number			FmtData	CmpLst	Defect List Format		
2	Reserved						MkCDA	MkPlst
3	Reserved							
4	Reserved							
5	Rsrvd	ErsCntl	Reserved				Flag	Link

EXPLANATION

The FORMAT UNIT command is used to make the required information on the medium for the SCSI controller to manage it. The make CDA (MkCDA) bit* and the make P list (MkPlist) bit** are effective only for the Sony unique defect management (Format Mode 0, 1 and 2). These bits have no effect to Format Mode 3. When the MkCDA bit is 1, the drive creates CDA on the medium. If the MkPlst bit is 1 at this time, the primary defect list is written in the CDA. When an unformatted medium is formatted in Format Mode 0, 1, or 2, the make CDA bit must be set to 1.

An erase control (ErsCntl) bit*** of 0 causes the automatic erase operation before the writing of the data when the SMO-E501 is directed to perform the certify operation by the initiator. An ErsCntl bit of 1 suppresses the erase operation.

Normally, the format mode is set by the initiator using the MODE SELECT command before the execution of FORMAT UNIT command. Unless the MODE SELECT command is used, the current mode select parameters are used to format the medium. If the Format Mode is 0 or 1, FmtData, CmpLst, and Defect List Format fields must be 0. If the Format Mode is 2 or 3,

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* This bit is a vendor unique bit.

** This bit is a vendor unique bit.

*** This bit is a vendor unique bit.

Defect List Format may be Block Format or Physical Sector Format. FmtData, CmpLst and Defect List Format fields are one of the following:

FmtData (bit 4)	CmpLst (bit 3)	Defect List Format (bit 2)	(bit 1)	(bit 0)	Description
0	0	0	0	0	No Defect List Header and no Defect Descriptor
1	x	0	0	0	Block Format
1	x	1	0	1	Physical Sector Format
All other codes					Reserved
(x: arbitrary)					

When the complete list (CmpLst) bit is set to 1, the previous G list is not used to make the defect list. When the CmpLst bit is clear to 0, the previous G list is added to the defect list.

When the FmtData bit is 1, the SMO-E501 goes into DATA OUT phase and receives the defect list from the initiator. The defect list contains a four-byte header followed by zero, one, or more defect descriptor(s). The length of the defect descriptors varies with the format of the defect list. The defect list format is as follows:

Defect List Header								
Byte	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
0	Reserved							
1	FOV	DPRY	DCRT	Rsrvd	Reserved			
2	Defect List Length (MSB)							
3	Defect List Length (LSB)							
Defect Descriptor(s)								
a(0)-b(0)	Defect Descriptor 0							
a(1)-b(1)	Defect Descriptor 1							
	• • •							
a(i)-b(i)	Defect Descriptor i							

a(i)=il
b(i)=(i+1)l-1
l:length of Defect Descriptor

The format options valid (FOV) bit must be 1 when the DCRT and/or DPRY bit is set, otherwise the CHECK CONDITION status will be returned. The disable certification (DCRT) bit controls the target certification routine. A DCRT bit of 1 disables the SMO-E501 from certifying the medium. If this bit is set to 0, the SMO-E501 will certify the entire medium, and defective sectors detected during certification will be used to make a new defect list. The disable primary bit (DPRY) is effective only for the disk which was formatted as Format Mode 2. A disk formatted in Mode 3 is not affected. A disable primary (DPRY) bit of 1 indicates that the primary defect list is not used to make the new defect list. If this bit is set to 0, the primary defect list is added to the new defect list.

Byte	Defect Descriptor
0	Reserved
1	Track Number of Defect (MSB)
2	Track Number of Defect (LSB)
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Sector Number of Defect

Physical Sector Format

In the physical sector format, the track number of defect field indicates the physical track number of the defect and the defect sector number field indicates the physical sector number of the defect.

Byte	Defect Descriptor
0	Reserved
1	Defect Block Address (MSB)
2	Defect Block Address
3	Defect Block Address (LSB)

Block Format

In the block format, the defect block address field indicates the logical block address of the defective sector. The logical block address is converted to the physical track/sector by the SMO-E501 according to the current format mode of the medium.

In both cases, the defective sector list has to be in ascending order.

REASSIGN BLOCKS 07H

FUNCTION

Reassigns the defective sectors.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (07H)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved						Flag	Link

EXPLANATION

The REASSIGN BLOCKS command reassigns the specified defective sectors to the nearest spare band. This command is valid for the medium which is formatted in Format Mode 2 or 3. The initiator transfers a defect list that contains the logical block addresses to be reassigned. The specified defective sectors will be listed in the BST (Format Mode 2) or SDL (Format Mode 3), and are controlled by the Band Sparing Algorithm or by the linear Replacement Algorithm. The defect list contains a four-byte header followed by zero, one, or more defect descriptor(s). The length of each defect descriptor is four bytes.

Defect List Header								
Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reserved							
1	Reserved							
2	Defect List Length (MSB)							
3	Defect List Length (LSB)							
Defect Descriptor(s)								
a(0)-b(0)	Defect Descriptor 0							
a(1)-b(1)	Defect Descriptor 1							
	• • •							
a(i)-b(i)	Defect Descriptor i							

a(i)=il
b(i)=(i+1)l-1
l:length of Defect Descriptor

The defect list length specifies the total length in bytes of the defect descriptors that follow. The format of the defect descriptor is as follows:

Byte	Defect Descriptor
0	Reserved
1	Defect Block Address (MSB)
2	Defect Block Address
3	Defect Block Address (LSB)

FUNCTION

Reads data from the specified logical block address.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (08H)							
1	Logical Unit Number			Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Transfer Length							
5	Reserved						Flag	Link

EXPLANATION

The READ command requests the SMO-E501 to read data from the medium and transfer this data to the initiator. The logical block address field specifies the logical block at which the read operation begins. The transfer length field specifies the number of contiguous logical blocks of data to be transferred. A transfer length of 0 indicates that 256 logical blocks are transferred. Any other value indicates the number of logical blocks to be transferred. Unless the RC bit of the mode select parameters is set to 1, the data read from the medium is ECC corrected.

FUNCTION

Erases data from the specified logical block address.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (09H)							
1	Logical Unit Number			Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Block Length							
5	Reserved						Flag	Link

EXPLANATION

The ERASE command requests the SMO-E501 to erase data from the medium. The logical block address field specifies the logical block at which the erase operation begins. The block length field specifies the number of contiguous logical blocks to be erased. A transfer length of 0 indicates that 256 logical blocks are erased. Any other value indicates the number of logical blocks to be erased.

If the AWRE bit is set to 1 (MODE SELECT command 15H), and the specified block is detected as defective during the erase operation (in this case, ID error, tracking failure, or focus failure due to medium defects), automatic reallocation occurs.

See the succeeding WRITE command for information on the interaction of the ERASE and WRITE commands.

* This command is a vendor unique command.

FUNCTION

Writes data to the specified logical block address.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (0AH)							
1	Logical Unit Number			Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Transfer Length							
5	Rsrvd	ErsCntl	Reserved				Flag	Link

EXPLANATION

The WRITE command requests the SMO-E501 to write data to the medium. The logical block address field specifies the logical block at which the write operation begins. The transfer length field specifies the number of continuous logical blocks of data to be transferred. A transfer length of 0 indicates that 256 logical blocks are transferred. Any other value indicates the number of logical blocks to be transferred. When this command is performed, the SMO-E501 automatically adds the error correction code (ECC) to the each logical block data and then writes to the medium.

An erase control (ErsCntl) bit* of 0 automatically invokes the erase command before the writing of the data --- usually this option is used. An erase control bit of 1 suppresses the erase operation. This option is for applications in where increased writing speed is desired. When this option is used, the initiator has to erase the area where the write operation is to be done using the ERASE command before the WRITE command is executed.

If the AWRE bit is set to 1(MODE SELECT command 15H), and the specified block is detected as defective during the write operation of this command (in this case, ID error, tracking failure, or focus failure due to the medium defect), then the automatic write reallocation occurs.

* This bit is a vendor unique bit.

FUNCTION

Moves the optical head to the physical track where the specified logical block exists.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (0BH)							
1	Logical Unit Number			Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Reserved							
5	Reserved						Flag	Link

EXPLANATION

The SEEK command requests the drive unit to move the optical head to the physical track where the specified logical block exists.

FUNCTION

Reads the information related to the drive unit.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (12H)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Allocation Length							
5	Reserved						Flag	Link

EXPLANATION

The INQUIRY command requests that the information related to the drive unit be sent to the initiator. The allocation length specifies the number of bytes that the initiator has allocated for the returned INQUIRY data. Allocation length of 0 indicates that no INQUIRY data is transferred. This condition is not considered as an error. The SMO-E501 transfers allocation length bytes or all available INQUIRY data (36 bytes), 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 SMO-E501 performs the INQUIRY command and does not clear the UNIT ATTENTION condition.

The INQUIRY data is returned in the following format:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Peripheral Device Type							
1	RMB	Device-Type Qualifier						
2	ISO Version		ECMA Version			ANSI-Approved Version		
3	Reserved							
4	Additional Length (1FH)							
5	Reserved							
6	Reserved							
7	Reserved							
8-15	Vendor Identification (in ASCII)							
16-31	Product Identification (in ASCII)							
32-35	Revision Level (in ASCII)							

If the drive block is properly connected to the SCSI controller block and responds to the selection from the SCSI controller block, the INQUIRY data is returned with peripheral device type field set to 0 (Direct-access device). Otherwise, it is returned with the field set to 7FH (Logical unit not present). As the SMO-E501 does not support logical unit number 1 through 7, an INQUIRY command to these logical units always returns 7FH for the peripheral device type.

A removable medium (RMB) bit of 1 indicates the medium is removable. The SMO-E501 only supports removable media, so this bit is always set to 1. The SMO-E501 is not using the device-type qualifier field currently, and returns 0. ISO version, ECMA version, and ANSI-approved version fields indicate compliance of the current firmware to these standards. The additional length indicates the additional parameter length in bytes. This field always returns 31 (1FH). The vendor identification field returns "SONY" in ASCII. The product identification field returns "SMO-C501-xxE" in ASCII (xx is arbitrary numerical characters in ASCII). The revision level field returns the current firmware version in "x.xx" format (x is arbitrary numerical characters in ASCII).

FUNCTION

Sets medium or drive unit parameters.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (15H)							
1	Logical Unit Number			PF	Reserved			SP
2	Reserved							
3	Reserved							
4	Parameter List Length							
5	Reserved						Flag	Link

EXPLANATION

The MODE SELECT command provides a means for the initiator to specify medium or drive unit parameters. The parameter list length specifies the length in bytes of the MODE SELECT parameter list that will be transferred in the DATA OUT phase. A parameter list length of 0 indicates that no data is transferred. This condition is not considered as an error. The MODE SELECT parameter list contains a four-byte header, followed by 0 or more pages. A page format (PF) bit has no effect to SMO-E501. The MODE SELECT parameter list is sent with the page format, and 0 or more pages can be sent. The save parameters (SP) bit is effective for Format Mode 0, 1, and 2. In Format Mode 3, a CHECK CONDITION status will be returned if the SP bit is set to 1. A SP bit of 1 causes the SMO-E501 to save pages 01H and 02H to the Mode Information Sector of the CDA (Control Data Area) after changing the current value. A SP bit of 0 causes changes of the current value only. The format of the MODE SELECT parameter list is as follows:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
MODE SELECT Header								
0	Reserved							
1	Medium Type (00H)							
2	Reserved							
3	Block Descriptor Length (00H)							
Page(s)								
0	Reserved			Page Code				
1	Page -Specific Parameter Length							
2 | n	Page-Specific Parameters							

The medium type field has to contain 0 (indicates default medium type) and the block descriptor field has to contain 0. The SMO-E501 supports the following pages.

Page Code	Description
01H	Error Recovery Parameters
02H	Disconnect/Reconnect Control Parameters
20H*	Format Parameters

Page 01H Error Recovery Parameters

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reserved		Page Code (01H)					
1	Page Length (06H)							
2	AWRE	Reserved		RC	Reserved			
3	Retry Count							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							

An automatic write reallocation enable (AWRE) bit of 1 (MODE SELECT command 15H) enables the automatic reallocation of the defective sector(s) when the SMO-E501 detects the

* This page is a vendor unique page.

medium error during the write or erase operation of the write-type command (the ERASE (09H), WRITE (0AH), COPY, ERASE (29H), WRITE (2AH), WRITE AND VERIFY, COPY AND VERIFY, WRITE LONG command) or verify error during the WRITE AND VERIFY command or COPY AND VERIFY command. This bit is effective only when the disk is formatted as Format Mode 2 or 3. A read continuous (RC) bit of 1 requests that the SMO-E501 transfers the data without adding delays which would increase data integrity during the READ command. If this bit is set to 1, the SMO-E501 does not correct the error bytes by the ECC. The Retry Count field specifies how many times the SMO-E501 retries the read/write operation before it reports the error to the initiator.

Page 02H Disconnect/Reconnect Control Parameters

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reserved		Page Code (02H)					
1	Page Length (0AH)							
2	Buffer Full Ratio							
3	Buffer Empty Ratio							
4-11	Reserved							

The buffer full ratio and the buffer empty ratio fields indicate the numerator of a fractional multiplier that has 256 as its denominator. The buffer full ratio field indicates, on read-type commands, how full the buffer shall be prior to reconnecting. The buffer empty ratio field indicates, on write-type commands, how empty the buffer shall be prior to reconnecting.

Page 20H Format Parameters

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reserved		Page Code (20H)					
1	Page Length (0AH)							
2	Format Mode							
3-11	Format Mode Specific Data							

When Format Mode is 0 or 1, Byte 3 through 11 must be 00H. When Format Mode is 2 or 3, depending on byte 3, the following two types of formats (Type 0 and Type 1) exist. In case of Format Mode 2, if the mode information is saved to the medium by the MODE SELECT command with the SP bit being set to 1 or in case of Format Mode 3 by the FORMAT UNIT command, Type 1 is transformed to Type 0 and then saved.

Format Mode 2 and 3

Type 0

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
2	Format Mode (02H or 03H)							
3	Type (00H)							
4	Size of User Band (MSB)							
5	Size of User Band							
6	Size of User Band							
7	Size of User Band (LSB)							
8	Size of Spare Band (MSB)							
9	Size of Spare Band (LSB)							
10	Reserved							
11	Reserved							

The size of user band field indicates the length of a band in number of logical blocks. The size of spare band field indicates the length of a spare band located beside a user band in number of logical blocks. In Format Mode 2, each spare band consists of a lower spare band and an upper spare band, then the number of allocated spare blocks per band is twice as many as the specified value. In Format Mode 3, each spare band consists of only an upper spare band, then the number of allocated spare sectors per band is equal to the specified value.

Type 1

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
2	Format Mode (02H or 03H)							
3	Type (01H)							
4	Reserved							
5	Reserved							
6	Number of Bands (MSB)							
7	Number of Bands (LSB)							
8	Size of Spare Band (MSB)							
9	Size of Spare Band (LSB)							
10	Reserved							
11	Reserved							

The number of bands field indicates how many bands exist in the medium. The size of spare band field indicates the length of a spare band in number of logical blocks. The meaning of 'size of spare band field' is the same as Type 0.

The default value of the parameters is as follows. This value is set when power on reset, SCSI bus reset or BUS DEVICE RESET message is received. (If the medium is inside of the drive when RESET condition happens, saved value is retrieved from the medium (if it exists) and set to the current value. It means that the default value is overridden by the saved value in the medium)

page	field	default value
01H	AWRE	0
01H	RC	0
01H	Retry Count	2
02H	Buffer Full Ratio	80H
02H	Buffer Empty Ratio	80H
20H	Format Mode	3
20H	Type	1
20H	Number of Band	1
20H	Size of Spare Band	2048

FUNCTION

Gains the exclusive control of a specified logical unit.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (16H)							
1	Logical Unit Number			3rdPty	Third Party Device ID			Rsrvd
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved						Flag	Link

EXPLANATION

This command is used to reserve the logical unit for exclusive use of the initiator. The reservation is effective until the reservation is superseded by another valid RESERVE command from the initiator that makes the reservation or until released by a RELEASE command from the same initiator, by a BUS DEVICE RESET message from any initiator, or by a RESET condition. If the logical unit is reserved for another initiator, attempts to perform any command except the REQUEST SENSE and INQUIRY command on the reserved logical unit is rejected with RESERVATION CONFLICT status.

If the third-party (3rdPty) bit is set to 1, the logical unit is reserved for the SCSI device specified in the third-party device ID field. This option is called as a third-party reservation. It is intended for use in multiple-initiator systems. If the 3rdPty bit is set to 0, the specified logical unit is reserved for the initiator which issued the RESERVE command.

An initiator that holds a current reservation may modify that reservation by issuing another RESERVE command to the same logical unit. The superseding RESERVE command releases the previous reservation state when the new reservation request is granted.

RELEASE 17H

FUNCTION

Releases a specified logical unit from the reservation state.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (17H)							
1	Logical Unit Number			3rdPty	Third Party Device ID			Rsrvd
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved						Flag	Link

EXPLANATION

The RELEASE command is used to release the specified logical unit which was previously reserved by the initiator. An attempt to release the logical unit which is not in the reservation state is not considered as an error. In this case, the SMO-E501 returns a GOOD status.

When the logical unit is reserved using the third-party reservation option, the initiator that issued the RESERVE command with the third-party reservation option has to release the logical unit using the third-party release option. If the third-party (3rdPty) bit is set to 1, the reservation of the logical unit for the initiator specified in the third-party device ID field is released. This option is called third-party release. If the 3rdPty bit is set to 0, the reservation of the logical unit for the initiator which issued the RELEASE command is released.

FUNCTION

Copies data from a specified area of the logical unit (medium) to another area of the same logical unit.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (18H)							
1	Logical Unit Number			Reserved				
2	Parameter List Length (MSB)							
3	Parameter List Length							
4	Parameter List Length (LSB)							
5	Rsrvd	ErsCntl	Reserved				Flag	Link

EXPLANATION

The COPY command provides a means to copy data from one area of the logical unit to another area of the same logical unit. The SMO-E501 does not support copies to or from another SCSI device, nor third party copies. The parameter list length specifies the length in bytes of the COPY parameter list that will be transferred in the DATA OUT phase. A parameter list length of 0 indicates that no data is transferred. This condition is not considered as an error. The COPY parameter list begins with a four-byte header that contains the COPY function code and priority. Following the header is zero, one, or more segment descriptor(s). In the SMO-E501 one segment consists of 16 bytes and a maximum of 256 segment descriptors are permitted, and the parameter list length has to be 0 or 4+16*n (n=0, 1, ..,256).

An erase control (ErsCntl) bit* of 0 causes the automatic erase operation before the writing of the data. An ErsCntl bit of 1 suppress the erase operation. When this option is used, the initiator has to erase the area where the write operation is to be done using ERASE command before this command.

* This bit is a vendor unique-bit.

If the AWRE bit is set to 1, and the specified block is detected as defective during the write operation of this command (in this case, ID error, tracking failure, or focus failure due to the medium defect), then the automatic write reallocation occurs.

The format of the COPY parameter list is as follows:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
COPY Header								
0	Copy Function Code (02H)					Priority (00H)		
1	Reserved							
2	Reserved							
3	Reserved							
Segment Descriptor(s)								
0 | 15	Segment Descriptor 0							
16 | 31	Segment Descriptor 1							
|	|							
A | B	Segment Descriptor n							

A = 16 * n, B = 16 * n + 15

The copy function code and the priority has to be 02H (COPY transfers among direct-access devices) and 00H respectively. The format for the segment descriptors is as follows:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Source Address			DC	Rsrvd	Source LUN		
1	Destination Address			Reserved		Destination LUN		
2	Reserved							
3	Reserved							
4	Number of Blocks (MSB)							
5	Number of Blocks							
6	Number of Blocks							
7	Number of Blocks (LSB)							
8	Source Logical Block Address (MSB)							
9	Source Logical Block Address							
10	Source Logical Block Address							
11	Source Logical Block Address (LSB)							
12	Destination Logical Block Address (MSB)							
13	Destination Logical Block Address							
14	Destination Logical Block Address							
15	Destination Logical Block Address (LSB)							

The source address and destination address fields specify the SCSI devices and the source LUN and destination LUN specify the logical units used for this segment of the COPY command. In the SMO-E501 the source address and destination address have to contain the same SCSI ID of the target that receives the COPY command. The destination count(DC) bit of 1 directs the SCSI controller to use the number of blocks(byte 4 through 7) with the value of the destination logical unit. The DC bit of 0 directs the SCSI controller to use the number of blocks with the value of the source logical unit.

FUNCTION

Reads medium or drive unit parameters.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (1AH)							
1	Logical Unit Number			PF	Reserved			
2	PC		Page Code					
3	Reserved							
4	Allocation Length							
5	Reserved						Flag	Link

EXPLANATION

The MODE SENSE command provides a means for the initiator to read the medium or drive unit parameters. The allocation length field specifies the number of bytes that the initiator has allocated for the returned MODE SENSE data. An allocation length of 0 indicates that no MODE SENSE data has been transferred. This condition is not considered as an error. The SMO-E501 transfers allocation length bytes or all available MODE SENSE data, whichever is less.

A page format (PF) bit of 1 indicates that the MODE SENSE data is transferred in the format specified by the page control (PC) field and the page code field of the CDB. The PC field defines the type of parameter values to be returned as follows. In case of a PF bit of 0, the PC and page code field have the same meaning as in case of a PF bit of 1.

bit 7	bit 6	Type of parameter Values
0	0	Current Values
0	1	Changeable Values
1	0	Default Values
1	1	Saved Values

The page code field specifies which page or pages are to be returned. The page code 01H, 02H and 20H are available for the SMO-E501. If 3FH is specified as a page code, all the pages

(01H, 02H and 20H) are sent to the initiator. In case of the page code of 0, all the pages are sent to the initiator as same as with the page code of 3FH. If the Format Mode is 3 and Page Control (PC) field bits are 11 for Saved Values, only page code 20H can be used.

The MODE SENSE data contains a four-byte header, followed by zero or more pages.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Sense Data Length							
1	Medium Type (00H)							
2	WP	Reserved						
3	Block Descriptor Length (00H)							
Page(s)								
0	PS	Rsrvd	Page Code					
1	Page -Specific Parameter Length							
2 | n	Page-Specific Parameters							

The sense data length specifies the length in bytes of the following MODE SENSE data. The medium type field always returns 0 (default medium type). A write protected (WP) bit of 1 indicates that the medium is write protected. A WP bit of 0 indicates that the medium is write enabled. The parameters saveable (PS) bits of each page header are set to 1 to indicate that the supported parameters can be saved to the medium by the SMO-E501. Refer to the MODE SELECT command for detailed information about each page.

START/STOP UNIT 1BH

FUNCTION

Starts or stops rotating the medium, and/or ejects the medium from the drive unit.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (1BH)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved						Eject	Start
5	Reserved						Flag	Link

EXPLANATION

This command is used to start or stop rotating the medium inside the drive unit, and/or to eject the medium from the specified logical unit. A start bit of 1 requests the SMO-E501 to start rotating the medium. A start bit of 0 requests the SMO-E501 to stop rotating the medium. An eject bit* of 1 indicates that the medium is to be unloaded if the start bit is 0. If both the eject bit and the start bit are set to 1, the START/STOP UNIT command returns the CHECK CONDITION status.

* The specification of this bit is based on SCSI-2 draft. This bit is not defined in *ANSI X3.131-1986* or *CCS Rev 4B.*

FUNCTION

Requests analysis data to be sent to the initiator.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (1CH)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Allocation Length (MSB)							
4	Allocation Length (LSB)							
5	Reserved						Flag	Link

EXPLANATION

The RECEIVE DIAGNOSTIC RESULTS command requests analysis data be sent to the initiator after completion of a SEND DIAGNOSTIC command. The allocation length specifies the number of bytes that the initiator has allocated for returned diagnostic data. An allocation length of 0 indicates that no DIAGNOSTIC data* is to be transferred. This condition is not considered as an error. The SMO-E501 transfers allocation length bytes or all available DIAGNOSTICS data (20 bytes), whichever is less.

The DIAGNOSTIC data is returned in the following format:

* This data is a vendor unique data.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Parameter Length (13H)							
1	Reserved							
2	Error Source				Reserved			
3	Test 7	Test 6	Test 5	Test 4	Test 3	Test 2	Test 1	Test 0
4	Internal Error Code fot Test 0 (MSB)							
5	Internal Error Code fot Test 0 (LSB)							
6	Internal Error Code fot Test 1 (MSB)							
7	Internal Error Code fot Test 1 (LSB)							
8	Internal Error Code fot Test 2 (MSB)							
9	Internal Error Code fot Test 2 (LSB)							
10	Internal Error Code fot Test 3 (MSB)							
11	Internal Error Code fot Test 3 (LSB)							
12	Internal Error Code fot Test 4 (MSB)							
13	Internal Error Code fot Test 4 (LSB)							
14	Internal Error Code fot Test 5 (MSB)							
15	Internal Error Code fot Test 5 (LSB)							
16	Internal Error Code fot Test 6 (MSB)							
17	Internal Error Code fot Test 6 (LSB)							
18	Internal Error Code fot Test 7 (MSB)							
19	Internal Error Code fot Test 7 (LSB)							

The Error Source contains information about the failure source. Bit 0 to 7 of the byte 3 (Test 0 to Test 7) contains each diagnostic result. A Test n (n=0, 1, ..7) of 1 indicates that a specified diagnostic test fails. A Test n of 0 indicates that it passes successfully. Bytes 4 to 15 contain each Internal Error Code from the specified logical unit that gives more detailed information about the failure. The Internal Error Code for Test 0 (byte 4) corresponds to the test result, Test 0.

The Error Source and Internal Error Code are explained in Appendix A. (Refer to Appendix A for details)

FUNCTION

Requests the SMO-E501 to perform diagnostic tests.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (1DH)							
1	Logical Unit Number			Reserved		SelfTest	DevOfL	UnitOfL
2	Reserved							
3	Parameter List Length (LSB)							
4	Parameter List Length (LSB)							
5	Reserved						Flag	Link

EXPLANATION

The SEND DIAGNOSTIC command requests the SMO-E501 to perform diagnostic tests on the SCSI controller block, on the drive block, or on both. This command should be followed by a RECEIVE DIAGNOSTIC RESULTS command, except when the self test (SelfTest) bit is 1. The parameter list length specifies the length in bytes of the SEND DIAGNOSTIC parameter list* that is transferred during the DATA OUT phase. A parameter list length of 0 indicates that no data is transferred. This condition is not considered as an error. A logical unit off line (UnitOfL) bit of 1 enables write operations on user medium or operations that affect user visible medium positioning. A SCSI device off-line (DevOfL) bit of 1 enables diagnostic operations that adversely affect operations to the logical unit on the SMO-E501. A SelfTest bit of 1 directs the SMO-E501 to complete its default self test. If the self test is requested, the parameter list length has to be set to 0. If the self test successfully passes, the command is terminated with a GOOD status; otherwise, the command is terminated with a CHECK CONDITION status and, if extended sense is requested, the sense key will be set to HARDWARE ERROR. A SelfTest of 0 directs the SMO-E501 to perform a specified diagnostic test, then the parameter list length has to be set to 6.

* This parameter list is a vendor unique parameter list.

The default self test (SelfTest=1) in the SMO-E501 performs the following diagnostic operations sequentially:

Step	Description
0	SCSI controller block Self Diagnostics
1	Drive block Self Diagnostics
2	Drive Functional Diagnostics
3	Disk Access Diagnostics

The function in each diagnostic operation is explained in the advanced diagnostics in detail.

The advanced diagnostic test is invoked when the initiator sets the SelfTest bit to 0 and sends the SEND DIAGNOSTIC parameter list. The format of the SEND DIAGNOSTIC parameter list is as follows:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Subcommand Code							
1	Reserved							
2	Loop Count							
3	Test 7	Test 6	Test 5	Test 4	Test 3	Test 2	Test 1	Test 0
4	Reserved							
5	Reserved							

The Subcommand Code is used for selecting a particular diagnostics. Effective subcommands are:

Subcommand Code	Description
00H	SCSI controller block Self Diagnostics
01H	Drive block Self Diagnostics
02H	Drive Functional Diagnostics
03H	Disk Access Diagnostics

The Loop Count contains the number of repetition times of the diagnostics. In case of Loop Count 00H, it means 256 repetitions. From Test 0 through Test 7, a bit of 1 direct the SMO-E501 to skip the specified test, a bit of 0 directs to perform the specified test. The meaning of Test n (n=0, 1, ..7) is defined individually for each subcommand.

Subcommand 00H SCSI controller block Self Diagnostics

Test procedures in the SCSI controller block Self Diagnostics are:

Step	Description
0	ROM (ECP-X.XX) Test
1	RAM Test
2	HIC (Host Interface Controller) Chip Test
3	BMM (Buffer Memory Manager) Chip Test
4	DIC (Drive Interface Controller) Chip Test
5	ECC (ECC processor) Chip Test
6	Buffer Memory Test
7	Reserved

Subcommand 01H Drive block Self Diagnostics

Test procedures in the Drive block Self Diagnostics are:

Step	Description
0	Stop Spindle Test
1	DCN (Drive Control block) Test
2	ACN (Analog Control block) Test
3	BCN (Bias magnet Control block) Test
4	Reserved
5	Reserved
6	Reserved
7	Reserved

Subcommand 02H Drive Functional Diagnostics

Test procedures in the Drive Functional Diagnostics are:

Step	Description
0	Stop Spindle Test
1	Start Spindle Test
2	Select ROM Mode Test
3	Select MO Mode Test
4	High Order Seek Test
5	Seek Test
6	Magnet Erase Mode Test
7	Magnet Write Mode Test

Subcommand 03H Disk Access Diagnostics

Test procedures in the Disk Access Diagnostics are:

Step	Description
0	Inner SFP Read Test
1	Inner Manufacturer Zone Erase/Write/Read Test
2	Reserved
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved

PREVENT/ALLOW MEDIUM REMOVAL 1EH

FUNCTION

Prevents or allows removal of the medium in the logical unit.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (1EH)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							Prevent
5	Reserved						Flag	Link

EXPLANATION

The PREVENT/ALLOW MEDIUM REMOVAL command requests that the SMO-E501 enables or disables the removal of the medium in the drive unit. When the prevent bit is set to 0, this command allows removal of the medium. If the prevent bit is set to 1, it inhibits removal of the medium. When medium removal is inhibited, the eject button of the drive unit is disabled and a START/STOP UNIT command with its eject bit set to 1 returns the CHECK CONDITION status.

The prevention of medium removal condition terminates upon receipt of a PREVENT/ALLOW MEDIUM REMOVAL command with the prevent bit set to 0, or by the receipt of a BUS DEVICE RESET message from any initiator or a RESET condition.

READ CAPACITY 25H

FUNCTION

Reads capacity of the medium.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (25H)							
1	Logical Unit Number			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Reserved							
8	Reserved							PMI
9	Reserved						Flag	Link

EXPLANATION

The READ CAPACITY command provides a means for the initiator to request information regarding the capacity of the logical unit. The last logical block address of the medium and the length of the logical block are returned. The partial medium indicator (PMI) bit has no effect on the returned data in the SMO-E501. When the PMI bit is set to 0, the logical block address in the CDB must be set to 0. When the PMI bit is set to 1, the logical block address in the CDB does not need to be set to 0. The capacity of the logical unit depends on the format mode and the sector size of the medium.

The READ CAPACITY data format is as follows.

Byte	Description
0	Logical Block Address (MSB)
1	Logical Block Address
2	Logical Block Address
3	Logical Block Address (LSB)
4	Block Length (MSB)
5	Block Length
6	Block Length
7	Block Length (LSB)

The block length field contains the length of the specified block in bytes.

FUNCTION

Reads data from the specified logical block address.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (28H)							
1	Logical Unit Number			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Reserved						Flag	Link

EXPLANATION

The READ command requests the SMO-E501 to read the data from the medium and then transfer the data to the initiator. The logical block address field specifies the logical block at which the read operation begins. The transfer length field specifies the number of contiguous logical blocks of data to be transferred. A transfer length of 0 indicates that no logical blocks are transferred. This condition is not considered as an error. Any other value indicates the number of logical blocks to be transferred. Unless the RC bit of the mode select parameters is set to 1, the data read from the medium is corrected by the ECC.

The function of this command is exactly the same as that of the Group 0 READ command (08H). However, the transfer length can be specified in 16 bits, and the relative addressing is available for this command.

FUNCTION

Executes erase operation from the specified logical block address.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (29H)							
1	Logical Unit Number			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Block Length (MSB)							
8	Block Length (LSB)							
9	Reserved						Flag	Link

EXPLANATION

The ERASE command requests the SMO-E501 to execute erase operation. The logical block address field specifies the logical block at which the erase operation begins. The block length field specifies the number of contiguous logical blocks to be erased. A transfer length of 0 indicates that no logical blocks are erased. This condition is not considered as an error. Any other value indicates the number of logical blocks to be erased.

If the AWRE bit is set to 1, and the specified block is detected as defective during the erase operation of this command (in this case, ID error, tracking failure, or focus failure due to the medium defect), then the automatic reallocation occurs.

This command is for the initiator which uses the write-type command with its erase control bit set to 1. The block length can be specified in 16 bits, and the relative addressing is available for this command.

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* This command is a vendor unique command.

FUNCTION

Writes data to the specified logical block address.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (2AH)							
1	Logical Unit Number			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Rsrvd	ErsCntl	Reserved				Flag	Link

EXPLANATION

The WRITE command requests the SMO-E501 to write data to the medium. The logical block address field specifies the logical block at which the write operation begins. The transfer length field specifies the number of contiguous logical blocks of data to be transferred. A transfer length of 0 indicates that no logical blocks are transferred. This condition is not considered as an error. Any other value indicates the number of logical blocks to be transferred. When this command is performed, the SMO-E501 automatically adds the error correction code (ECC) to each logical block data and then writes to the medium.

Before the writing of the data, an erase control (ErsCntl) bit* of 0 induces the automatic erase operation — usually, this is the option used. An ErsCntl bit of 1 suppresses the erase operation. This option is for the application in which the fast writing speed is needed. When this option is used, the initiator has to erase the area where the write operation is to be done using ERASE command before the WRITE command is executed.

* This bit is a vendor unique bit.

If the AWRE bit is set to 1, and the specified block is detected as defective during the write operation of this command (in this case, ID error, tracking failure, or focus failure due to the medium defect), then the automatic write reallocation occurs.

The function of this command is exactly the same as that of the Group 0 WRITE command (0AH). However, the transfer length can be specified in 16 bits, and the relative addressing is available for this command.

FUNCTION

Moves the optical head to the physical track where the specified logical block exists.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (2BH)							
1	Logical Unit Number			Reserved				
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Reserved							
8	Reserved							
9	Reserved						Flag	Link

EXPLANATION

The SEEK command requests the drive unit to move the optical head to the physical track where the specified logical block exists. This function is exactly the same as that of Group 0 SEEK command (0BH).

WRITE AND VERIFY 2EH

FUNCTION

Writes data to the medium and then verifies the written data by checking the error correction code.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (2EH)							
1	Logical Unit Number			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Rsrvd	ErsCntl	Reserved				Flag	Link

EXPLANATION

The WRITE AND VERIFY command requests the SMO-E501 to write data to the medium and then verify the written data by checking the error correction code (ECC). The logical block address field specifies the logical block at which the write operation begins. The transfer length field specifies the number of contiguous logical blocks of data to be transferred. A transfer length of 0 indicates that no logical blocks are transferred. This condition is not considered as an error. Any other value indicates the number of logical blocks to be transferred. During the write operation, the SMO-E501 automatically adds the ECC to each logical block data. Verification is performed by reading written data and checking the ECC.

Before the writing of the data, an erase control (ErsCntl) bit* of 0 induces the automatic erase operation --- usually, this is the option used. An ErsCntl bit of 1 suppress the erase operation. This option is for the application in which the fast writing speed is needed. When this option is used, the initiator has to erase the area where the write operation is to be done using ERASE command before the WRITE AND VERIFY command is executed.

* This bit is a vendor unique bit.

If the AWRE bit is set to 1, and the specified block is detected as defective during the write operation of this command (in this case, ID error, tracking failure, or focus failure due to the medium defect), then the automatic write reallocation occurs. Furthermore, if the verify error is detected during its verification process, the SMO-E501 also reallocates the alternative block automatically. The verification error threshold is set about half of the error correction capability of the SMO-E501.

FUNCTION

Verifies the data starting from the specified logical block address by checking the error correction code.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (2FH)							
1	Logical Unit Number			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Verification Length (MSB)							
8	Verification Length (LSB)							
9	Reserved						Flag	Link

EXPLANATION

The VERIFY command requests the SMO-E501 to verify the written data by checking the error correction code (ECC). The logical block address field specifies the logical block at which the verification begins. The verification length field specifies the number of contiguous logical blocks of data to be verified. A verification length of 0 indicates that no logical blocks are verified. This condition is not considered as an error. Any other value indicates the number of logical blocks to be verified.

The verification error threshold is set about half of the error correction capability of the SMO-E501.

FUNCTION

Reads the medium defect information

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (37H)							
1	Logical Unit Number			Reserved				
2	Reserved			PList	GList	Defect List Format		
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Allocation Length (MSB)							
8	Allocation Length (LSB)							
9	Reserved						Flag	Link

EXPLANATION

The READ DEFECT DATA command requests that the SMO-E501 transfer the medium defect data to the initiator. The allocation length field specifies the number of bytes that the initiator has allocated for the returned READ DEFECT DATA. An allocation length of 0 indicates that no READ DEFECT DATA is transferred. This condition is not considered as an error. The SMO-E501 transfers allocation length bytes or all available READ DEFECT DATA, whichever is less.

A P list (PList) bit of 1 requests the SMO-E501 to return a primary list of defects. A G list (GList) bit of 1 requests the SMO-E501 to return a grown list of defects. The defect list format field specifies the format of the defect list returned. This command returns the defect lists depending on the effective format mode of the medium, not depending the current format mode. If the effective format mode of the media is 0 or 1, only the PList can be available when it exists in the CDA. If the effective format mode of the medium is 2, the PList corresponds to the defect list recorded in the CDA, and the GList corresponds to the defect list recorded in the DTA. If the effective format mode is 3, the PList corresponds to the defect list recorded in the PDL, and the GList corresponds the defect list recorded in the PDL+SDL. But only the

physical sector format is available for the READ DEFECT DATA command. Available combination of the parameters are as follows:

PList (bit 4)	GList (bit 3)	Defect List Format (bit 2)	(bit 1)	(bit 0)	Description
1	0	1	0	1	P list is sent in physical format.
0	1	1	0	1	G lists is sent in physical format.
All other codes					Reserved

The READ DEFECT DATA contains a four-byte header followed by zero or more defect descriptors. Refer to the FORMAT UNIT command for the description of the defect descriptor. The READ DEFECT DATA header is as follows:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reserved							
1	Reserved			PList	GList	Defect List Format		
2	Defect List Length (MSB)							
3	Defect List Length (LSB)							

The PList, GList and defect list format field have the same meaning as that of CDB. The defect list length specifies the total length in bytes of the defect descriptors that follow.

FUNCTION

Copies data from a specified area of the logical unit to another area of the same logical unit and then verifies the written data by checking the error correction code.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (3AH)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Parameter List Length (MSB)							
4	Parameter List Length							
5	Parameter List Length (LSB)							
6	Reserved							
7	Reserved							
8	Reserved							
9	Rsrvd	ErsCntl	Reserved				Flag	Link

EXPLANATION

The COPY AND VERIFY command performs the same function as the COPY command, except that a verification of the data written to the destination logical unit is performed after the data is written. The parameter list transferred to the SMO-E501 is the same as for the COPY command. This parameter list contains the information to identify the logical units involved in the copy and the length of the copy. (See the description in the COPY command for additional information about the parameter list)

If the AWRE bit is set to 1, and the specified block is detected as defective during the write operation of this command (in this case, ID error, tracking failure, or focus failure due to the medium defect), then the automatic write reallocation occurs. Furthermore, if the verify error is detected during its verification process, the SMO-E501 also reallocates the alternative block automatically. The verification error threshold is set about half of the error correction capability of the SMO-E501.

FUNCTION

Writes data to the data buffer of the SMO-E501.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (3BH)							
1	Logical Unit Number			Reserved				BCV
2	Reserved							
3	Reserved							
4	Buffer Offset (MSB)							
5	Buffer Offset (LSB)							
6	Reserved							
7	Byte Transfer Length (MSB)							
8	Byte Transfer Length (LSB)							
9	Reserved						Flag	Link

EXPLANATION

Normally, this command is used in conjunction with the READ BUFFER command to test the data buffer memory of the SMO-E501 and the SCSI bus integrity. The transfer data consists of a four-byte header and the WRITE BUFFER data. Transfer data length is specified by the byte transfer length field. A byte transfer length of 0 indicates that no Write Buffer Header and no WRITE BUFFER data is transferred. This condition is not considered as an error. As maximum transfer data length is 65535 bytes, up to 65531 bytes of WRITE BUFFER data can be transferred. A buffer control valid (BCV) bit of 0 indicates that the WRITE BUFFER data is stored in the buffer memory starting from address 0. In this case, the buffer offset field must be set to 0. When the BCV bit is set to 1, the buffer offset field indicates the starting address of the buffer memory where the WRITE BUFFER data is written. The SMO-E501 has the 65536 bytes of buffer memory. If the written data exceeds address 65535, the exceeded data is written from address 0 continuously. The Write Buffer Header is as follows:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							

FUNCTION

Reads data form the data buffer of the SMO-E501.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (3CH)							
1	Logical Unit Number			Reserved				BCV
2	Reserved							
3	Reserved							
4	Buffer Offset (MSB)							
5	Buffer Offset (LSB)							
6	Reserved							
7	Byte Transfer Length (MSB)							
8	Byte Transfer Length (LSB)							
9	Reserved						Flag	Link

EXPLANATION

Normally, this command is used in conjunction with the WRITE BUFFER command to test the data buffer memory of the SMO-E501 and the SCSI bus integrity. The transfer data consists of a four-byte header and the READ BUFFER data. Transfer data length is specified by the byte transfer length field. A byte transfer length of 0 indicates that no Read Buffer Header and no READ BUFFER data is transferred. This condition is not considered as an error. As maximum transfer data length is 65535 bytes, up to 65531 bytes of READ BUFFER data can be transferred. A buffer control valid (BCV) bit of 0 indicates that the READ BUFFER data is read from the address 0 of the buffer memory. In this case, the buffer offset field must be set to 0. When this bit is set to 1, the READ BUFFER data is read from the address specified by the byte offset field. The SMO-E501 has the 65536 bytes of buffer memory. If the address of the transfer data exceeds 65535, data is read from address 0 continuously. The Read Buffer Header is as follows:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reserved							
1	Reserved							
2	Available Length (MSB)							
3	Available Length (LSB)							

The available length field indicates the available READ BUFFER data length in bytes. The SMO-E501 always returns 65531 for this.

FUNCTION

Reads data from the specified logical block address with ECC data.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (3EH)							
1	Logical Unit Number			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Reserved						Flag	Link

EXPLANATION

The READ LONG command requests the SMO-E501 to read the data and error correction code (ECC) from the medium and transfer the data and ECC information to the initiator. The logical block address field specifies the logical block at which the read operation begins. The transfer length field specifies the number of contiguous logical blocks of data and ECC information to be transferred. A transfer length of 0 indicates that no data is transferred. This condition is not considered as an error. Any other value indicates the number of logical blocks to be transferred. The READ LONG command does not correct the data with the ECC. When the logical block length is 1024 (512) bytes, the length of ECC information is 176** (98) bytes

* The definition of this command is different from that of *CCS Rev 4B*.

** This value includes the ECC, CRC and control bytes.

FUNCTION

Writes data to the specified logical block address without using the ECC generation circuitry.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (3FH)							
1	Logical Unit Number			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Rsrvd	ErsCntl	Reserved				Flag	Link

EXPLANATION

The WRITE LONG command requests the SMO-E501 to write data onto the medium without using the ECC generating circuitry of the SMO-E501. The logical block address field specifies the logical block at which the write operation begins. The transfer length field specifies the number of contiguous logical blocks of data and ECC information to be transferred. A transfer length of 0 indicates that no data is transferred. This condition is not considered as an error. Any other value indicates the number of logical blocks of data and ECC information to be transferred. As the SMO-E501 does not generate the ECC information, the initiator has to send the ECC information properly. When the logical block length is 1024** (512) bytes, the length of ECC information is 176 (98) bytes.

Before the writing of the data, an erase control (ErsCntl) bit*** of 0 causes the automatic erase operation --- usually, this is the option used. An erase control bit of 1 suppress the

---

* The definition of this command is different from that of *CCS Rev 4B.*

** This value includes the ECC, CRC and control bytes.

*** This bit is a vendor unique bit.

erase operation. This option is for the application in which the fast writing speed is needed. When this option is used, the initiator has to erase the area where the write operation is to be done using the ERASE command before the WRITE LONG command is executed.

If the AWRE bit is set to 1, and the specified block is detected as defective during the write operation of this command (in this case, ID error, tracking failure, or focus failure due to the medium defect), then the automatic write reallocation occurs.

APPENDIX A INTERNAL ERROR CODE

The Internal Error Code (IEC) which is returned by the RECEIVE DIAGNOSTIC RESULTS command consists of 2 bytes (16 bits) and identifies the failure in detail. In the Internal Error Code, there are three types of code depending on the specified diagnostic function. The meaning of each code is as follows:

SCSI controller block Self Diagnostics (Type 0)

IEC	Description
0100H	ROM (ECP) Test Failure
0200H	RAM Test Failure (pattern=FFH)
0300H	RAM Test Failure (pattern=00H)
0400H	HIC (Host Interface Controller) Chip Test Failure
05XXH	BMM (Buffer Memory Manager) Chip Test Failure
06XXH	DIC (Drive Interface Controller) Chip Test Failure
07XXH	ECC (ECC Processor) Chip Test Failure
08XXH	Buffer Memory Test Failure

Drive block Self Diagnostics (Type 1)

IEC	Description
12XXH	ROM (EDP)Test Failure
13XXH	RAM Test Failure
18XXH	IOP (I/O Processor) Chip Failure
19XXH	MDA (Mod/Demod & Address decoder) Chip Failure
21XXH	Focus Servo Failure
22XXH	Tracking Servo Failure
23XXH	Slide Servo Failure
24XXH	Spindle Servo Failure
25XXH	ACN (Analog Control block) Voltage checking Failure
31XXH	BCN (Bias magnet Control block) Board Failure

Drive Functional Diagnostics & Disk Access Diagnostics (Type 2)

The Internal Error Code consists of three fields as follows:

Bit 15-12	Error Source
	Bit 15 : Host
	Bit 14 : SCSI controller block

Bit 13 : Drive block

Bit 12 : Media

Bit 11-10 Error Level

00 : Recovered Error

01 : Recoverable Error 1

10 : Recoverable Error 2

11 : Unrecoverable Error

Bit 9-0 Error Code

Error Code	Description
101H	ECC error more than 0 byte in any interleave
102H	ECC error more than 1 byte in any interleave
103H	ECC error more than 2 byte in any interleave
104H	ECC error more than 3 byte in any interleave
105H	ECC error more than 4 byte in any interleave
106H	ECC error more than 5 byte in any interleave
107H	ECC error more than 6 byte in any interleave
108H	ECC error more than 7 byte in any interleave
109H	ECC error more than 8 byte in any interleave
201H	Address not detected (no address)
202H	Address not detected (<=1)
203H	Address not detected (<=2)
204H	Illegal interrupt occurred (wait for no INT)
205H	Illegal interrupt occurred (wait for start INT)
206H	Illegal interrupt occurred (wait for end INT)
207H	Illegal interrupt occurred (wait for syndrome INT)
208H	Illegal time out (wait for no INT)
209H	Illegal time out (unknown INT state)
20AH	Micro hung up (before end INT)
20BH	Micro hung up (before syndrome INT)
20CH	SEQSTOP not become
20FH	Write protect error
300H	Write fault (ESDI)
301H	Interface fault, Write fault (ESDI)
302H	Seek fault
303H	Unimplemented command fault (ESDI)
304H	Invalid command fault (ESDI)

305H	Interface fault (ESDI)
306H	Parity fault (ESDI)
307H	Coarse seek failure
308H	Focus failure, Coarse seek failure
309H	Not track following
30AH	Not track following, Tracking failure
30BH	Not track following, Focus failure
30CH	Tracking failure
30DH	Focus failure, Tracking failure
30EH	Focus failure
30FH	Focus failure, Not track following, Tracking failure
310H	Phase lock/Tracking failure
311H	Not on correct track
312H	Not track following, Spindle not at speed failure
313H	Not track following, Tracking failure, Spindle not at speed failure
314H	Not track following, Focus failure, Spindle not at speed failure
315H	Tracking failure, Spindle not at speed failure
316H	Focus failure, Tracking failure, Spindle not at speed failure
317H	Focus failure, Spindle not at speed failure
318H	Focus failure, Not track following, Tracking failure, Spindle not at speed failure
319H	Spindle not at speed failure
31AH	Spindle not at speed failure, Write was terminated
31BH	Not track following, Tracking failure, Write was terminated
31CH	Not track following, Tracking failure, Spindle not at speed failure, Write was terminated
31DH	Tracking failure, Write was terminated
31EH	Tracking failure, Spindle not at speed failure, Write was terminated
31FH	Focus failure, Tracking failure, Spindle not at speed
320H	Focus failure, Tracking failure, Spindle not at speed failure, Write was terminated
321H	Focus failure, Not track following, Tracking failure, Spindle not at speed failure

322H	Focus failure, Not track following, Tracking Failure, Spindle not at speed failure, Write was terminated
323H	Load/Unload failure
324H	Sensor failure
325H	Drive block initialization failure
326H	Bias magnet failure
327H	Temperature alarm 1
328H	Focus over current failure 1
329H	Tracking over current failure 1
32AH	Spindle motor stopping failure
32BH	LD driver IL failure
32CH	LD driver IL failure, LD erase power failure
32DH	LD driver IL failure, LD erase power failure, LD read power failure
32EH	PEP optical pickup positioning error
32FH	PEP focus failure
330H	PEP searching gap time-out error
331H	PEP data capturing time-out error
332H	PEP Syncing data error
333H	PEP unexpected gap/EOD error
334H	PEP decoded byte count error
335H	PEP CRC error
336H	Temperature alarm 2
337H	Focus over current failure 2
338H	Tracking over current Failure 2
339H	LD erase power failure
33AH	LD read power failure
33BH	No active media present
33CH	Media type not supported
380H	Req/Ack handshake time-out error 0 (ESDI)
381H	Req/Ack handshake time-out error 1 (ESDI)
382H	Req/Ack handshake time-out error 2 (ESDI)
383H	Req/Ack handshake time-out error 3 (ESDI)
384H	Parity error on CONFIG/STSTUS DATA-(ESDI)
385H	Drive not Selected on
386H	Multiple drives selected
387H	Drive not selected off

388H	Drive not ready
389H	Command complete negated before sending command (ESDI)
38AH	Command complete time-out error (ESDI)
38BH	Command complete not negated after sending command (ESDI)
38CH	Attention after command execution cannot recover (ESDI)
38DH	Attention before command execution cannot recover (ESDI)
38EH	Invalid status bit in optical standard status
38FH	Search error in optical disk standard status
390H	Invalid status bit in optical device status
391H	Search error in optical device status
392H	No error status available
393H	Search error in optical disk extended status

Disk Management Explanation

EDITION I

PRINTING HISTORY

September,1990	edition 1.0	This version corresponds to ECP-1.01 that supports the ISO standard defect management scheme for 130mm Rewritable Optical Disks.

SECTION 1 INTRODUCTION

This document describes how the SONY Magneto Optical Disk Drive SMO-E501 manages the disk logically. The following topics are included in this document.

- Format modes
- Defect management strategies
- Logical format of the disk
- SCSI commands for disk management

For the complete SCSI specification of the SMO-E501, refer to the *SMO-E501 SCSI Specification* .

Throughout this document, the sector number and the byte offset of the sector is that of 1024 bytes/sector medium. The value of the 512 bytes/sector medium is written inside parentheses "( )" right after the value of 1024 bytes/sector medium.

SECTION 2 FORMAT MODE

The SMO-E501 supports two types of defect management schemes: these are:

-ISO standard defect management scheme for 130mm Rewritable Optical Disks
-Sony unique defect management

In order to manage the different defect management schemes, there are 4 disk-managing modes: Format Mode 0, 1, 2 and 3. Format Mode is one of the MODE SELECT/SENSE parameters specifying how the SMO-E501 manages the medium. Format Mode 0, 1, and 2 are modes used with the Sony unique defect management, and they may be useful for evaluating the drive unit or medium. Format Mode 3 is a mode which supports the ISO defect management, and is the default Format Mode of the SMO-E501. By selecting Format Mode 3, the host system can gain true compatibility, including defect management, toward the Magneto-Optical Disks that meet the 130mm Rewritable Optical Disk standard.

The SMO-E501 preserves the format mode information as MODE SELECT/SENSE parameters (Page 20H) in the internal RAM area. Normally, the format mode information is retrieved from the medium when it is spun up. If the information cannot be retrieved from the DDS (Disk Definition Structure) of the ISO scheme or the CDA (Control Data Area) of the Sony unique scheme, the previous format mode information is adopted as the current Format Mode information. Since this information is part of the MODE SELECT/SENSE parameters, it can be changed by the MODE SELECT command and examined by the MODE SENSE command.

If the current Format Mode stored in the RAM of the SMO-E501 differs from the saved Format Mode (of the medium), the SMO-E501 behaves as follows:

current Format Mode	saved Format Mode	behavior of the SMO-E501
0	0	Format Mode 0
0	1	Format Mode 0
0	2	Format Mode 0
0	3	Format Mode 0
0	4-255	Format Mode 0
0	none	Format Mode 0
1	0	Format Mode 1
1	1	Format Mode 1
1	2	Format Mode 1
1	3	Format Mode 1
1	4-255	Format Mode 1
1	none	invalid
2	0	invalid
2	1	invalid
2	2	Format Mode 2 (The Size of User Band and the Size of Spare Band have to be equal. The Type field have to be 0. Otherwise, the combination is invalid.)
2	3	invalid
2	4-255	invalid
2	none	invalid
3	0	invalid
3	1	invalid
3	2	invalid
3	3	Format Mode 3 (The size of User Band and the Size of Spare Band have to be equal. The Type field have to be 0. Otherwise, the combination is invalid.)
3	4-255	invalid
3	none	invalid

("none" means that the Format Information Sector which has the proper Sector Identifier cannot be retrieved.)

In case of invalid combination of Format Modes, CHECK CONDITION status ("MEDIUM ERROR/Medium Format Corrupted") is returned when the medium-access command (e.g. READ, WRITE, SEEK etc.) is issued to the SMO-E501.

2.1 Sony Unique Defect Management

There are 3 disk-managing modes in the Sony unique defect management scheme: Format Mode 0, 1, and 2. To identify the Sony unique defect management, there are 2 CDAs in track 0 and 2 CDAs in track 18749. The CDA may include the format information, mode information, and defect information, which will be retrieved after loading and used to specify the operational mode of the SMO-E501. Only in Format Mode 2, tracks from 2 to 3 are used for the DTA (Defect Table Area) where the defect lists are recorded.

2.1.1 Format Mode 0 (Sony Unique Mode)

For mat Mode 0 is a Sony unique mode that does not perform defect management. In Format Mode 0, the initiator can read or write any sector of the medium (track -8 through 18843) directly using the SCSI read or write commands (Fig. 2.1).

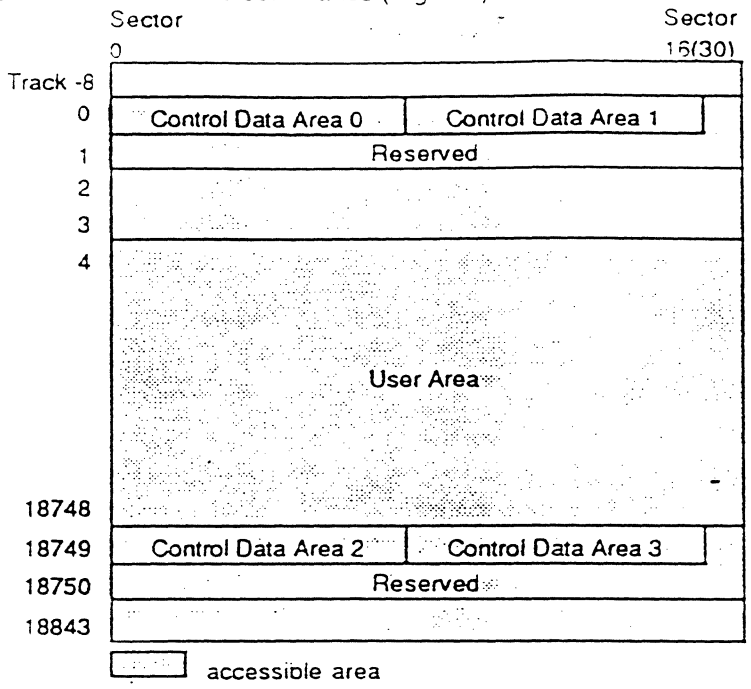

Fig. 2.1 Format Mode 0

The translation of the physical address to the logical block address (of the SCSI) is calculated with the following formula:

$$\text{logical block address} = (\text{physical track address} - 4) \times (\text{number of sectors per track}) + (\text{physical sector address})$$

The logical block address 0 is assigned to the physical track 4 sector 0, and the initiator can access from track -8 to track 18843. To gain access of tracks from -8 to 3, the group 1 medium-access commands can be used with a negative logical block address. This scheme is mainly adopted in order to prevent accidental access of the control track area including the CDA and DTA which include vital information. Format Mode 0 is a mode used for evaluating and testing the medium, drive, and SCSI controller effectively, because the initiator can access the whole area in the medium without alternation. Thus the initiator is able to obtain the raw characteristics of the medium and drive through SCSI.

2.1.2 Format Mode 1 (Sony Unique Mode)

In Format Mode 1, the initiator can directly read or write from/to any sector of the medium except the CDA and Reserved Area. In other words, the Defect Table and User Areas are accessible (Fig. 2.2).

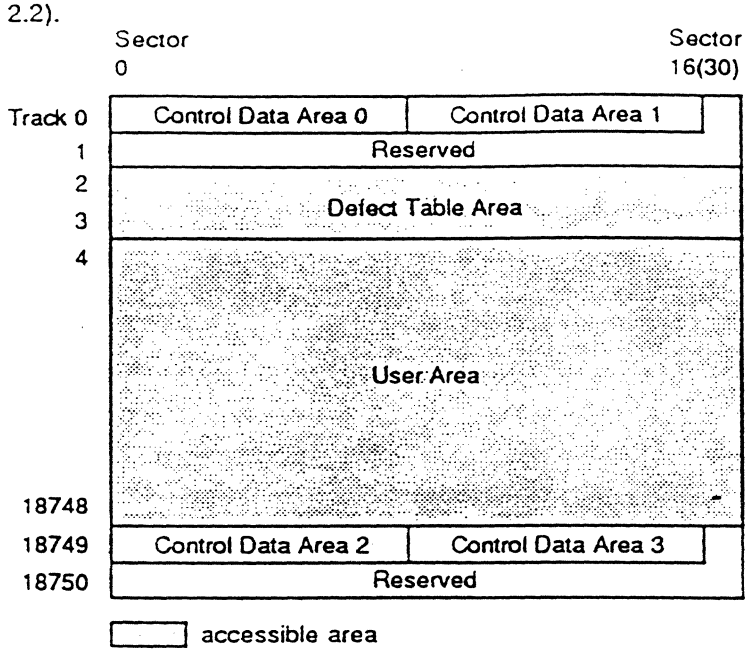

Fig. 2.2 Format Mode 1

The formula translating the physical address to the logical block address is illustrated below (same as in Format Mode 0):

logical block address = (physical track address - 4) x (number of sectors per track)
+ (physical sector address)

Using this mode, the initiator can access the DTA. Logical block address 0 is assigned to the physical track 4 sector 0, and the initiator can access from track 2 to track 18748. In order to gain access to tracks from 2 to 3 (DTA), the group 1 medium-access commands can be used with a negative logical block address. This mode may be utilized if the host system is required to manage the defective sectors by itself.

2.1.3 Format Mode 2 (Sony Unique Mode)

In Format Mode 2, the defective sectors are either reallocated automatically or via the SCSI commands from the initiator, by using the Sony unique defect management scheme. There are 2 basic algorithms in the Sony unique scheme. These are; "Sector Skipping Algorithm" and "Band Sparing Algorithm" (Refer to Section 3 for details). The medium is divided as:

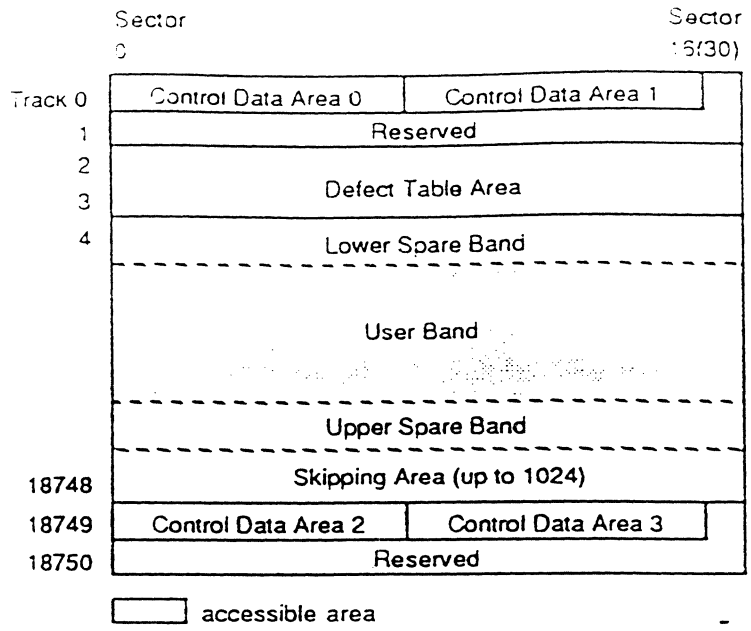

Fig. 2.3 Format Mode 2

In Fig. 2.3, there is one band in the medium. The formula utilized to translate the physical address to the logical block address is illustrated below:

logical block address = (physical track address - 4) x (number of sectors per track)
+ (physical sector address)
- ((band number - 1) x 2 + 1)x (size of spare band)
- (total number of defective sectors skipped until the physical address)

band number = 1, 2, .., N (N : number of bands)

Tracks from 2 to 3 are used for the DTA (Defect Table Area) which may include the SDT (Skipping Defect Table) and BST (Band Sparing Table). The SDT is used to store the defect list detected during the FORMAT UNIT command which may perform certification of the medium, and is used for the "Sector Skipping Algorithm". The BST is used to store the defect list detected after the FORMAT UNIT command, and is used for the "Band Sparing Algorithm". Tracks from 4 to 18748 are allocated for user and spare areas which may be divided into the user bands, spare bands, and skipping area (1024 sectors are reserved at the outer area of the disk). The size of the user and spare bands shall be specified by the initiator, using the MODE SELECT command. If the FORMAT UNIT command is issued after the MODE SELECT command, those parameters will be saved into the mode information sector in the CDA. The spare band includes alternative sectors which are detected after the formatting process of the SMO-E501 either in the event the WRITE AND VERIFY command and write-type command are used ("Band Sparing Algorithm"), or reassigned by the REASSIGN BLOCK command from the initiator.

The detailed defect management algorithm and logical structure of the disk are described in

the next section.

2.2 ISO Standard Defect Management

The SMO-E501 supports a disk-managing modes which complies with the ISO standard defect management scheme: Format Mode 3. To identify the ISO standard defect management, there are 3 definition tracks at the inner diameter and 3 at the outer diameter.

2.2.1 Format Mode 3 (ISO Standard Mode)

In Format Mode 3, the defective sectors are either reallocated automatically or via the SCSI commands from the initiator by using the ISO standard defect management scheme. The basic algorithms in the ISO standard scheme are identical to the Sony unique ones. Therefore this scheme is managed by "Sector Slipping Algorithm" and "Linear Replacement Algorithm" (Refer to Section 3 for details). The medium is divided as:

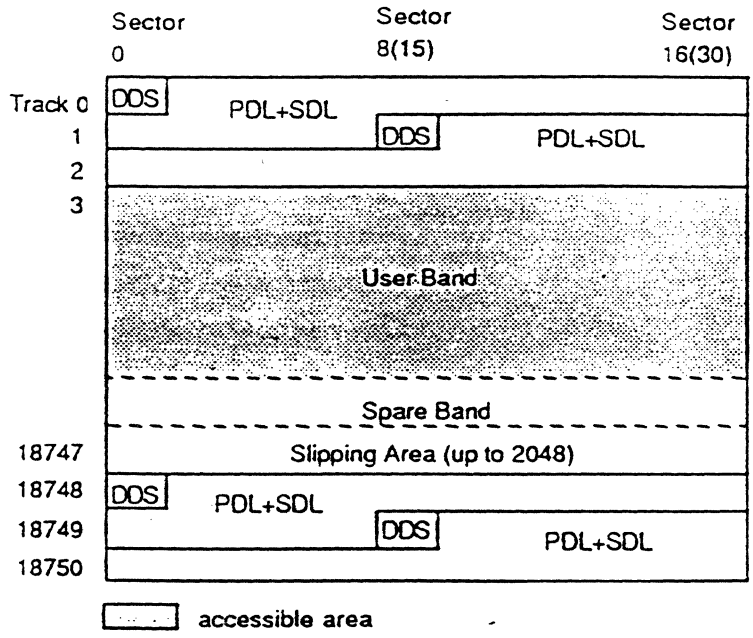

Fig. 2.4 Format Mode 3

In Fig. 2.4, there is one band in the medium. The formula translating the physical address to the logical block address is as follows:

logical block address = (physical track address - 3) x (number of sectors per track)
+ (physical sector address)
- (band number - 1) x (size of spare band)
- (total number of defective sectors skipped until the physical address)

band number = 1, 2, .., N (N : number of bands)

Definition tracks contain the DDS, PDL (Primary Defect List), and SDL (Secondary Defect List). The DDS defines the defect allocation algorithm and the way the user and spare areas are divided into data blocks and spare blocks. The PDL may include the defect list detected during the FORMAT UNIT command which may perform certification of the medium, and is used for the "Sector Slipping Algorithm". The SDL is used to store the defect list detected after the FORMAT UNIT command, and is used for the "Linear Replacement Algorithm". Tracks from 3 to 18747 are allocated as user and spare areas which may be divided into user bands, spare bands, and slipping area (2048 sectors are reserved at the outer area of the disk). The size of user band and the size of spare band shall be specified by the initiator using the MODE SELECT command. If the FORMAT UNIT command is issued after the MODE SELECT command, these parameters will be saved into the DDS. The spare band includes alternative sectors which are detected by the automatic reallocation process of the SMO-E501 either in the event the WRITE AND VERIFY command and write-type command are used ("Linear Replacement Algorithm"), or reassigned by the REASSIGN BLOCK command from the initiator.

The detailed defect management algorithm and logical structure of the disk are described in the next section.

SECTION 3 DEFECT MANAGEMENT STRATEGIES

Format Mode 2 and 3 are managed by identical algorithms which replace by reallocation a defective sector with an alternate sector.

These are:

Format Mode 2 : "Sector Skipping Algorithm", "Band Sparing Algorithm"

Format Mode 3 : "Sector Slipping Algorithm", "Linear Replacement Algorithm"

The "Sector Skipping Algorithm" is identical with the "Sector Slipping Algorithm". The "Band Sparing Algorithm" is identical with the "Linear Replacement Algorithm".

Throughout this section, these algorithms refer to Format Mode 3. In Format Mode 2, the description is placed inside the parentheses "[ ]" right after the description of Format Mode 3. The "Sector Slipping Algorithm" ["Sector Skipping Algorithm"] is utilized for defective sectors which have been known before or detected during the formatting process. The "Linear Replacement Algorithm" ["Band Sparing Algorithm"] is applied for the defective sectors which have been detected after the formatting process. The defective sector information is stored into specific areas of the disk which are called the PDL (Primary Defect List) [SDT (Skipping Defect Table)]and SDL (Secondary Defect List) [BST (Band Sparing Table)]. If a medium is loaded into the drive unit, the SMO-E501 reads the DDS, PDL, and SDL [CDA SDT, and BST] after spinning up the medium, and keeps the information in the internal RAM area. When the initiator issues the disk access command (SEEK, ERASE, WRITE, READ etc.), the SMO-E501 translates the logical block address to the intermediate address applying the "Linear Replacement Algorithm" ["Band Sparing Algorithm"], and translates the intermediate address to the physical address applying the "Sector Slipping Algorithm" ["Sector Skipping Algorithm"]. Actually, in order to reduce the processing time, both algorithms are applied at the same time in the SMO-E501.

3.1 Sector Slipping Algorithm [Sector Skipping Algorithm]

Through this algorithm, defective sectors which have been known before the FORMAT UNIT command or detected during the certification process of the FORMAT UNIT command are listed as defective, and thereafter are not used for reading or writing the data (by skipping referenced sectors). As the defective sectors are encountered, the address of the defective sector is logged into the PDL [SDT] in the form of a physical address and the next good sector becomes its replacement for the defective sector. Each time this happens, the user data area

slips one sector toward the end of the medium. An example of this algorithm is illustrated in Fig. 3.1.

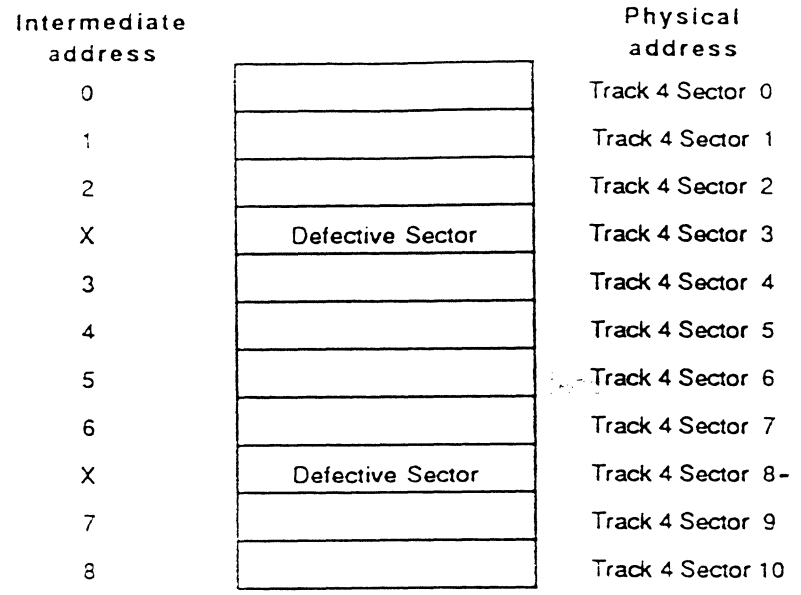

Fig. 3.1 Sector Slipping Argorithm [Sector Skipping Argorithm]

As illustrated in Fig. 3.1, the SMO-E501 adopts the intermediate address space which excludes all defective sectors slipped by the "Sector Slipping Algorithm" ["Sector Skipping Algorithm"]. Any good sector can be accessed uniquely using this intermediate address. The advantage of the "Sector Slipping Algorithm" ["Sector Skipping Algorithm"] is that the overhead (the seeking or rotational latency etc.) needed for the alternation of a defective sector is smaller than the one in other methods and the translation formula between the intermediate address space and physical address space is simple enough thus allowing faster calculate.

3.2 Linear Replacement Algorithm [Band Sparing Algorithm]

Trough this algorithm, the defective sectors detected during the write operation are reallocated into the spare areas which are located at each data band. The intermediate address space which excludes defective sectors listed in the PDL [SDT] can be divided into several bands* of the same size as shown in Fig. 3.2. Each band consists of a user and a spare band, located at the end of the user band [a user , a lower spare band, and an upper spare band]. Unless any reallocation is performed after the formatting, the logical block addresses are always allocated to the user bands. When a defective sector is detected during the write operation by the SMO-E501, that defective sector is reallocated automatically into

* These are identical to groups described in the ISO document

the spare band within the same band. If there are no spare sectors left within the same band, then all remaining defective sectors are reallocated into the spare band of the nearest band. This method is called as the "Linear Replacement Algorithm" ["Band Sparing Algorithm"]. The reallocation is performed either when the REASSIGN BLOCKS command is executed or when the automatic write reallocation routine is invoked during the write operation, which failed due to medium defects (in this case, mode select parameters page 01H AWRE bit have to be set). In the later case, the automatic write reallocation occurs when the recoverable hardware error closely related to the medium defect (for example, the tracking failure or focus failure) is detected or the data error exceeds the specified criteria during the WRITE AND VERIFY command. The information of the reallocation is stored in the SDL [BST] in the form of the physical address [intermediate address] of the defective sector and the physical address where the bad sector is reallocated to. As the reallocation is handled in this manner, there is no restriction to the number of reallocations except that the number of the defective sectors have to be less than or equal to 2048 .

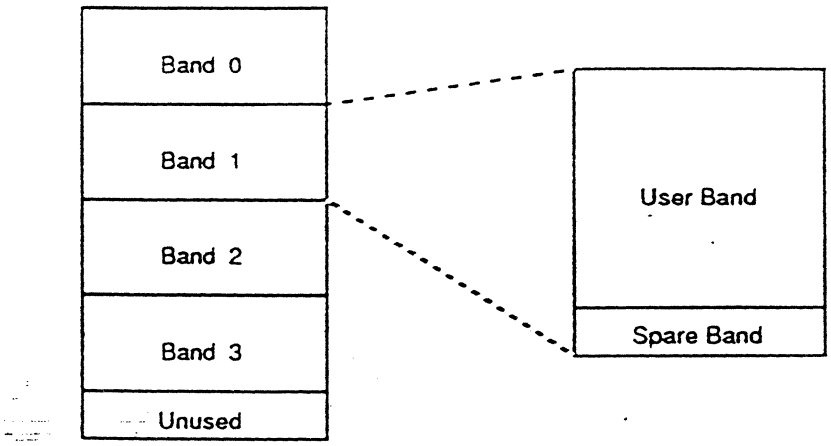

Fig. 3.2 Structure of Bands, Linear Replacement Algorithm

The size of the user and spare bands which are Type 0 parameters can be specified by the MODE SELECT command, and the information is stored into the DDS [Format Information Sector of the CDA] during the FORMAT UNIT command. It is also possible to specify the band structure of the medium using the number of bands and the size of spare band which are Type 1 parameters, too. When band structure is specified with Type 1 parameters, these parameters are transformed to Type 0 parameters and then saved to DDS [CDA] during the formatting process.

When there are fewer bands in a disk, the average distance from the user band to the sparing band becomes longer, so time needed to reach the reallocated sector may increase due to

the longer seek time. When there are many bands in a disk, although such seek time may decrease due to the small band size, the frequency of jumping the spare band at the band boundary may increase. Therefore the number of bands should be set to an appropriate value for a specific application.

The size of the user and spare bands have to meet the following conditions:

Format Mode 2

1024 bytes/sector	512 bytes/sector
size of user band ≥ 8	size of user band ≥ 16
7FFFH ≥ size of spare band ≥ 1	7FFFH ≥ size of spare band ≥ 1

Format Mode 3

1024 bytes/sector	512 bytes/sector
size of user band ≥ 9	size of user band ≥ 17
7FFFH ≥ size of spare band ≥ 1	7FFFH ≥ size of spare band ≥ 1

3.3 Logical Block Address and Physical Address

The translations of the logical block address to the physical address in Format Mode 2 and 3 are shown in Fig. 3.3 and Fig. 3.4 respectively. In these examples, there are three bands, four defective sectors which are handled by the "Sector Slipping Algorithm" ["Sector Skipping Algorithm"], and one defective sector which is handled by the "Linear Replacement Algorithm" ["Band Sparing Algorithm"].

The size of logical block address area is decided by the size of the user band and spare bands as follows:

Format Mode 2

size of logical block address area (sectors)

= (number of bands) x (size of user band)

number of bands

= integer (((18751 - 6) x (number of sectors per track) - 1024)
/ ((size of spare band) x 2 + (size of user band)))

Format Mode 3

size of logical block address area (sectors)

= (number of bands) x (size of user band)

number of bands

= integer (((18751 - 6) x (number of sectors per track) - 2048)
/ ((size of spare band) x 1 + (size of user band)))

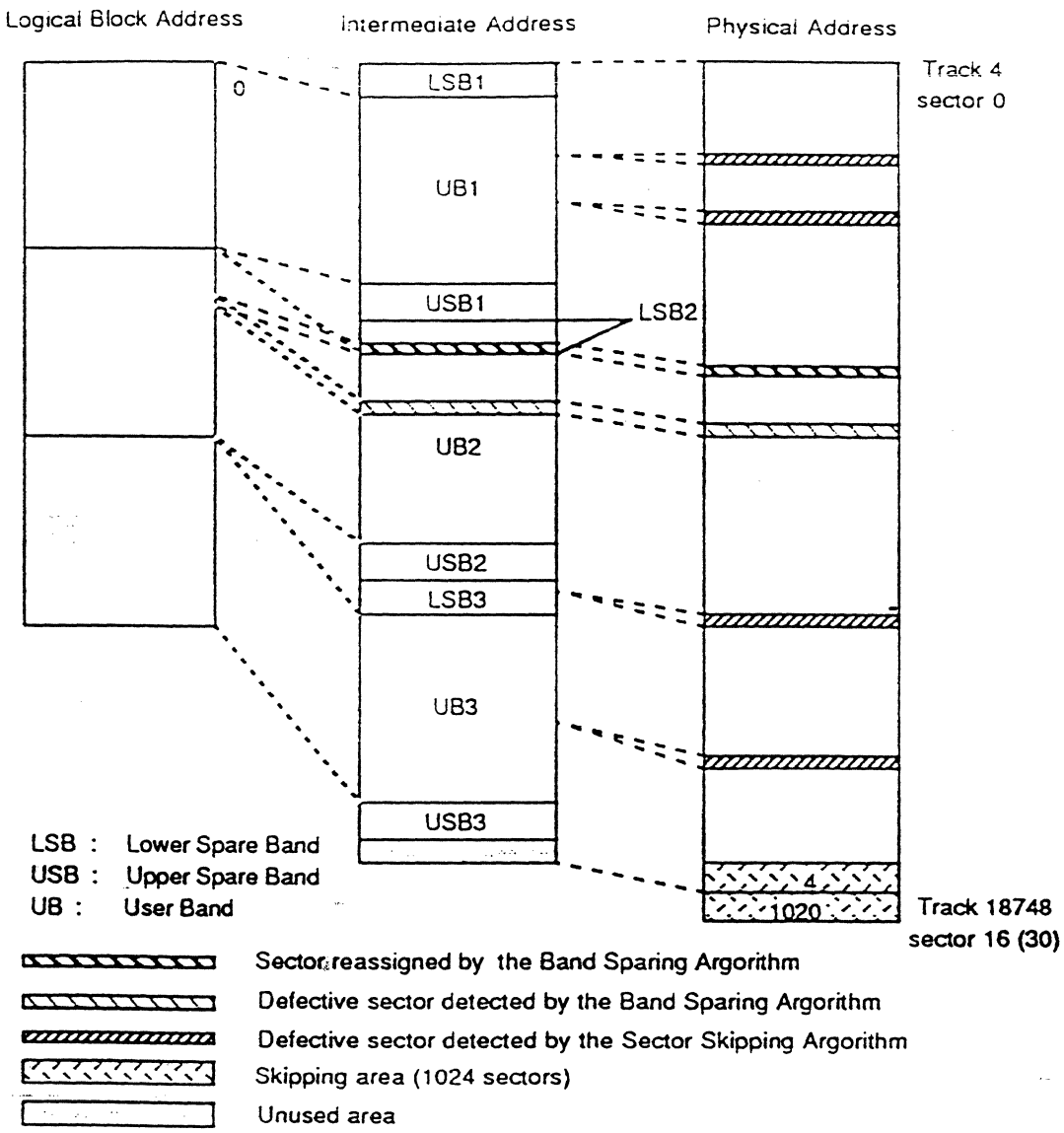

Fig. 3.3 An example of address allocation in Format Mode 2

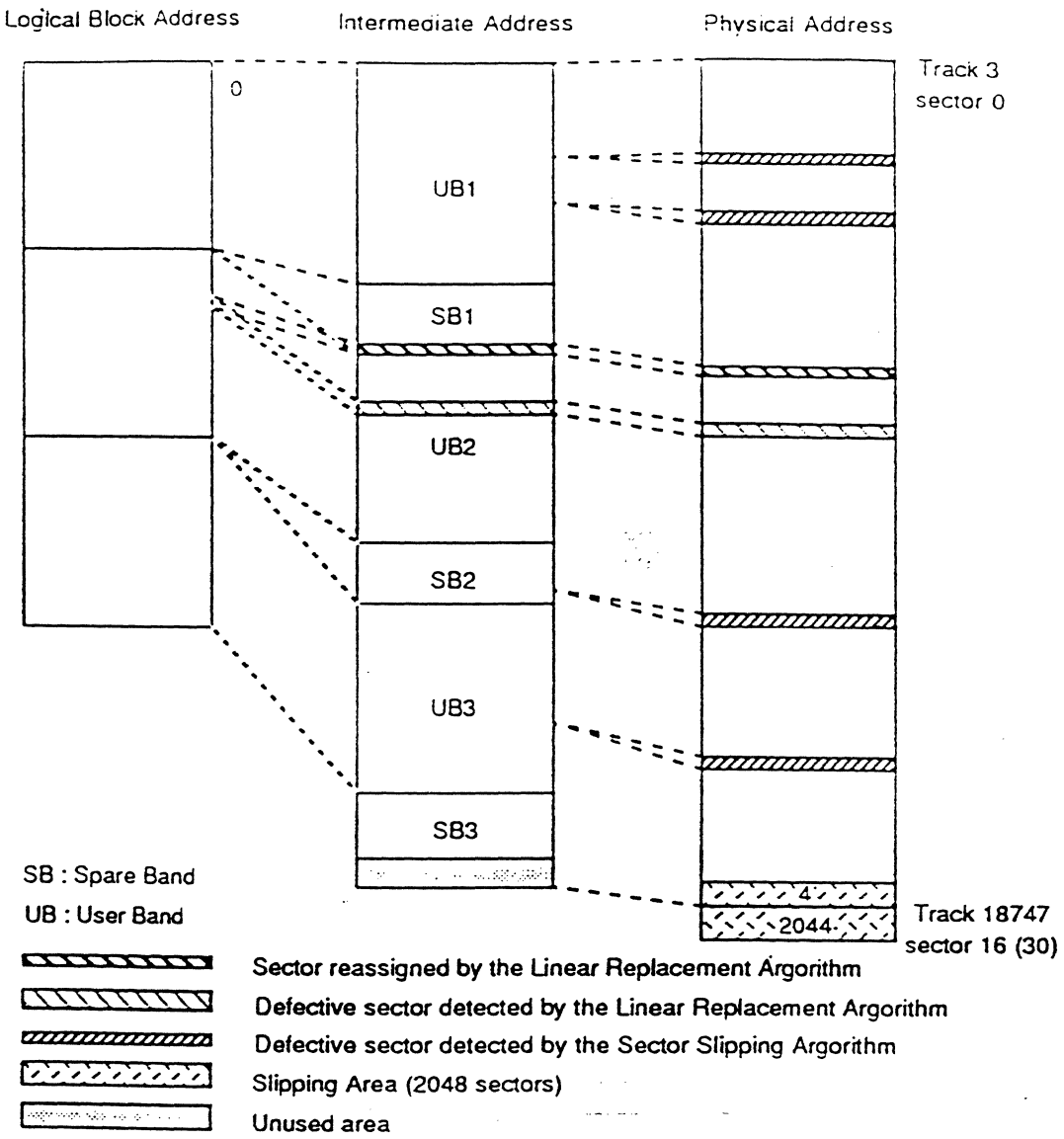

Fig. 3.4 An example of address allocation in Format Mode 3

SECTION 4 LOGICAL STRUCTURE OF THE DISK

4.1 Sony Unique Defect Management

4.1.1 Overview

The MO disk is divided into several distinct areas. These areas are used to define the defect management scheme being used, to store the defect information, and to store the user area. In case of Format Mode 0, 1, and 2, The disk surface is assigned logically as shown below:

1024 bytes/sector format

Physical Track/Sector	Contents
0/0 to 0/7	Control Data Area (CDA)0
0/8 to 0/15	Control Data Area (CDA) 1
0/16 to 1/16	Reserved
2/0 to 2/7	Defect Table Area (Skipping Defect Table 0)
2/8 to 2/15	Defect Table Area (Skipping Defect Table 1)
2/16	Defect Table Area (Reserved)
3/0 to 3/7	Defect Table Area (Band Sparing Table 0)
3/8 to 3/15	Defect Table Area (Band Sparing Table 1)
3/16	Defect Table Area (Reserved)
4/0 to 18748/16	User Area
18749/0 to 18749/7	Control Data Area (CDA)2
18749/8 to 18749/15	Control Data Area (CDA) 3
18749/16 to 18750/16	Reserved

512 bytes/sector format

Physical Track/Sector	Contents
0/0 to 0/14	Control Data Area (CDA)0
0/15 to 0/29	Control Data Area (CDA) 1
0/30 to 1/30	Reserved
2/0 to 2/14	Defect Table Area (Skipping Defect Table 0)
2/15 to 2/29	Defect Table Area (Skipping Defect Table 1)
2/30	Defect Table Area (Reserved)
3/0 to 3/14	Defect Table Area (Band Sparing Table 0)
3/15 to 3/29	Defect Table Area (Band Sparing Table 1)
/30	Defect Table Area (Reserved)
4/0 to 18748/30	User Area
18749/0 to 18749/14	Control Data Area (CDA)2
18749/15 to 18749/29	Control Data Area (CDA) 3
18749/30 to 18750/30	Reserved

4.1.2 Control Data Area

User Area format information, SCSI controller control mode information and information of defective sectors detected at the time of disk shipping, etc. are recorded in the Control Data Area (CDA). This takes up one track each both at the inner and outer circumferences, and each track is divided into two sections, so that the same information is recorded in opposite side seen from the center of the disk, in order to keep high data integrity. If one of the four

sectors which have the same sector offset of the CDA can be read, the information of the CDA is retrieved properly. Each CDA consists of the following sectors.

Sector offset	Contents
0 (0)	Format Information Sector
1 (1)	Mode Information Sector
2-7 (2-14)	Defect Information Sector or Unused Sector

Each sector of the CDA has the sector identification which indicates which of the four types of sectors it is. The format is as shown below.

Byte	Contents
0H-9H (0H-9H)	Sector Identifier
AH-3FFH (AH-1FFH)	Information dependent on Sector Identifier

The same value is written in bytes 0 to 9 for sector identification. The values are shown below.

Sector Identifier	Contents
0H	Unused Sector
1H	Format Information Sector
2H	Mode Information Sector
3H	Defect Information Sector
4H-FFH	Reserved

4.1.2.1 Unused Sector

Unused Sector indicates that there is no valid information in this sector. The format of the sector is shown below.

Byte	Contents
0H-9H (0H-9H)	Sector Identifier (00H, 00H, ... 00H)
AH-3FFH (AH-1FFH)	Reserved (00H, 00H, ... 00H)

4.1.2.2 Format Information Sector

The Format Information Sector is used to store the Format Mode and Format Mode dependent information. The contents of this sector, for each Format Mode is shown as below. When the SMO-E501 spins up the disk, it reads this sector and set the values to the current MODE SELECT/SENSE parameters and other internal variables.

Format Mode 0

Byte	Contents
0H-9H (0H-9H)	Sector Identifier (01H, 01H, ... 01H)
AH (AH)	Format Mode (00H)
BH-3FFH (BH-1FFH)	Reserved (00H, 00H, ... 00H)

Format Mode 1

Byte	Contents
0H-9H (0H-9H)	Sector Identifier (01H, 01H, ... 01H)
AH (AH)	Format Mode (01H)
BH-3FFH (BH-1FFH)	Reserved (00H, 00H, ... 00H)

Format Mode 2

Byte	Contents
0H-9H (0H-9H)	Sector Identifier (01H, 01H, ... 01H)
AH (AH)	Format Mode (02H)
BH (BH)	Type (00H)
CH-FH (CH-FH)	Size of User Band (MSB first)
10H-11H (10H-11H)	Size of Spare Band (MSB first)
12H-3FFH	(12H-1FFH) Reserved (00H, 00H, ... 00H)

4.1.2.3 Mode Information Sector

Pages 01H and 02H of the Mode Select Parameters are stored in this sector. When the MODE SELECT command is issued with its SP bit set, the values of the Page 01H and Page 02H is saved here. This value can be read from the initiator by sending the MODE SENSE command with its PF bit set and PC field set to 3H. When the SMO-E501 spins up the disk, it tries to read this sector after reading the Format Information Sector successfully. If valid information is retrieved from the medium, the SMO-E501 sets the values to the current MODE SELECT/SENSE parameters. The format of this sector is as follows:

Byte	Contents
0H-9H (0H-9H)	Sector Identifier (02H, 02H, ... 02H)
AH (AH)	Data Length (17H)
BH (BH)	Medium Type (00H)
CH (CH)	Reserved (00H)
DH (DH)	Block Descriptor Length (00H)
EH (EH)	Page Code (01H)
FH (FH)	Page Specific Parameter Length (06H)
10H (10H)	Error Recovery Flags
11H (11H)	Retry Count
12H-15H (12H-15H)	Reserved (00H, 00H, 00H, 00H)
16H (16H)	Page Code (02H)
17H (17H)	Page Specific Parameter Length (0AH)
18H (18H)	Buffer Full Ratio
19H (19H)	Buffer Empty Ratio
1AH-21H (1AH-21H)	Reserved (00H, 00H, ... 00H)
22H-3FFH	(22H-1FFH) Reserved (00H, 00H, ... 00H)

4.1.2.4 Defect Information Sector

This sector is used to store the Primary defect list (P List) of the medium. Usually, information of this sector is written by the media manufacturer and will not be changed for the medium's lifetime. When the FORMAT UNIT command is issued with its MkCDA and MkPlst both set to

one, a Primary defect list is made and is written into the medium. When the FORMAT UNIT command is issued with its MkCDA bit set to one and MkPlst bit clear to zero, all the Defect Information Sectors are deleted and Unused Sectors are written to this area. If the MkCDA bit is clear to zero, the FORMAT UNIT command does not change the Defect Information Sectors.

Byte	Contents
0H-9H (0H-9H)	Sector Identifier (03H, 03H, ... 03H)
AH (AH)	Defect Information Sector number (starts from 0)
BH (BH)	Number of Defect Information Sectors in this CDA
CH-DH (CH-DH)	Number of defective sector addresses written in this sector (MSB first)
EH-FH (EH-FH)	Certify Identifier 0 : Not certified at time of manufacturer shipping other than 0 : Certified at time of manufacturer shipping (value is vendor unique)
10H-3FFH (10H-1FEH)	List of defective sector addresses The physical addresses of the defective sectors are written here in ascending order. Each entry consists of 3 bytes in the following configuration. byte 0 : track address high byte byte 1 : track address low byte byte 2 : sector address (maximum 336 (165) entries are available for a sector)
(1FFH)	Reserved (00H)

4.1.3 Defect Table Area

The Defect Table Area is located in tracks from 2 to 3. This area is used for Skipping Defect Table (track 2) and Band Sparing Table (track 3) when Format Mode is 2. In Format Mode 0 or 1, the initiator can use this area like other data area (In order to read or write this area, use the Group 1 read/write commands).

4.1.3.1 Skipping Defect Table

This table is used to store the defective sector information used for the "Sector Skipping Algorithm" in Format Mode 2. The information of this table is written when the FORMAT UNIT command is executed. The format of the Skipping Defect Table Sector is as follows:

Byte	Contents
0H (0H)	Skipping Defect Table Sector number (starts from 0) (FFH indicates that the sector is unused)
1H (1H)	Number of Skipping Defect Table Sectors
2H-3H (2H-3H)	Number of defective sector addresses written in this sector (MSB first)
4H-3FFH (4H-1FEH)	List of defective sector addresses The physical addresses of the defective sectors are written here in ascending order. Each entry consists of 3 bytes in the following configuration. byte 0 : track address high byte byte 1 : track address low byte byte 2 : sector address (maximum 340 (169) entries are available for a sector)
(1FFH)	Reserved (00H)

If a defective sector is located in the Skipping Defect Table area, the same data is written into the next sector (If the Skipping Defect Table area is exhausted, FORMAT UNIT command returns CHECK CONDITION status). Unused sectors in the Skipping Defect Table area are filled with FFH pattern.

4.1.3.2 Band Sparing Table

This table is used to store the defective sector information detected after the FORMAT UNIT command. The information of this table is used for "Band Sparing Algorithm" in Format Mode 2. The format of the Band Sparing Table Sector is as follows:

Byte	Contents
0H (0H)	Band Sparing Table Sector number (starts from 0) (FFH indicates that the sector is unused)
1H (1H)	Reserved (00H)
2H-3H (2H-3H)	Number of defective sector addresses written in this sector (MSB first)
4H-3FFH (4H-1FBH)	List of defective sector addresses Pairs of the defective sector intermediate address and the physical address of its reallocation are written here. Each entry consists of 6 bytes in the following configuration. byte 0 : Intermediate Address (MSB) byte 1 : Intermediate Address byte 2 : Intermediate Address (LSB) byte 3 : track address high byte byte 4 : track address low byte byte 5 : sector address (maximum 170 (84) entries are available for a sector)
(1FCH-1FFH)	Reserved (00H, 00H, 00H, 00H)

If a defective sector is located in the Band Sparing Table area, the same data is written into the next sector. If the next sector is not available, the command (the REASSIGN BLOCKS,

WRITE AND VERIFY command, or write-type command) which reallocates the bad sectors returns a CHECK CONDITION status.

4.2 ISO Standard Defect Management

4.2.1 Overview

The MO disk is divided into several distinct areas. These areas are used to define the defect management scheme being used, to store the defect information, and to store the user area. In Format Mode 3, the disk surface is assigned logically as shown below:

1024 bytes/sector format

Physical Track/Sector	Contents
0/0	Disk Definition Structure (DDS) 0
0/1 to 1/7	Primary Defect List (PDL) 0
	Secondary Defect List (SDL) 0
1/8	Disk Definition Structure (DDS) 1
1/9 to 2/15	Primary Defect List (PDL) 1
	Secondary Defect List (SDL) 1
/16	Reserved
3/0 to 18747/16	User Area
18748/0	Disk Definition Structure (DDS) 2
18748/1 to 18749/7	Primary Defect List (PDL) 2
	Secondary Defect List (SDL) 2
18749/8	Disk Definition Structure (DDS) 3
18749/9 to 18750/15	Primary Defect List (PDL) 3
	Secondary Defect List (SDL) 3
18750/16	Reserved

512 bytes/sector format

Physical Track/Sector	Contents
0/0	Disk Definition Structure (DDS) 0
0/1 to 1/14	Primary Defect List (PDL) 0
	Secondary Defect List (SDL) 0
1/15	Disk Definition Structure (DDS) 1
1/16 to 2/29	Primary Defect List (PDL) 1
	Secondary Defect List (SDL) 1
2/30	Reserved
3/0 to 18747/30	User Area
18748/0	Disk Definition Structure (DDS) 2
18748/1 to 18749/14	Primary Defect List (PDL) 2
	Secondary Defect List (SDL) 2
18749/15	Disk Definition Structure (DDS) 3
18749/16 to 18750/29	Primary Defect List (PDL) 3
	Secondary Defect List (SDL) 3
18750/30	Reserved

The DDS, PDL, and SDL are recorded four times, twice at inner tracks and twice at outer tracks in order to keep high data integrity.

4.2.2 Disk Definition Structure

The Disk Definition Structure (DDS) defines the defect management scheme, the way the user and spare bands are divided, and the start address of the PDL and SDL area. The format of the DDS is as follows:

Byte	Contents
0H (0H)	DDS Identifier (0AH)
1H (1H)	DDS Identifier (0AH)
2H (1H)	Reserved (00H)
3H (3H)	0XH (X=1:disk certified X=2:disk not certified, Linear Replacement only)
4H-5H (4H-5H)	Number of Bands : N (MSB first, 2 bytes)
6H-9H (6H-9H)	Size of User Band : n (MSB first, 4 bytes)
AH-DH (AH-DH)	Size of Spare Band : m (MSB first, 4 bytes)
EH-11H (EH-11H)	Start Address of PDL (4 bytes) byte 0 : track address (MSB) byte 1 : track address byte 2 : track address (LSB) byte 3 : sector address
12H-15H (12H-15H)	Start Address of SDL (4 bytes) byte 0 : track address (MSB) byte 1 : track address byte 2 : track address (LSB) byte 3 : sector address
16H-3FFH	(16H-1FFH) Reserved (00H)

Byte 3H of the DDS specifies the defect management algorithm. If it is set to 01H, then the "Sector Slipping Algorithm" is adopted with the "Linear Replacement Algorithm". If it is set to 02H, then only the "Linear Replacement Algorithm" is used. Fields from byte 4H through DH specify the band structure of the medium. The user area and spare area are divided into N discrete recording areas called bands. Each band contains n user blocks and m spare blocks. When the "Sector Slipping Algorithm" is used, 2048 sectors are reserved at the outer area of the disk for slipping, then the rest of the area is divided into N bands. Bytes from EH through 11H and bytes from 12H through 15H are used to show the start address of the PDL and SDL respectively.

4.2.3 Defect List Area

The Defect List Area is located at inner tracks from 0 through 2 and outer tracks from 18748 through 18750. This area is composed of the PDL and SDL and is used for recording all defect lists.

4.2.3.1 Primary Defect List

The Primary Defect List is used for storing the defective sector information which is managed by the "Sector Slipping Algorithm". The information of this table is written when the FORMAT

UNIT command is executed. The PDL contains the PDL identifier, list length in entries, and ordered defect entries. The format of PDL is as follows:

Byte	Contents
0H (0H)	PDL Identifier (00H)
1H (1H)	PDL Identifier (01H)
2H-3H (2H-3H)	List Length in entries (MSB first)
4H-3FFH (4H-1FEH)	List of defective sector addresses The physical addresses of the defective sectors are written here in ascending order. Each entry consists of 4 bytes in the following byte 0 : track address high byte byte 1 : track address low byte byte 2 : track address (LSB) byte 3 : sector address

configuration.

All unused bytes of the sectors reserved to store the defect list are set to FFH. If there are no slipped sectors as a result of the formatting process, then the PDL is written with the first bad sector addresses as all FFH and the list length bytes are set to 00H. If in the absence of sectors for the PDL, the FORMAT UNIT command returns a CHECK CONDITION status.

4.2.3.2 Secondary Defect List

The Secondary Defect List is used for storing the defective sector information which is detected after the FORMAT UNIT command. The information of this table is managed by the "Linear Replacement Algorithm". The SDL consists of the SDL identifier, number of sub-lists, list length in bytes, addressed sub lists each containing the address of the defective sectors and those of their replacement sectors. The format of the SDL is as follows:

Byte	Contents
0H (0H)	SDL Identifier (00H)
1H (1H)	SDL Identifier (02H)
2H (2H)	(00H)
3H (3H)	Number of sub-lists (0YH)
4H-5H (4H-5H)	List length in bytes (MSB first)
6H (6H)	SDL Identifier (02H)
7H (7H)	First sub-list (01H)
8H-9H (8H-9H)	Sub-list length in bytes (MSB first)
10H-3F9H (4H-1F9H)	Sub-list of defective sector addresses Pairs of the physical address of the defective sector and the physical address of its reallocation are written here in ascending order. Each entry consists of 8 bytes in the following configuration. Defective sector address byte 0 : track address (MSB) byte 1 : track address byte 2 : track address (LSB) byte 3 : sector address Replacement sector address byte 4 : track address (MSB) byte 5 : track address byte 6 : track address (LSB) byte 7 : sector address

All unused bytes of the sectors reserved to store the list are set to FFH. If there is no available sector in the following area, the command (the REASSIGN BLOCKS, WRITE AND VERIFY command, or the write-type command) which reallocates the bad sectors returns a CHECK CONDITION status.

SECTION 5 MISCELLANEOUS

5.1 Defect List of the SCSI

In the CCS*, the following four types of defect list are defined:

- P list: Primary defect list. The defect list recorded by the disk manufacturer.
- C list Target certification list. The defect list detected during the certification process of the FORMAT UNIT command.
- D list Data defect list. The list supplied by the initiator during FORMAT UNIT command.
- G list Grown defect list. The defects identified by or to the target other than the P list.

Using these defect lists, the FORMAT UNIT command makes the effective defect list which is used to control the defect management. In the CCS definition, the relation of these lists is as follows:

CCS

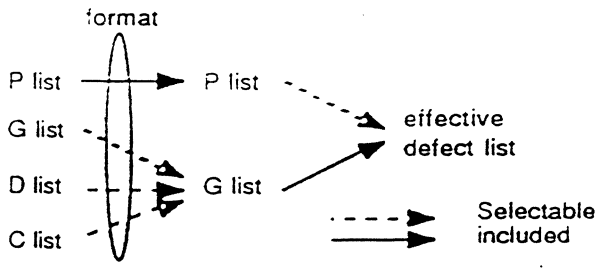

Fig. 5.1 CCS

As this method is too complicated (because the SMO-E501 has to maintain three defect tables) to implement, the SMO-E501 adopts the following method in Format Mode 2:

Format Mode 2

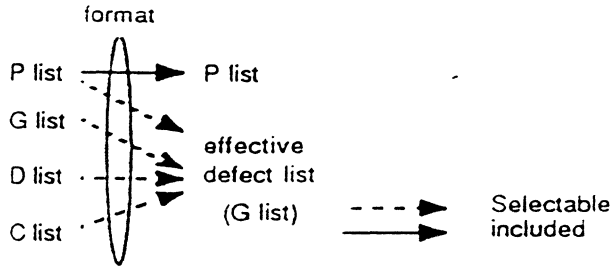

Fig. 5.2 FORMAT MODE 2 (SMO-C501)

The P list corresponds to Defect Information Sector of the CDA, and the G list corresponds to the Skipping Defect Table + Band Sparing Table in the SMO-E501.

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* *Common Command Set (CCS) of the Small Computer System Interface (SCSI) Rev. 4B*

In Format Mode 3, the SMO-E501 adopts the following method:

Format Mode 3

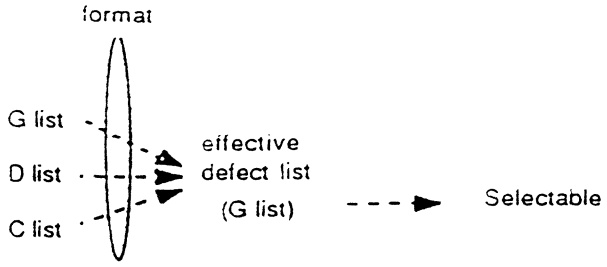

Fig. 5.3 FORMAT MODE 3 (SMO-C501)

The G list corresponds to the PDL + SDL in the SMO-E501.

5.2 Format Parameters

Parameters of the FORMAT UNIT command are used to control the defect management by initiator choice. There are effective combinations of format parameters, and consequently lists, used for creating the effective defect list. The following tables show the relationship between format parameters and lists used.

Format Mode 2

FmtData	CmpLst	Defect List Format	P	G	D	C
0	0	0	O	O	X	O
1	0	0 or 5	※	O	O	※
1	1	0 or 5	※	X	O	※

O : used X : not used

※

FOV	DPRY	DCRT	P	C
0	0	0	O	O
1	0	1	O	X
1	1	0	X	O
1	1	1	X	X

O : used X : not used

Format Mode 3

FmtData	CmpLst	Defect List Format	G	D	C
0	0	0	O	X	O
1	0	0 or 5	O	O	※※
1	1	0 or 5	X	O	※※

O : used X : not used

※※

FOV	DPRY	DCRT	C
0	0	0	O
1	0	1	X
1	1	0	O
1	1	1	X

O : used X : not used

In the above tables, "O" means that the list specified is used for creating the effective defect list during the FORMAT UNIT command. "X" means that such a list is not used.

5.3 Criteria of Error Detection

The following criteria is used to detect the defective sectors in the SMO-E501.

operation	ID Detect Level	Error Correction Level
certify routine of the FORMAT UNIT command	2	3
WRITE/ERASE command	2	-
verify of the VERIFY and WRITE AND VERIFY command	2	4
READ command	1	8*

(*In case there is a interleave which contains 7 or 8 bytes error and there is no interleave which contains more than 8 bytes error, the SMO-E501 returns a CHECK CONDITION status (RECOVERED ERROR/"Recovered Read data with target's ECC correction ")).

There are three sector ID fields for each sector of the disk. ID Detect Level indicates how many sector IDs have to be read properly to execute read or write operations.

Level 0 : Validity check of the sector ID is not executed.(Normally, this mode is not used.)

Level 1 : If one sector ID is read properly, read or write operation is executed.

Level 2 : If two sector IDs are read properly, read or write operation is executed.

Level 3 : If three sector IDs are read properly, read or write operation is executed.

Error Correction Level indicates the range of error correction by ECC.

Level 0 : If there is one error byte in the sector, it is treated as defective sector.

Level 1 (~8) : If there is a interleave which contains more than 1 (~8) errors in the sector, it is treated as defective sector.

SCSI Command Table for SMO-E511 Multifunction

SCSI Command Table

Command	Code	Multifunction Drive		MO Drive
		SMO-E511		SMO-E501
		Rewritable	Write-Once	Rewritable
Test Unit Ready	00H	X	X	X
Rezero Unit	01H	X	X	X
Request Sense	03H	X	* 1	X
Format Unit	04H	X	* 2	X
Reassign Block	07H	X	-	X
Read (6)	08H	X	* 3	X
Erase (6)	09H	X	-	X
Write (6)	0AH	X	* 4	X
Seek (6)	0BH	X	X	X
Inquiry	12H	* 5	* 5	X
Mode Select (6)	15H	X	* 6	X
Reserve	16H	X	X	X
Release	17H	X	X	X
Copy	18H	X	-	X
Mode Sense (6)	1AH	X	* 6	X
Start/Stop Unit	1BH	X	X	X
Receive Diagnostics Results	1CH	X	X	X
Send Diagnostic	1DH	X	X	X
Prevent/Allow Medium Removal	1EH	X	X	X
Read Capacity	25H	X	X	X
Read (10)	28H	X	* 3	X
Erase (10)	29H	X	-	X
Write (10)	2AH	X	* 4	X
Seek (10)	2BH	X	X	X
Write and Verify (10)	2EH	X	* 4	X
Verify (10)	2FH	X	* 7	X
Read Defect Data	37H	X	X	X
Copy and Verify	3AH	X	-	X
Write Buffer	3BH	X	X	X
Read Buffer	3CH	X	X	X
Read Long	3EH	X	X	X
Write Long	3FH	X	-	X

SCSI Command Table Key

X: Command Supported, no changes.

-: Command not Supported for Write-Once function.

1: Newly add the Sense Key (BLANK CHECK : 08H)
Newly add the Additional Sense Code (Overwrite Attempted : 92H, Blank Sector Detected : 93H, Written Sector Detected : 94H).

2: The Format command for the Write-Once media is only accepted if the Write-Once m in the drive is unformatted, and supports the format mode 3 only for the Write-Once media.
There are two limits of the Format command due to Write-Once considerations.
The first is that the defect list, if used, must be in Physical Sector Format.
The second is that certification is enforced .

3: All Reads operation for the Write-Once media may be followed by a blank check pass This will occur if blank checking is enabled (See Mode Select for Write-Once media and if a Read fails for an ECC unrecoverable error.
The Sense Code for error condition are as followed.
(1) Blank sector detected : Sense Key of Blank Check (08H)
Additional Sense Code of Blank Sector Detected (9
(2) Unrecovered read error with written sector :
Sense Key of Medium Error (03H)
Additional Sense Code of Unrecovered Read Error (

4: All Writes operation for the Write-Once media are preceded by a blank check pass when blank checking is enabled (See Mode Select for Write-Once media)
If a written sector is detected, following Sense Code will be returned.
(1) Written sector detected : Sense Key of Blank Check (08H)
Additional Sense Code of Overwrite Attempt (92H)

5: The Inquiry data are difined as followed.
Byte 0 : Peripheral Device Type (00H) : Rewritable media is in the drive
(04H) : Write-Once media is in the drive
Byte 8 ~15 : Vender Identification (in ASCII) "SONY "
Byte 16 ~31 : Product Identification (in ASCII) "SMO-C511-XXE "
Byte 32 ~35 : Revision Level (in ASCII) "X.XX "

6: The Mode Select and Mode Sense commands for Write-Once media support the EBC bi (Mode parameter Header byte 2, bit 1). When this bit is set to 1, it indicates that checking is, or should, be enabled. When not set, only blank checking on Write & Verify command is enabled.

Since Write-Once media should only be performed in format mode 3, there are limit on Mode Select, page 20H, for Write-Once media. If a previously formatted Write-media is in the drive, a Mode Select with page 20H returns illegal Request. If an unformatted Write-Once media is in the drive, page 20H is allowed but must be a format mode 3 .

7: The Verify command for Write-Once media supports the BV bit (CDB byte 1, bit 2). If to 1, this command performs a blank check to verify the sector in question are blan If a written sector is detected, following Sense Code will be returned.

(1) Written sector detected : Sense Key of Blank Check (08H)
Additional Sense Code of Written Sector Detected

If the BV bit is not set, a normal verify of written sectors is performed.

SECTION 4 COMMANDS for Write-Once media

INTRODUCTION

This section describes detailed functions of each command supported in the SMO-E511 for Write-Once media. Entries are arranged in order of the operation code.

Each entry includes:

- Command name
- Operation code
- Brief description of the command (FUNCTION)
- Command descriptor block (CDB)
- Detailed description of the command (EXPLANATION)

The following are explanations of each component:

Command name and operation code

Command name and operation code are printed at the first line of each entry in large fonts. The operation code is written in hexadecimal notation.

FUNCTION

Brief description of the command is described here.

CDB

This part shows the format of the command supported in the SMO-E511. The logical unit number field is used to specify the logical unit when the IDENTIFY message is not sent to the SMO-E511. If the logical unit is specified by IDENTIFY message, contents of this field are ignored by the SMO-E511. A link bit of 1 indicates that the SMO-E511 links to the next command upon successful completion of the current command. When the command is terminated successfully, the SMO-E511 returns the INTERMEDIATE/GOOD status and LINKED COMMAND COMPLETE or LINKED COMMAND COMPLETE (WITH FLAG) message depending on the state of the flag bit. The flag bit may be set to 1 only when the link bit is 1. If this bit is set to 1 with the link bit, the SMO-E511 returns the LINKED COMMAND COMPLETE (WITH FLAG) message upon successful completion of the command. If this bit is set to 0, it returns the LINKED COMMAND COMPLETE message. During the linked commands, the logical unit number field has to contain the same value unless the logical unit number is specified by IDENTIFY

message. If the logical unit number field is different from that of the previous CDB, the command returns the CHECK CONDITION status and sets the Sense Key/Additional Sense Code to "ILLEGAL REQUEST/Invalid LUN". Some group 1 commands have a relative address (RelAdr) bit. The RelAdr bit is set to 1 to indicate that the logical block address of the command descriptor block is a two's complement displacement. This negative or positive displacement is to be added to the logical block address last accessed on the logical unit to form the logical block address for this commands. The Reserved (or Rsrvd) field indicates that the field is reserved and has to be set to 0 by the initiator.

The SMO-E511 supports the following group 0 and group 1 commands for Write-Once media (upper 3 bits of the operation code is called group code).

group 0 (6-byte command)

Code	Description
00H	**TEST UNIT READY** Provides a means to check if the logical unit is ready.
01H	**REZERO UNIT** Moves the optical head to the physical track 0.
03H	**REQUEST SENSE** Requests the detailed error information.
04H	**FORMAT UNIT** Initializes the medium if previously unformatted.
08H	**READ** Reads data from the specified logical block address.
0AH	**WRITE** Writes data to the specified logical block address.
0BH	**SEEK** Moves the optical head to the physical track where the specified logical block exists.
12H	**INQUIRY** Reads the information related to the the drive unit.
15H	**MODE SELECT** Sets medium or drive unit parameters.
16H	**RESERVE** Gains the exclusive control of a specified logical unit.
17H	**RELEASE** Releases a specified logical unit from the reservation state.
1AH	**MODE SENSE** Reads medium or drive unit parameters.
1BH	**START/STOP UNIT** Starts or stops rotating the medium, and/or ejects the medium from the drive unit.
1CH	**RECEIVE DIAGNOSTIC RESULTS** Requests analysis data to be sent to the initiator.
1DH	**SEND DIAGNOSTIC** Requests the SMO-E511 to perform diagnostic tests.
1EH	**PREVENT/ALLOW MEDIUM REMOVAL** Prevents or allows removal of the medium in the logical unit.

group 1 (10-byte command)

Code	Description
25H	**READ CAPACITY** Reads capacity of the medium.
28H	**READ** Reads data from the specified logical block address.
2AH	**WRITE** Writes data to the specified logical block address.
2BH	**SEEK** Moves the optical head to the physical track where the specified logical block exists.
2EH	**WRITE AND VERIFY** Writes data to the medium and then verifies the written data by checking the error correction code.
2FH	**VERIFY** Verifies the data starting from the specified logical block address by checking the error correction code.
37H	READ DEFECT DATA Reads the medium defect information
3BH	**WRITE BUFFER** Writes data to the data buffer of the SMO-E511.
3CH	**READ BUFFER** Reads data form the data buffer of the SMO-E511.
3EH	**READ LONG** Reads data from the specified logical block address with ECC data.

EXPLANATION

Detailed description of the command is explained here.

The Reserved (or Rsrvd) field in returned data indicates that the field contains 0.

TEST UNIT READY 00H

FUNCTION

Provides a means to check if the logical unit is ready.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (00H)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved						Flag	Link

EXPLANATION

This command is used to check if the logical unit is ready. When the logical unit is not ready to accept a medium-access command, this command returns a CHECK CONDITION status.

REZERO UNIT 01H

FUNCTION

Moves the optical head to physical track 0.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (01H)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved						Flag	Link

EXPLANATION

This command is used to recalibrate the optical head. The optical head is moved to the inner-most track (physical track 0).

REQUEST SENSE 03H

FUNCTION

Requests detailed error information from the drive.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (03H)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Allocation Length							
5	Reserved						Flag	Link

EXPLANATION

In the event a command ended unsuccessfully, the drive stores the error information in the internal RAM area and returns the CHECK CONDITION status. The information stored is called 'sense data' and is preserved for the initiator (which issued the command resulting in the CHECK CONDITION status) until it is retrieved via the REQUEST SENSE command or until any other command for the same logical unit has been received. Upon receipt of any subsequent command to the logical unit from the initiator receiving the CHECK CONDITION status, the SMO-E511 clears the Sense Key/Additional Sense Code to No Sense/No Additional Sense Information.

The REQUEST SENSE command requests the target to transfer the sense data to the initiator. The allocation length specifies the number of bytes that the initiator has allocated for returned sense data . If the allocation length is set to 0, the SMO-E511 returns sense data in the Nonextended Sense Data Format. In this case, 4 bytes of sense data are returned. If the allocation length is set to a nonzero value, the SMO-E511 returns sense data in the Extended Sense Data Format. The SMO-E511 transfers allocation length bytes or all available sense data (18 bytes), whichever is less.

The first byte of the sense data consists of AdValid, Error Class and Error Code field. Error Classes 0 through 6 use the Nonextended Sense Data Format and Error Class 7 uses the Extended Sense Data Format.

Nonextended Sense Data Format

The Nonextended Sense Data format is shown in the following table.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	AdValid	Error Class			Error Code			
1	Logical Block Address (MSB)							
2	Logical Block Address							
3	Logical Block Address (LSB)							

When the address valid (AdValid) bit is set to 1, the Logical Block Address field contains valid information relate the Error Class and the Error Code. Bit 0 to 6 of byte 0 (Error Class + Error Code) contains the same value as the Additional Sense Code in the Extended Sense Data Format. Refer to the next paragraph for detailed information about the Additional Sense Code.

Extended Sense Data Format

The table below shows the format of the Extended Sense Data which consists of 18 bytes:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	AdValid	Error Class (7)			Error Code (0)			
1	Reserved							
2	Reserved				Sense Key			
3	Information Byte (MSB)							
4	Information Byte							
5	Information Byte							
6	Information Byte (LSB)							
7	Additional Sense Length (0AH)							
8	Reserved							
9	Reserved							
10	Reserved							
11	Reserved							
12	Additional Sense Code							
13	Reserved							
14	Reserved							
15	Reserved							
16	Reserved							
17	Reserved							

The Error Class is 7 and it specifies extended sense. The Error Code is 0 and it specifies the extended sense data format. The Sense Key reports the error condition. Refer to the Sense Key descriptions in the next paragraph. When the address valid (AdValid) bit is set to 1, the Information Byte field contains valid information related to the Additional Sense Code. During 'write' type commands (WRITE (0AH, 2AH) and WRITE AND VERIFY (2EH) command), bytes 8 to 11 are set with non zero values.

Sense Key

The Sense Key in the Extended Sense Data reports either the nature of the detected error or the drive condition. The following Sense Keys are implemented in the SMO-E511.

Sense Key	Description
0H	**NO SENSE** Indicates that there is no specific sense key information to be reported for the designated logical unit. This sense key is returned when the command is completed successfully.
1H	**RECOVERED ERROR** Indicates that the last command was completed successfully with some recovery action performed by the SMO-E511.
2H	**NOT READY** Indicates that the logical unit cannot be accessed.
3H	**MEDIUM ERROR** Indicates that the command terminated with an unrecovered error condition caused by a medium defect.
4H	**HARDWARE ERROR** Indicates that the SMO-E511 detected a hardware error.
5H	**ILLEGAL REQUEST** Indicates that there was an illegal parameter in the command descriptor block or in the additional parameters supplied as data for some commands.
6H	**UNIT ATTENTION** Indicates that the medium has been loaded, the unit has been reset, or the Mode Select parameters has been changed.
7H	**DATA PROTECT** Indicates that a command that writes the medium has been attempted but cannot be performed due to the Write Protect setting of the medium cartridge switch.
8H	**BLANK CHECK** A blank sector was detected during a READ (group 0 or 1) or VERIFY, or a written sector was detected during a WRITE (group 0 or 1) or a WRITE AND VERIFY command.

Additional Sense Code

The Additional Sense Code provides either detailed error information or the drive condition. The following list shows the Additional Sense Codes implemented in the SMO-E511 and the related Sense Keys.

Code	Description
00H	**No Additional Sense Information** (NO SENSE) No additional sense information to report.
02H*	**No Command Complete** (HARDWARE ERROR) The command complete signal was not returned from the drive block.
03H	**Write Fault** (HARDWARE ERROR) The Write command failed. The logical block address where the fault was detected may be returned in the Logical Block Address field or the Information Byte field of the sense data.
04H	**Drive Not Ready** (NOT READY) The READY signal from the drive block was negated. (The medium in the drive is not spun up, the focus or slide servo is unlocked.)
05H	**Drive Not Selected** (NOT READY) The drive block is not selected.
07H	**Multiple Drives Selected** (HARDWARE ERROR) Multiple drives responded for the same drive number.
08H	**Logical Unit Communication Failure** (HARDWARE ERROR) An error was detected during communication between the drive block and the SCSI controller block (e.g. parity error).
09H	**Track Following Error** (HARDWARE ERROR) Still-jump failed and the optical head could not stay on the same track.
0AH*	**No Disk** (NOT READY) A medium is not inserted into the drive unit.
0BH*	**Load/Unload Failure** (HARDWARE ERROR) A failure was detected during loading or unloading the cartridge.
0CH*	**Spindle Failure** (HARDWARE ERROR) The spindle servo was not locked with the reference signal and the medium was not rotated correctly.
0DH*	**Focus Failure** (HARDWARE ERROR) The focus servo was not activated. Issue the START/STOP UNIT command with the Start bit set to 1 to restart the drive.

* These codes are newly added or have a different meaning from that of *CCS Rev 4B*.

0EH* **Tracking Failure** (HARDWARE ERROR)

The tracking servo could not be locked.

0FH* **Bias Magnet Failure** (HARDWARE ERROR)

The bias magnet of the drive failed.

10H **ID CRC Error** (HARDWARE ERROR)

The ID field could not be read without a CRC error.

11H **Unrecovered Read Data Error** (MEDIUM ERROR)

Data errors could not be corrected by the error correction code. The logical block address where the fault was detected may be returned in the Logical Block Address field or Information Byte field of the sense data.

15H **Seek Positioning Error** (HARDWARE ERROR)

Seeking to the specified track failed despite a number of retrials.

18H **Recovered Read Data with ECC Procedure** (RECOVERED ERROR)

An interleave containing 7 or 8 error bytes was located. Error correction was successful.

20H **Invalid Command Operation Code** (ILLEGAL REQUEST)

The specified command operation code is not implemented or an invalid command is requested.

21H **Illegal Logical Block Address** (ILLEGAL REQUEST)

The specified logical block address was outside the valid area.

23H* **Illegal Function for Medium Type** (ILLEGAL REQUEST)

The format parameter is invalid for the medium type.

24H **Illegal Field in CDB** (ILLEGAL REQUEST)

There was an error in the received Command Descriptor Block (CDB). This Additional Sense Code is returned under the following situations.

- The reserved field in CDB is not zero.
- Invalid combination of parameters (e.g. Both the eject bit and the start bit are set in the START/STOP UNIT command).
- Illegal parameter at that state (e.g. A command using the relative address (RelAdr) bit is set to 1 is issued after a command who's link bit is not set to 1).

25H **Invalid LUN** (ILLEGAL REQUEST)

LUN 1 through 7 is specified or the specified LUN (0) does not respond to the selection from the SCSI controller block.

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* These codes are newly added or have a different meaning from that of *CCS Rev 4B*.

26H	**Invalid Field In Parameter List** (ILLEGAL REQUEST) There was an error in the received parameters.
27H	**Write Protected** (DATA PROTECT) Writing was aborted because the write protect switch of the cartridge is on.
28H	**Medium Changed** (UNIT ATTENTION) A medium was loaded. This Additional Sense Code is used to notify the initiator that the medium has been changed since the execution of the last command. This code implies that the Mode Select Parameters may be changed (2AH).
29H	**Power On or Reset or Bus Device Reset Occurred** (UNIT ATTENTION) This Additional Sense Code is used to notify the initiator that a RESET condition has taken place since last command. This code implies that the Mode Select Parameters may be changed.
2AH	**Mode Select Parameters Changed** (UNIT ATTENTION) This Additional Sense Code is used to notify the initiator that the mode select parameters have been changed since the execution of the last command.
30H*	**Incompatible Cartridge** (MEDIUM ERROR) The ID hole(s) location of the cartridge is/are invalid.
31H*	**Medium Format Corrupted** (MEDIUM ERROR) PEP, SFP, the format information sector in the DDS is/are invalid.
32H	**No Defect Spare Location Available** (MEDIUM ERROR) The number of defect sectors listed in the PDL and SDL for the format mode 3 exceeded the 2048 limit, or the number of defect sectors listed in the SDL exceeded the specified value calculated by the number of groups and spare blocks per group.
38H*	**Recovered with Automatic Reallocation** (RECOVERED ERROR) Automatic write reallocation was executed successfully.
39H*	**Automatic Reallocation Failure** (MEDIUM ERROR) Automatic write reallocation failed after retrying three times.
3AH*	**Defect List Update Failure** (MEDIUM ERROR) Updating of the defect table failed after the successful sparing of the data sector.
3DH*	**Defect List Not Available** (MEDIUM ERROR or RECOVERED ERROR or ILLEGAL REQUEST) The specified defect list is not available.

* These codes are newly added or have a different meaning from that of *CCS Rev 4B*.

42H* **Power On Diagnostic Failure** (HARDWARE ERROR)
The power on diagnostics failed.

43H **Message Reject Error** (HARDWARE ERROR)
The command was aborted because the initiator rejected the message from the SMO-E511 by issuing the MESSAGE REJECT message.

44H **Internal SCSI controller Error** (HARDWARE ERROR)
The SMO-E511 detected an error related to the SCSI controller block hardware or firmware.

47H **SCSI Interface Parity Error** (HARDWARE ERROR)
The command was aborted due to parity error on the SCSI bus.

48H **Initiator Detected Error** (HARDWARE ERROR)
The command was aborted because the INITIATOR DETECTED ERROR message was sent from the initiator.

49H **Inappropriate/Illegal Message** (HARDWARE ERROR)
The command was aborted due to an inappropriate illegal message from the initiator.

80H* **Limited Laser Life** (HARDWARE ERROR)
Over-current was detected in the laser diode or the laser power is below the lower limit.

81H* **Focus Coil Over-current Failure** (HARDWARE ERROR)
Over-current was detected in the focus coil of the optical pick up.The coil is protected by a relay.

82H* **Tracking Coil Over-current Failure** (HARDWARE ERROR)
Over-current was detected in the tracking coil of the optical pick up.The coil is protected by a relay.

83H* **Temperature Alarm** (HARDWARE ERROR)
The Internal temperature of the drive exceeded the limit (60°C).

92H* **Overwrite Attempted** (BLANK CHECK)
The written sector was detected during the write operation.

93H* **Blank Sector Detected** (BLANK CHECK)
The blank sector was detected during the read or verify operation.

94H* **Written Sector Detected** (BLANK CHECK)
The written sector was detected during the verify operation.

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* These codes are newly added or have a different meaning from that of *CCS Rev 4B.*

FORMAT UNIT 04H

FUNCTION

Initializes the medium.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (04H)							
1	Logical Unit Number			FmtData	CmpLst	Defect List Format		
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved						Flag	Link

EXPLANATION

The FORMAT UNIT command is used to make the required information on the medium for the SCSI controller to manage it. This operation can take place once during the lifetime of a disk surface, and the FORMAT UNIT command supports format mode 3 only for Write-Once media.

Normally, the format mode is set by the initiator using the MODE SELECT command before the execution of FORMAT UNIT command. For the Write-Once media, Defect List Format should be Physical Sector Format. FmtData, CmpLst and Defect List Format fields are one of the following:

FmtData (bit 4)	CmpLst (bit 3)	Defect List Format (bit 2)	(bit 1)	(bit 0)	Description
0	0	0	0	0	No Defect List Header and no Defect Descriptor
1	1	1	0	1	Physical Sector Format
All other codes (x: arbitrary)					Reserved

When the FmtData bit is 1, the SMO-E511 goes into DATA OUT phase and receives the defect list from the initiator. The defect list contains a four-byte header followed by zero, one, or more defect descriptor(s). The length of the defect descriptors varies with the format of the defect list. The defect list format is as follows:

Defect LIst Header								
Byte	**Bit 7**	**Bit 6**	**Bit 5**	**Bit 4**	**Bit 3**	**Bit 2**	**Bit 1**	**Bit 0**
0	Reserved							
1	Reserved							
2	Defect List Length (MSB)							
3	Defect List Length (LSB)							
Defect Descriptor(								
a(0)-b(0)	Defect Descriptor 0							
a(1)-b(1)	Defect Descriptor 1							
	• • •							
a(i)-b(i)	Defect Descriptor i							

a(i)=il
b(i)=(i+1)l-1
l:length of Defect Descriptor

In the physical sector format, the track number of defect field indicates the physical track number of the defect and the defect sector number field indicates the physical sector number of the defect.

The defective sector list has to be in ascending order.

Byte	Defect Descriptor
0	Reserved
1	Track Number of Defect (MSB)
2	Track Number of Defect (LSB)
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Sector Number of Defect

Physical Sector Format

READ 08H

FUNCTION

Reads data from the specified logical block address.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (08H)							
1	Logical Unit Number			Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Transfer Length							
5	Reserved						Flag	Link

EXPLANATION

The READ command requests the SMO-E511 to read data from the medium and transfer this data to the initiator. The logical block address field specifies the logical block at which the read operation begins. The transfer length field specifies the number of contiguous logical blocks of data to be transferred. A transfer length of 0 indicates that 256 logical blocks are transferred. Any other value indicates the number of logical blocks to be transferred. Unless the RC bit of the mode select parameters is set to 1, the data read from the medium is ECC corrected.

If the EBC bit is set to 1, blank checking is performed. (See the Mode Select command for more details.)

WRITE 0AH

FUNCTION

Writes data to the specified logical block address.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (0AH)							
1	Logical Unit Number			Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Transfer Length							
5	Reserved						Flag	Link

EXPLANATION

The WRITE command requests the SMO-E511 to write data to the medium. The logical block address field specifies the logical block at which the write operation begins. The transfer length field specifies the number of continuous logical blocks of data to be transferred. A transfer length of 0 indicates that 256 logical blocks are transferred. Any other value indicates the number of logical blocks to be transferred. When this command is performed, the SMO-E511 automatically adds the error correction code (ECC) to the each logical block data and then writes to the medium.

If the AWRE bit is set to 1(MODE SELECT command 15H), and the specified block is detected as defective during the write operation of this command (in this case, ID error, tracking failure, or focus failure due to the medium defect), then the automatic write reallocation occurs.

If the EBC bit is set to 1, blank checking is performed. (See the Mode Select command for more details.)

SEEK 0BH

FUNCTION

Moves the optical head to the physical track where the specified logical block exists.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (0BH)							
1	Logical Unit Number			Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Reserved							
5	Reserved						Flag	Link

EXPLANATION

The SEEK command requests the drive unit to move the optical head to the physical track where the specified logical block exists.

INQUIRY 12H

FUNCTION

Reads the information related to the drive unit.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (12H)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Allocation Length							
5	Reserved						Flag	Link

EXPLANATION

The INQUIRY command requests that the information related to the drive unit be sent to the initiator. The allocation length specifies the number of bytes that the initiator has allocated for the returned INQUIRY data. Allocation length of 0 indicates that no INQUIRY data is transferred. This condition is not considered as an error. The SMO-E511 transfers allocation length bytes or all available INQUIRY data (36 bytes), 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 SMO-E511 performs the INQUIRY command and does not clear the UNIT ATTENTION condition.

The INQUIRY data is returned in the following format:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Peripheral Device Type							
1	RMB	Device-Type Qualifier						
2	ISO Version		ECMA Version			ANSI-Approved Version		
3	Reserved							
4	Additional Length (1FH)							
5	Reserved							
6	Reserved							
7	Reserved							
8-15	Vendor Identification (in ASCII)							
16-31	Product Identification (in ASCII)							
32-35	Revision Level (in ASCII)							

If the drive block is properly connected to the SCSI controller block, responds to the selection from the SCSI controller block and detects the Write-Once media is present in the drive, the INQUIRY data is returned with peripheral device type field set to 04H (Write-once Read-multiple device). Otherwise, it is returned with the field set to 00H (Rewritable media present) or 7FH (Logical unit not present). As the SMO-E511 does not support logical unit number 1 through 7, an INQUIRY command to these logical units always returns 7FH for the peripheral device type.

A removable medium (RMB) bit of 1 indicates the medium is removable. The SMO-E511 only supports removable media, so this bit is always set to 1. The SMO-E511 is not using the device-type qualifier field currently, and returns 0. ISO version, ECMA version, and ANSI-approved version fields indicate compliance of the current firmware to these standards. The additional length indicates the additional parameter length in bytes. This field always returns 31 (1FH). The vendor identification field returns "SONY" in ASCII. The product identification field returns "SMO-C511-xxE" in ASCII (xx is arbitrary numerical characters in ASCII). The revision level field returns the current firmware version in "x.xx" format (x is arbitrary numerical characters in ASCII).

MODE SELECT 15H

FUNCTION

Sets medium or drive unit parameters.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (15H)							
1	Logical Unit Number			PF	Reserved			
2	Reserved							
3	Reserved							
4	Parameter List Length							
5	Reserved						Flag	Link

EXPLANATION

The MODE SELECT command provides a means for the initiator to specify medium or drive unit parameters. The parameter list length specifies the length in bytes of the MODE SELECT parameter list that will be transferred in the DATA OUT phase. A parameter list length of 0 indicates that no data is transferred. This condition is not considered as an error. The MODE SELECT parameter list contains a four-byte header, followed by 0 or more pages. A page format (PF) bit has no effect to SMO-E511. The MODE SELECT parameter list is sent with the page format, and 0 or more pages can be sent. The format of the MODE SELECT parameter list is as follows:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
MODE SELECT Header								
0	Reserved							
1	Medium Type (00H)							
2	Reserved							EBC
3	Block Descriptor Length (00H)							
Page(s)								
0	Reserved			Page Code				
1	Page -Specific Parameter Length							
2 | n	Page-Specific Parameters							

The medium type field has to contain 0 (indicates default medium type) and the block descriptor field has to contain 0.

If the EBC (Enable Blank Check) bit is set to 1, the blank checking is performed following failed Read operation, or prior to Write and Write & Verify operations. If the EBC bit is 0, the blank checking is disabled for Read and Write operations. However the blank checking cannot be disabled for a Write& Verify command.

The SMO-E511 supports the following pages.

Page Code	Description
01H	Error Recovery Parameters
02H	Disconnect/Reconnect Control Parameters
20H*	Format Parameters

Page 01H Error Recovery Parameters

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reserved		Page Code (01H)					
1	Page Length (06H)							
2	AWRE	Reserved		RC	Reserved			
3	Retry Count							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							

* This page is a vendor unique page.

An automatic write reallocation enable (AWRE) bit of 1 (MODE SELECT command 15H) enables the automatic reallocation of the defective sector(s) when the SMO-E511 detects the medium error during the write operation of the write-type command (the WRITE (0AH), WRITE (2AH), WRITE AND VERIFY (2EH) command) or verify error during the WRITE AND VERIFY command. This bit is effective only when the disk is formatted as Format Mode 3. A read continuous (RC) bit of 1 requests that the SMO-E511 transfers the data without adding delays which would increase data integrity during the READ command. If this bit is set to 1, the SMO-E511 does not correct the error bytes by the ECC. The Retry Count field specifies how many times the SMO-E511 retries the read/write operation before it reports the error to the initiator.

Page 02H Disconnect/Reconnect Control Parameters

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reserved		Page Code (02H)					
1	Page Length (0AH)							
2	Buffer Full Ratio							
3	Buffer Empty Ratio							
4-11	Reserved							

The buffer full ratio and the buffer empty ratio fields indicate the numerator of a fractional multiplier that has 256 as its denominator. The buffer full ratio field indicates, on read-type commands, how full the buffer shall be prior to reconnecting. The buffer empty ratio field indicates, on write-type commands, how empty the buffer shall be prior to reconnecting.

Page 20H Format Parameters

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reserved		Page Code (20H)					
1	Page Length (0AH)							
2	Format Mode							
3-11	Format Mode Specific Data							

SMO-E511 only supportes the format mode 3 for the Write-Once media. Depending on byte 3, the following two types of formats (Type 0 and Type 1) exist.

Format Mode 3

Type 0

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
2	Format Mode (03H)							
3	Type (00H)							
4	Size of User Band (MSB)							
5	Size of User Band							
6	Size of User Band							
7	Size of User Band (LSB)							
8	Size of Spare Band (MSB)							
9	Size of Spare Band (LSB)							
10	Reserved							
11	Reserved							

The size of user band field indicates the length of a band in number of logical blocks. The size of spare band field indicates the length of a spare band located beside a user band in number of logical blocks. In Format Mode 3, each spare band consists of only an upper spare band, then the number of allocated spare sectors per band is equal to the specified value.

Type 1

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
2	Format Mode (03H)							
3	Type (01H)							
4	Reserved							
5	Reserved							
6	Number of Bands (MSB)							
7	Number of Bands (LSB)							
8	Size of Spare Band (MSB)							
9	Size of Spare Band (LSB)							
10	Reserved							
11	Reserved							

The number of bands field indicates how many bands exist in the medium. The size of spare band field indicates the length of a spare band in number of logical blocks. The meaning of 'size of spare band field' is the same as Type 0.

The default value of the parameters is as follows. This value is set when power on reset, SCSI bus reset or BUS DEVICE RESET message is received. (If the medium is inside of the drive when RESET condition happens, saved value is retrieved from the medium (if it exists) and set to the current value. It means that the default value is overridden by the saved value in the medium)

page	field	default value
01H	AWRE	0
01H	EBC	1
01H	RC	0
01H	Retry Count	2
02H	Buffer Full Ratio	80H
02H	Buffer Empty Ratio	80H
20H	Format Mode	3
20H	Type	1
20H	Number of Band	1
20H	Size of Spare Band	2048

RESERVE 16H

FUNCTION

Gains the exclusive control of a specified logical unit.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (16H)							
1	Logical Unit Number			3rdPty	Third Party Device ID			Rsrvd
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved						Flag	Link

EXPLANATION

This command is used to reserve the logical unit for exclusive use of the initiator. The reservation is effective until the reservation is superseded by another valid RESERVE command from the initiator that makes the reservation or until released by a RELEASE command from the same initiator, by a BUS DEVICE RESET message from any initiator, or by a RESET condition. If the logical unit is reserved for another initiator, attempts to perform any command except the REQUEST SENSE and INQUIRY command on the reserved logical unit is rejected with RESERVATION CONFLICT status.

If the third-party (3rdPty) bit is set to 1, the logical unit is reserved for the SCSI device specified in the third-party device ID field. This option is called as a third-party reservation. It is intended for use in multiple-initiator systems. If the 3rdPty bit is set to 0, the specified logical unit is reserved for the initiator which issued the RESERVE command.

An initiator that holds a current reservation may modify that reservation by issuing another RESERVE command to the same logical unit. The superseding RESERVE command releases the previous reservation state when the new reservation request is granted.

RELEASE 17H

FUNCTION

Releases a specified logical unit from the reservation state.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (17H)							
1	Logical Unit Number			3rdPty	Third Party Device ID			Rsrvd
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved						Flag	Link

EXPLANATION

The RELEASE command is used to release the specified logical unit which was previously reserved by the initiator. An attempt to release the logical unit which is not in the reservation state is not considered as an error. In this case, the SMO-E511 returns a GOOD status.

When the logical unit is reserved using the third-party reservation option, the initiator that issued the RESERVE command with the third-party reservation option has to release the logical unit using the third-party release option. If the third-party (3rdPty) bit is set to 1, the reservation of the logical unit for the initiator specified in the third-party device ID field is released. This option is called third-party release. If the 3rdPty bit is set to 0, the reservation of the logical unit for the initiator which issued the RELEASE command is released.

MODE SENSE 1AH

FUNCTION

Reads medium or drive unit parameters.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (1AH)							
1	Logical Unit Number			PF	Reserved			
2	PC		Page Code					
3	Reserved							
4	Allocation Length							
5	Reserved						Flag	Link

EXPLANATION

The MODE SENSE command provides a means for the initiator to read the medium or drive unit parameters. The allocation length field specifies the number of bytes that the initiator has allocated for the returned MODE SENSE data. An allocation length of 0 indicates that no MODE SENSE data has been transferred. This condition is not considered as an error. The SMO-E511 transfers allocation length bytes or all available MODE SENSE data, whichever is less.

A page format (PF) bit of 1 indicates that the MODE SENSE data is transferred in the format specified by the page control (PC) field and the page code field of the CDB. The PC field defines the type of parameter values to be returned as follows. In case of a PF bit of 0, the PC and page code field have the same meaning as in case of a PF bit of 1.

bit 7	bit 6	Type of parameter Values
0	0	Current Values
0	1	Changeable Values
1	0	Default Values
1	1	Saved Values

The page code field specifies which page or pages are to be returned. The page code 01H, 02H and 20H are available for the SMO-E511. If 3FH is specified as a page code, all the pages (01H, 02H and 20H) are

sent to the initiator. In case of the page code of 0, all the pages are sent to the initiator as same as with the page code of 3FH. If the Format Mode is 3 and Page Control (PC) field bits are 11 for Saved Values, only page code 20H can be used.

The MODE SENSE data contains a four-byte header, followed by zero or more pages.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Sense Data Length							
1	Medium Type (00H)							
2	WP	Reserved						EBC
3	Block Descriptor Length (00H)							
Page(s)								
0	PS	Rsrvd	Page Code					
1	Page -Specific Parameter Length							
2 | n	Page-Specific Parameters							

The sense data length specifies the length in bytes of the following MODE SENSE data. The medium type field always returns 0 (default medium type). A write protected (WP) bit of 1 indicates that the medium is write protected. A WP bit of 0 indicates that the medium is write enabled. The parameters saveable (PS) bits of each page header are set to 1 to indicate that the supported parameters can be saved to the medium by the SMO-E511. Refer to the MODE SELECT command for detailed information about each page.

If the EBC (Enable Blank Check) bit is set to 1, blank checking is performed following failed Read operation, or prior to Write and Write&Verify operations. If the EBC bit is 0, the blank checking is disabled for Read and Write operations. However the blank checking cannot be disabled for a Write& Verify command.

START/STOP UNIT 1BH

FUNCTION

Starts or stops rotating the medium, and/or ejects the medium from the drive unit.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (1BH)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved						Eject	Start
5	Reserved						Flag	Link

EXPLANATION

This command is used to start or stop rotating the medium inside the drive unit, and/or to eject the medium from the specified logical unit. A start bit of 1 requests the SMO-E511 to start rotating the medium. A start bit of 0 requests the SMO-E511 to stop rotating the medium. An eject bit* of 1 indicates that the medium is to be unloaded if the start bit is 0. If both the eject bit and the start bit are set to 1, the START/STOP UNIT command returns the CHECK CONDITION status.

* The specification of this bit is based on SCSI-2 draft. This bit is not defined in *ANSI X3.131-1986* or *CCS Rev 4B.*

RECEIVE DIAGNOSTIC RESULTS 1CH

FUNCTION

Requests analysis data to be sent to the initiator.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (1CH)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Allocation Length (MSB)							
4	Allocation Length (LSB)							
5	Reserved						Flag	Link

EXPLANATION

The RECEIVE DIAGNOSTIC RESULTS command requests analysis data be sent to the initiator after completion of a SEND DIAGNOSTIC command. The allocation length specifies the number of bytes that the initiator has allocated for returned diagnostic data. An allocation length of 0 indicates that no DIAGNOSTIC data* is to be transferred. This condition is not considered as an error. The SMO-E511 transfers allocation length bytes or all available DIAGNOSTICS data (20 bytes), whichever is less.

The DIAGNOSTIC data is returned in the following format:

* This data is a vendor unique data.

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Parameter Length (13H)							
1	Reserved							
2	Error Source				Reserved			
3	Test 7	Test 6	Test 5	Test 4	Test 3	Test 2	Test 1	Test 0
4	Internal Error Code fot Test 0 (MSB)							
5	Internal Error Code fot Test 0 (LSB)							
6	Internal Error Code fot Test 1 (MSB)							
7	Internal Error Code fot Test 1 (LSB)							
8	Internal Error Code fot Test 2 (MSB)							
9	Internal Error Code fot Test 2 (LSB)							
10	Internal Error Code fot Test 3 (MSB)							
11	Internal Error Code fot Test 3 (LSB)							
12	Internal Error Code fot Test 4 (MSB)							
13	Internal Error Code fot Test 4 (LSB)							
14	Internal Error Code fot Test 5 (MSB)							
15	Internal Error Code fot Test 5 (LSB)							
16	Internal Error Code fot Test 6 (MSB)							
17	Internal Error Code fot Test 6 (LSB)							
18	Internal Error Code fot Test 7 (MSB)							
19.	Internal Error Code fot Test 7 (LSB)							

The Error Source contains information about the failure source. Bit 0 to 7 of the byte 3 (Test 0 to Test 7) contains each diagnostic result. A Test n (n=0, 1, ..7) of 1 indicates that a specified diagnostic test fails. A Test n of 0 indicates that it passes successfully. Bytes 4 to 15 contain each Internal Error Code from the specified logical unit that gives more detailed information about the failure. The Internal Error Code for Test 0 (byte 4) corresponds to the test result, Test 0.

The Error Source and Internal Error Code are explained in Appendix A. (Refer to Appendix A for details)

SEND DIAGNOSTIC 1DH

FUNCTION

Requests the SMO-E511 to perform diagnostic tests.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (1DH)							
1	Logical Unit Number			Reserved		SelfTest	DevOfL	UnitOfL
2	Reserved							
3	Parameter List Length (LSB)							
4	Parameter List Length (LSB)							
5	Reserved						Flag	Link

EXPLANATION

The SEND DIAGNOSTIC command requests the SMO-E511 to perform diagnostic tests on the SCSI controller block, on the drive block, or on both. This command should be followed by a RECEIVE DIAGNOSTIC RESULTS command, except when the self test (SelfTest) bit is 1. The parameter list length specifies the length in bytes of the SEND DIAGNOSTIC parameter list* that is transferred during the DATA OUT phase. A parameter list length of 0 indicates that no data is transferred. This condition is not considered as an error. A logical unit off line (UnitOfL) bit of 1 enables write operations on user medium or operations that affect user visible medium positioning. A SCSI device off-line (DevOfL) bit of 1 enables diagnostic operations that adversely affect operations to the logical unit on the SMO-E511. A SelfTest bit of 1 directs the SMO-E511 to complete its default self test. If the self test is requested, the parameter list length has to be set to 0. If the self test successfully passes, the command is terminated with a GOOD status; otherwise, the command is terminated with a CHECK CONDITION status and, if extended sense is requested, the sense key will be set to HARDWARE ERROR. A SelfTest of 0 directs the SMO-E511 to perform a specified diagnostic test, then the parameter list length has to be set to 6.

* This parameter list is a vendor unique parameter list.

The default self test (SelfTest=1) in the SMO-E511 performs the following diagnostic operations sequentially:

Step	Description
0	SCSI controller block Self Diagnostics
1	Drive block Self Diagnostics
2	Drive Functional Diagnostics
3	Disk Access Diagnostics

The function in each diagnostic operation is explained in the advanced diagnostics in detail.

The advanced diagnostic test is invoked when the initiator sets the SelfTest bit to 0 and sends the SEND DIAGNOSTIC parameter list. The format of the SEND DIAGNOSTIC parameter list is as follows:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Subcommand Code							
1	Reserved							
2	Loop Count							
3	Test 7	Test 6	Test 5	Test 4	Test 3	Test 2	Test 1	Test 0
4	Reserved							
5	Reserved							

The Subcommand Code is used for selecting a particular diagnostics. Effective subcommands are:

Subcommand Code	Description
00H	SCSI controller block Self Diagnostics
01H	Drive block Self Diagnostics
02H	Drive Functional Diagnostics
03H	Disk Access Diagnostics

The Loop Count contains the number of repetition times of the diagnostics. In case of Loop Count 00H, it means 256 repetitions. From Test 0 through Test 7, a bit of 1 direct the SMO-E511 to skip the specified test, a bit of 0 directs to perform the specified test. The meaning of Test n (n=0, 1, ..7) is defined individually for each subcommand.

Subcommand 00H SCSI controller block Self Diagnostics

Test procedures in the SCSI controller block Self Diagnostics are:

Step	Description
0	ROM (MCP-X.XX) Test
1	RAM Test
2	HIC (Host Interface Controller) Chip Test
3	BMM (Buffer Memory Manager) Chip Test
4	DIC (Drive Interface Controller) Chip Test
5	ECC (ECC processor) Chip Test
6	Buffer Memory Test
7	Reserved

Subcommand 01H Drive block Self Diagnostics

Test procedures in the Drive block Self Diagnostics are:

Step	Description
0	Stop Spindle Test
1	DCN (Drive Control block) Test
2	ACN (Analog Control block) Test
3	BCN (Bias magnet Control block) Test
4	Reserved
5	Reserved
6	Reserved
7	Reserved

Subcommand 02H Drive Functional Diagnostics

Test procedures in the Drive Functional Diagnostics are:

Step	Description
0	Stop Spindle Test
1	Start Spindle Test
2	Select ROM Mode Test
3	Select MO Mode Test
4	High Order Seek Test
5	Seek Test
6	Magnet Mode 0 Test
7	Magnet Mode 1 Test

Subcommand 03H Disk Access Diagnostics

Test procedures in the Disk Access Diagnostics are:

Step	Description
0	Inner SFP Read Test
1	Inner Manufacturer Zone Test
2	Reserved
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved

PREVENT/ALLOW MEDIUM REMOVAL 1EH

FUNCTION

Prevents or allows removal of the medium in the logical unit.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (1EH)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							Prevent
5	Reserved						Flag	Link

EXPLANATION

The PREVENT/ALLOW MEDIUM REMOVAL command requests that the SMO-E511 enables or disables the removal of the medium in the drive unit. When the prevent bit is set to 0, this command allows removal of the medium. If the prevent bit is set to 1, it inhibits removal of the medium. When medium removal is inhibited, the eject button of the drive unit is disabled and a START/STOP UNIT command with its eject bit set to 1 returns the CHECK CONDITION status.

The prevention of medium removal condition terminates upon receipt of a PREVENT/ALLOW MEDIUM REMOVAL command with the prevent bit set to 0, or by the receipt of a BUS DEVICE RESET message from any initiator or a RESET condition.

READ CAPACITY 25H

FUNCTION

Reads capacity of the medium.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (25H)							
1	Logical Unit Number			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Reserved							
8	Reserved							PMI
9	Reserved						Flag	Link

EXPLANATION

The READ CAPACITY command provides a means for the initiator to request information regarding the capacity of the logical unit. The last logical block address of the medium and the length of the logical block are returned. The partial medium indicator (PMI) bit has no effect on the returned data in the SMO-E511. When the PMI bit is set to 0, the logical block address in the CDB must be set to 0. When the PMI bit is set to 1, the logical block address in the CDB does not need to be set to 0. The capacity of the logical unit depends on the format mode and the sector size of the medium.

The READ CAPACITY data format is as follows.

Byte	Description
0	Logical Block Address (MSB)
1	Logical Block Address
2	Logical Block Address
3	Logical Block Address (LSB)
4	Block Length (MSB)
5	Block Length
6	Block Length
7	Block Length (LSB)

The block length field contains the length of the specified block in bytes.

READ 28H

FUNCTION

Reads data from the specified logical block address.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (28H)							
1	Logical Unit Number			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Reserved						Flag	Link

EXPLANATION

The READ command requests the SMO-E511 to read the data from the medium and then transfer the data to the initiator. The logical block address field specifies the logical block at which the read operation begins. The transfer length field specifies the number of contiguous logical blocks of data to be transferred. A transfer length of 0 indicates that no logical blocks are transferred. This condition is not considered as an error. Any other value indicates the number of logical blocks to be transferred. Unless the RC bit of the mode select parameters is set to 1, the data read from the medium is corrected by the ECC.

If the EBC bit is set to 1, blank checking is performed. (See the Mode Select command for more details.)

The function of this command is exactly the same as that of the Group 0 READ command (08H). However, the transfer length can be specified in 16 bits, and the relative addressing is available for this command.

WRITE 2AH

FUNCTION

Writes data to the specified logical block address.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (2AH)							
1	Logical Unit Number			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Reserved						Flag	Link

EXPLANATION

The WRITE command requests the SMO-E511 to write data to the medium. The logical block address field specifies the logical block at which the write operation begins. The transfer length field specifies the number of contiguous logical blocks of data to be transferred. A transfer length of 0 indicates that no logical blocks are transferred. This condition is not considered as an error. Any other value indicates the number of logical blocks to be transferred. When this command is performed, the SMO-E511 automatically adds the error correction code (ECC) to each logical block data and then writes to the medium.

If the AWRE bit is set to 1, and the specified block is detected as defective during the write operation of this command (in this case, ID error, tracking failure, or focus failure due to the medium defect), then the automatic write reallocation occurs.

If the EBC bit is set to 1, blank checking is performed. (See the Mode Select command for more details.)

The function of this command is exactly the same as that of the Group 0 WRITE command (0AH). However, the transfer length can be specified in 16 bits, and the relative addressing is available for this command.

SEEK 2BH

FUNCTION

Moves the optical head to the physical track where the specified logical block exists.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (2BH)							
1	Logical Unit Number				Reserved			
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Reserved							
8	Reserved							
9	Reserved						Flag	Link

EXPLANATION

The SEEK command requests the drive unit to move the optical head to the physical track where the specified logical block exists. This function is exactly the same as that of Group 0 SEEK command (0BH).

WRITE AND VERIFY 2EH

FUNCTION

Writes data to the medium and then verifies the written data by checking the error correction code.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (2EH)							
1	Logical Unit Number			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Reserved						Flag	Link

EXPLANATION

The WRITE AND VERIFY command requests the SMO-E511 to write data to the medium and then verify the written data by checking the error correction code (ECC). The logical block address field specifies the logical block at which the write operation begins. The transfer length field specifies the number of contiguous logical blocks of data to be transferred. A transfer length of 0 indicates that no logical blocks are transferred. This condition is not considered as an error. Any other value indicates the number of logical blocks to be transferred. During the write operation, the SMO-E511 automatically adds the ECC to each logical block data. Verification is performed by reading written data and checking the ECC.

If the AWRE bit is set to 1, and the specified block is detected as defective during the write operation of this command (in this case, !D error, tracking failure, or focus failure due to the medium defect), then the automatic write reallocation occurs. Furthermore, if the verify error is detected during its verification process, the SMO-E511 also reallocates the alternative block automatically. The verification error threshold is set about half of the error correction capability of the SMO-E511.

Even if the EBC bit is set to 0, blank checking is performed. (See the Mode Select command for more details.)

VERIFY 2FH

FUNCTION

Verifies the data starting from the specified logical block address by checking the error correction code.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (2FH)							
1	Logical Unit Number			Reserved		BV	Reserved	RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Verification Length (MSB)							
8	Verification Length (LSB)							
9	Reserved						Flag	Link

EXPLANATION

The VERIFY command has two mode of operation depending on the set of BV bit. If the BV bit is set to 0, the VERIFY command requests the SMO-E511 to verify the written data by checking the error correction code (ECC). The verification error threshold is set about half of the error correction capability of the SMO-E511. If the BV bit is set to 1, the VERIFY command requests the SMO-E511 to verify the block are blank (unwritten) by using the blank search method.

The logical block address field specifies the logical block at which the verification begins. The verification length field specifies the number of contiguous logical blocks of data to be verified. A verification length of 0 indicates that no logical blocks are verified. This condition is not considered as an error. Any other value indicates the number of logical blocks to be verified.

READ DEFECT DATA 37H

FUNCTION

Reads the medium defect information

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (37H)							
1	Logical Unit Number			Reserved				
2	Reserved			PList	GList	Defect List Format		
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Allocation Length (MSB)							
8	Allocation Length (LSB)							
9	Reserved						Flag	Link

EXPLANATION

The READ DEFECT DATA command requests that the SMO-E511 transfer the medium defect data to the initiator. The allocation length field specifies the number of bytes that the initiator has allocated for the returned READ DEFECT DATA. An allocation length of 0 indicates that no READ DEFECT DATA is transferred. This condition is not considered as an error. The SMO-E511 transfers allocation length bytes or all available READ DEFECT DATA, whichever is less.

A P list (PList) bit of 1 requests the SMO-E511 to return a primary list of defects. A G list (GList) bit of 1 requests the SMO-E511 to return a grown list of defects. The defect list format field specifies the format of the defect list returned. This command returns the defect lists depending on the effective format mode of the medium, not depending the current format mode. Hence the effective format mode is 3, the PList corresponds to the defect list recorded in the PDL, and the GList corresponds the defect list recorded in the PDL+SDL. But only the physical sector format is available for the READ DEFECT DATA command. Available combination of the parameters are as follows:

PList (bit 4)	GList (bit 3)	Defect List Format (bit 2)	(bit 1)	(bit 0)	Description
1	0	1	0	1	P list is sent in physical format.
0	1	1	0	1	G lists is sent in physical format.
All other codes					Reserved

The READ DEFECT DATA contains a four-byte header followed by zero or more defect descriptors. Refer to the FORMAT UNIT command for the description of the defect descriptor. The READ DEFECT DATA header is as follows:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reserved							
1	Reserved			PList	GList	Defect List Format		
2	Defect List Length (MSB)							
3	Defect List Length (LSB)							

The PList, GList and defect list format field have the same meaning as that of CDB. The defect list length specifi the total length in bytes of the defect descriptors that follow.

WRITE BUFFER 3BH

FUNCTION

Writes data to the data buffer of the SMO-E511.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (3BH)							
1	Logical Unit Number			Reserved				BCV
2	Reserved							
3	Reserved							
4	Buffer Offset (MSB)							
5	Buffer Offset (LSB)							
6	Reserved							
7	Byte Transfer Length (MSB)							
8	Byte Transfer Length (LSB)							
9	Reserved						Flag	Link

EXPLANATION

Normally, this command is used in conjunction with the READ BUFFER command to test the data buffer memory of the SMO-E511 and the SCSI bus integrity. The transfer data consists of a four-byte header and the WRITE BUFFER data. Transfer data length is specified by the byte transfer length field. A byte transfer length of 0 indicates that no Write Buffer Header and no WRITE BUFFER data is transferred. This condition is not considered as an error. As maximum transfer data length is 65535 bytes, up to 65531 bytes of WRITE BUFFER data can be transferred. A buffer control valid (BCV) bit of 0 indicates that the WRITE BUFFER data is stored in the buffer memory starting from address 0. In this case, the buffer offset field must be set to 0. When the BCV bit is set to 1, the buffer offset field indicates the starting address of the buffer memory where the WRITE BUFFER data is written. The SMO-E511 has the 65536 bytes of buffer memory. If the written data exceeds address 65535, the exceeded data is written from address 0 continuously. The Write Buffer Header is as follows:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							

READ BUFFER 3CH

FUNCTION

Reads data form the data buffer of the SMO-E511.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (3CH)							
1	Logical Unit Number			Reserved				BCV
2	Reserved							
3	Reserved							
4	Buffer Offset (MSB)							
5	Buffer Offset (LSB)							
6	Reserved							
7	Byte Transfer Length (MSB)							
8	Byte Transfer Length (LSB)							
9	Reserved						Flag	Link

EXPLANATION

Normally, this command is used in conjunction with the WRITE BUFFER command to test the data buffer memory of the SMO-E511 and the SCSI bus integrity. The transfer data consists of a four-byte header and the READ BUFFER data. Transfer data length is specified by the byte transfer length field. A byte transfer length of 0 indicates that no Read Buffer Header and no READ BUFFER data is transferred. This condition is not considered as an error. As maximum transfer data length is 65535 bytes, up to 65531 bytes of READ BUFFER data can be transferred. A buffer control valid (BCV) bit of 0 indicates that the READ BUFFER data is read from the address 0 of the buffer memory. In this case, the buffer offset field must be set to 0. When this bit is set to 1, the READ BUFFER data is read from the address specified by the byte offset field. The SMO-E511 has the 65536 bytes of buffer memory. If the address of the transfer data exceeds 65535, data is read from address 0 continuously. The Read Buffer Header is as follows:

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Reserved							
1	Reserved							
2	Available Length (MSB)							
3	Available Length (LSB)							

The available length field indicates the available READ BUFFER data length in bytes. The SMO-E511 always r 65531 for this.

READ LONG* 3EH

FUNCTION

Reads data from the specified logical block address with ECC data.

CDB

Byte	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	Operation Code (3EH)							
1	Logical Unit Number			Reserved				RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Reserved						Flag	Link

EXPLANATION

The READ LONG command requests the SMO-E511 to read the data and error correction code (ECC) from the medium and transfer the data and ECC information to the initiator. The logical block address field specifies the logical block at which the read operation begins. The transfer length field specifies the number of contiguous logical blocks of data and ECC information to be transferred. A transfer length of 0 indicates that no data is transferred. This condition is not considered as an error. Any other value indicates the number of logical blocks to be transferred. The READ LONG command does not correct the data with the ECC. When the logical block length is 1024 (512) bytes, the length of ECC information is 176** (98) bytes

* The definition of this command is different from that of *CCS Rev 4B*.

** This value includes the ECC, CRC and control bytes.