FUJITSU

M2622S/SA/SB
M2623S/SA/SB
M2624S/SA/SB

Intelligent Disk Drives
OEM Manual
— Specifications & Installation —

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LIST OF EFFECTIVE PAGES

PAGE	REV
Cover	03
Blank	—
i	03
ii	02
iii	03
iv	03
v	02
vi	02
vii	02
viii	02
ix	02
x	02
xi	02
xii	02
xiii	02
xiv	02
xv	02
xvi	02
xvii	02
xviii	02
1-1	02
1-2	02
1-3	02
1-4	02
1-5	02
1-6	03
1-7	02
1-8	02
1-9	02
1-10	02
2-1	02
2-2	02
2-3	02
2-4	02
2-5	02
2-6	02
2-7	02
2-8	02
2-9	02
2-10	02
2-11	02
2-12	02
2-13	02
2-14	02
2-15	02
2-16	02
2-17	02
2-18	02
3-1	02
3-2	02
3-3	02

PAGE	REV
3-4	02
3-5	02
3-6	02
3-7	02
3-8	03
3-9	02
3-10	02
3-11	02
3-12	02
3-13	02
3-14	02
3-15	02
3-16	02
3-17	02
3-18	02
4-1	02
4-2	02
4-3	02
4-4	02
4-5	02
4-6	02
4-7	02
4-8	02
4-9	02
4-10	02
4-11	02
4-12	02
4-13	02
4-14	02
4-15	02
4-16	02
4-17	02
4-18	02
4-19	02
4-20	02
4-21	02
4-22	02
4-23	02
4-24	02
4-25	02
4-26	02
5-1	02
5-2	02
5-3	02
5-4	02
5-5	02
5-6	02
5-7	02
5-8	02
5-9	02
5-10	02

PAGE	REV
5-11	02
5-12	02
5-13	02
5-14	02
5-15	02
5-16	02
5-17	02
5-18	02
5-19	02
5-20	02
5-21	02
5-22	02
5-23	02
5-24	02
5-25	02
5-26	02
5-27	02
5-28	02
5-29	02
5-30	02
5-31	02
5-32	02
5-33	02
5-34	02
6-1	02
6-2	02
6-3	02
6-4	02
6-5	02
6-6	02
6-7	02
6-8	02
6-9	02
6-10	02
A-1	03
A-2	02
B-1	02
B-2	02
C-1	02
C-2	03
Reader Comment Card	—
Blank	—
Cover	03

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PREFACE

This manual describes the M2622Sx/M2623Sx/M2624Sx 3.5-inch fixed disk drives with an embedded SCSI controller.

This manual detailes the specifications and functions of the above disk drive, and gives the requirements and procedures for installing it into a host computer system.

This manual is written for users who have a basic understanding of fixed disk drives and their use in computer systems. The MANUAL ORGANIZATION section describes organization and scope of this manual. The need arises, use the other manuals.

Chapter 1 GENERAL DESCRIPTION

This chapter introduces the M2622Sx/M2623Sx/M2624Sx disk drives and discusses their standard features, hardware, and system configuration.

Chapter 2 SPECIFICATIONS

This chapter gives detailed specifications of the M2622Sx/M2623Sx/M2624Sx disk drives and their installation environment

Chapter 3 DATA FORMAT

This chapter describes the data structure of the disk, the address method, and what to do about media defects.

Chapter 4 INSTALLATION PREREQUISITES

This chapter describes the basic physical and electrical requirements for installing M2622Sx/M2623Sx/M2624Sx disk drives.

Chapter 5 INSTALLATION

This chapter explains how to instal M2622Sx/M2623Sx/M2624Sx disk drives. It includes the notice and procedures for setting device number and operation modes, mounting the disk drive, connecting the cables, and confirming drive operation.

Chapter 6 DIAGNOSIS and MAINTENANCE

This chapter describes the automatic diagnosis, and maintenance of the M2622Sx/M2623Sx/M2624Sx disk drive.

APPENDIX A to C

The appendixes give supplementary information, including the location of mounting setting terminal, and connectors, a table of setting items, and the signal assignments of interface connectors.

The model numbers have a suffix that describes the electrical requirements of the SCSI interface between host system and disk drive and the data formatted at the factory.
(example: M2624S, M2622SA, M2623SB, M2624SA)
This manual uses M2624 as representative model numbers.
The M2624 is abbreviated "IDD", "Drive", or "Device".

CONVENTIONS

This manual uses the following conventions:

Warning: Warning indicates that fatal damage to the disk drive may occur if the user does not perform the procedure correctly.

Note: Note indicates that inconvenience to the user, such as loss of data, may occur if the user does not perform the procedure correctly, and it indicates information that should be called to the attention of the user.

DISCLAIMER

Failure of the M2622Sx/M2623Sx/M2624Sx intelligent disk drive is defined as a failure requiring adjustments, repairs, or replacement. Fujitsu is not responsible for drive failures caused by misuse by the user, poor environmental conditions, power trouble, host problems, cable failures, or any failure not caused by the drive itself.

MANUAL ORGANIZATION

OEM MANUAL Specifications & Installation <This manual>	1. General Description 2. Specifications 3. Data Format 4. Installation Prerequisites 5. Installation 6. Diagnosis and Maintenance
OEM MANUAL SCSI Physical Specifications	1. SCSI Bus 2. SCSI Message 3. SISI Bus Error Recovery Procedure
OEM MANUAL SCSI Logical Specifications	1. Command Processing 2. Data Buffer Management 3. Command Specification 4. Sense Data and Error Recovery Procedure 5. Disk Management
CE MANUAL	1. Specifications and Unit Configuration 2. Diagnosis and Maintenance 3. Troubleshooting and Fault isolation 4. Removal and Replacement Procedures 5. Theory of Operation

FUNCTIONAL LIMITATION

The specifications and functions described in this manual are limited as follows according to the version of this drive.

Usable version of these function are noticed by ENGINEERING CHANGE REQUEST/NOTICE.

	Function	Usable version of this drive		
		Machine version	EPROM version	Production revision of standard INQUIRY data (ASCII)
1	RECOVER ID command	Current version of this drive cannot use.		
2	RECOVER DATA command			

CONTENTS

FIGURES

TABLES

Glossary

Bus condition: Asynchronous condition for causing SCSI bus status transition. There are two types of bus conditions, ATTENTION and RESET.

Bus phase: Name of an SCSI bus state. The SCSI bus is in one of the following phases: BUS FREE, ARBITRATION, SELECTION, RESELECTION, or INFORMATION TRANSFER. The INFORMATION TRANSFER phase is divided into DATA IN, DATA OUT, COMMAND, STATUS, MESSAGE IN, and MESSAGE OUT phases depending on the type of information being transferred.

CCS: Common Command Set which is the standard SCSI logical specification stipulated by a working committee of ANSI. Functions necessary for direct access devices are defined.

CDB: Command Descriptor Block -- a group of data that describes the command for I/O and is transferred from an initiator to a target.

Command: Issued to a target to direct an input/output operation and written as CDB.

Disconnect: Operation performed by the target to free itself from the SCSI bus and the initiator temporarily when SCSI bus operation becomes unnecessary during command processing.

Initiator: SCSI device that has initiated an input/output operation on the SCSI device. This can be abbreviated as INIT.

Logical unit: Simple unit of equipment that can be directed to perform one I/O operation on the SCSI bus.

LUN: Logical unit number used to identify a logical unit.

Message: Information that controls a series of bus phases and I/O sequence between the initiator and the target on the SCSI bus.

Reconnect: Operation performed by the target to reconnect itself with the initiator when operation on the SCSI bus becomes necessary after disconnection.

SCSI: Small Computer System Interface which is an input/output interface standardized by American National Standard Institute (ANSI). [Standard number: ANSI X3.131-1986]

SCSI device: General term for a device (Input/output device, I/O controller, and host adapter, etc.) connected to on SCSI bus.

SCSI ID: Physical device address used to identify an SCSI device on the SCSI bus. This number is specific to each SCSI device. SCSI IDs are #0 to #7, each corresponding to one bit on the data bus.

Sense code: One-byte of code attached to sense data identify the type of the detected error.

Sense data: Detailed information created by the target when any error is involved in the command termination status. This information is transferred to report the error.

Sense key: Four-bit code attached to sense data to identify the class of the detected error.

Status: One byte of information that is transferred from a target to an initiator on termination of each command to indicate the command termination status.

Target: SCSI device which performs I/O initiated by an initiator. It can be abbreviated as TARG.

REFERENCED STANDARDS

Item	Number	Name	Organization
1	ANSI X3.131-1986	American National Standard for Information Systems — Small Computer System Interface (SCSI)	American National Standards Institute (ANSI)
2	X3T9.2/85-52 Rev 4.B	COMMON COMMAND SET (CCS) of the Small Computer System Interface (SCSI)	American National Standards Institute (ANSI)
3	X3T9.2/86-109 Rev 10.C	Draft proposed American National Standard for Information systems — Small Computer System Interface - 2 (SCSI-2)	American National Standards Institute (ANSI)

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CHAPTER 1 GENERAL DESCRIPTION

This chapter describes the feature and configuration of the M2622Sx/M2623Sx/M2624Sx intelligent disk drives (IDD).

IDDs are high performance large capacity 3.5-inch fixed disk drives with an embedded SCSI controller.

The interface between the IDD and host system is based on SCSI (Small Computer System Interface) standard (ANSI X3.131 - 1986).

The flexibility and expandability of the SCSI, as well as the powerful command set of the IDD, allow the user to construct a high-performance reliable disk subsystem with large storage capacity.

The IDD is available with the following models based upon data format at factory shipment. Data format can be changed from the default format to another format at user site by reinitializing.

- M2622S/M2623S/M2624S: 256 bytes (data block length)
- M2622SA/M2623SA/M2624SA: 512 bytes (data block length)
- M2622SB/M2623SB/M2624SB: 1024 bytes (data block length)

1.1 Standard Features

(1) Compactness

Since the SCSI controller circuit is embedded in the standard 3.5-inch fixed disk drive form factor, the IDD is extremely compact. The IDD can be connected directly to the SCSI BUS of the host system.

(2) SCSI/CCS standard

The IDD provides not only SCSI basic functions but also the following features:

- Arbitration
- Disconnection/reselection
- Data bus parity
- Command set which meets the logical specification of the SCSI CCS (Common Command Set for Direct Access Device) requirements (Rev. 4B)

The SCSI commands can manipulate data through logical block addressing regardless of the physical characteristics of the disk drive. This allows software to accommodate future expansion of system functions.

(3) High speed data transfer

The data transfer rate on the SCSI bus is 3 MB/s maximum in asynchronous mode and 5 MB/s maximum in synchronous mode. Such a high data transfer rate on the SCSI bus can be useful with the large capacity buffer in the IDD.

Notes:

1. The maximum data transfer rate in asynchronous mode may be limited by the response time of initiator and the length of SCSI bus length.

2. The maximum data transfer rate in synchronous mode on the single-ended SCSI bus may be limited by the cable length and transmission characteristics of the SCSI bus.

(4) Continuous block processing

The addressing method of data blocks is logical block address. The initiator can access data by specifying block number in a logically continuous data space without concerning the physical structure of the track or cylinder boundaries.

The continuous processing up to [64K-1] blocks in a command can be achieved, and IDD can perform continuous read/write operation when processing data blocks on several tracks or cylinder.

(5) 240 KB data buffer

Data is transferred between SCSI bus and disk media through the embedded 240 KB data buffer in the IDD.

Since the initiator can control the disconnect/reconnect timing on the SCSI bus by specifying the condition of stored data to the data buffer or empty condition of the data buffer, the initiator can perform the effective input/output operations with utilizing high data transfer capability of the SCSI bus regardless of actual data transfer rate of the disk drive.

(6) Read-ahead cache feature

After executing the READ command, the IDD reads automatically and stores (prefetches) the subsequent data blocks into the data buffer (Read-ahead caching).

The high speed sequential data access can be achieved by transferring the data from the data buffer without reaccessing the disk in case the subsequent command requests the prefetched data blocks.

(7) Command stack feature

The IDD has a command stack feature corresponding to up to 7 initiators. Therefore, the IDD can accept and stack the input/output command issued by another initiator even if the IDD is executing another command. The stacked command is retrieved and executed in stacked order after the present command has completed.

(8) Reserve and release functions

The IDD can be accessed exclusively in the multi-host or multi-initiator environment by using the reserve and release functions.

(9) Error recovery

The IDD can try to recover from errors in SCSI bus or the disk drive using its powerful retry processing. If a recoverable data check occurs, error-free data can be transferred to the initiator after being corrected in the data buffer. The initiator software is released from the complicated error recover processing by these error recovery functions of the IDD.

(10) Automatic alternate block reassignment

If a defective data block is detected during read or write, the IDD can automatically reassign its alternate data block.

(11) Programable data block length

Data can be accessed with fixed block length unit. Data block length is programable, and can be set to the most suitable length, from 180 to 4,096 bytes with 2-byte boundary at formatting time.

(12) Defective block slipping

A logical data block can be reallocated in a physical sequence by slipping the defective data block at formatting. This results in high speed contiguous data block processing without a revolution delay due to defective data block.

(13) High speed positioning

A rotary voice coil motor achieves fast positioning.

(14) Large capacity

A capacity up to 608 MB (unformatted) can be obtained from 3.5-inch disk drives by dividing all cylinders into four partitions and changing the recording density on each partition (constant density recording). The disk subsystem with large capacity can be constructed in the good space efficiency.

(15) Start/Stop of spindle motor

Using the SCSI command, the host system can start and stop the spindle motor.

(16) Diagnosis

The IDD has a diagnostic capability which checks internal controller functions and drive operations to facilitate testing and repair.

(17) Low power consumption

By using highly integrated LSI components, the power consumption of the IDD is very low, and this enables the unit to be used in wide range of ambient temperature, between 5°C and 45°C.

(18) Low noise and low vibration

The IDD is ready, approx. 43 dB (A-scale weighting). This makes it ideal for office use. The IDD has rubber vibration isolators, which minimize the transfer of vibration.

1.2 Hardware Structure

Figure 1.1 shows the IDD outer view. The IDD consists of a disk enclosure (DE), a read/write preamplifier and controller (PCA), and mounting brackets.

The DE is completely sealed and consists of disks, heads, the spindle motor, the actuator, the recirculation filter, the breather filter, the cover, and base.

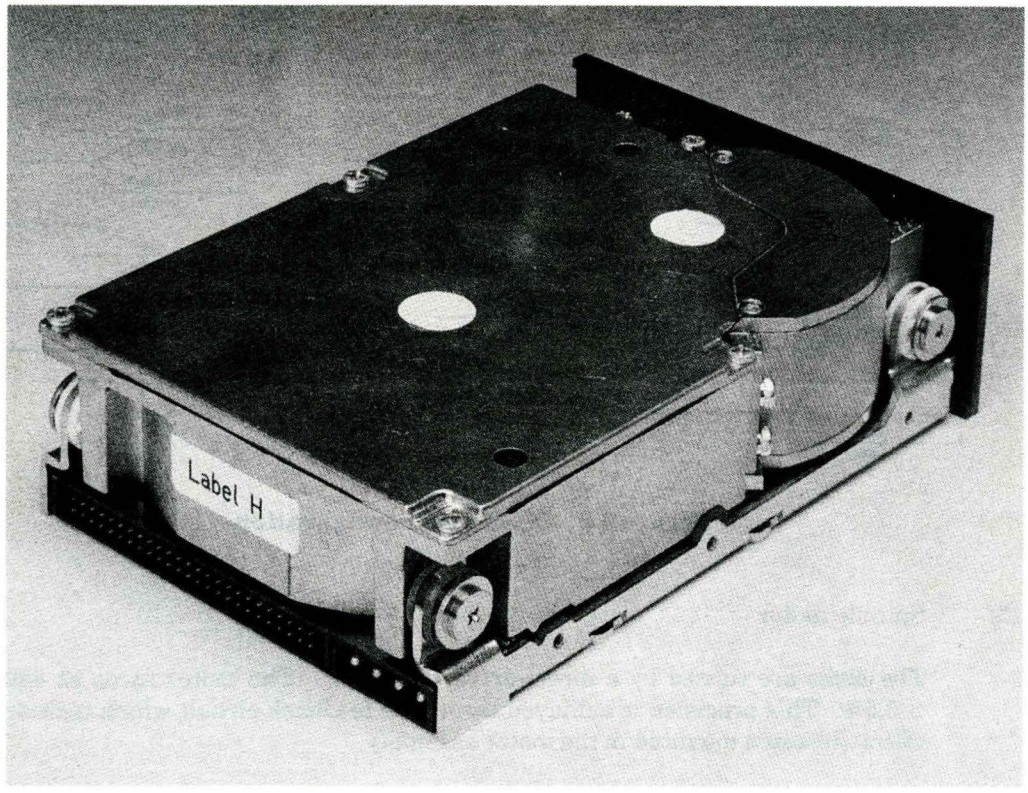

Figure 1.1 M2624S outer view

(1) Disks

The disks have an outer diameter of 95 mm (3.74-inch) and inner diameter of 25 mm (0.98-inch).

The disks are good for at least 10,000 contact starts and stops.

Each model contains following number of disks.

M2622 : 4
M2623 : 5
M2624 : 6

(2) Heads

The CSS (contact start/stop) type heads are in contact with the disks when the disks are not rotating, and automatically float when the rotaion is started. Figure 1.2 shows the configuration of disks and heads. The first disk has a prewritten servo pattern on its top surface (SR) for obtaining positioning control and read/write control information.

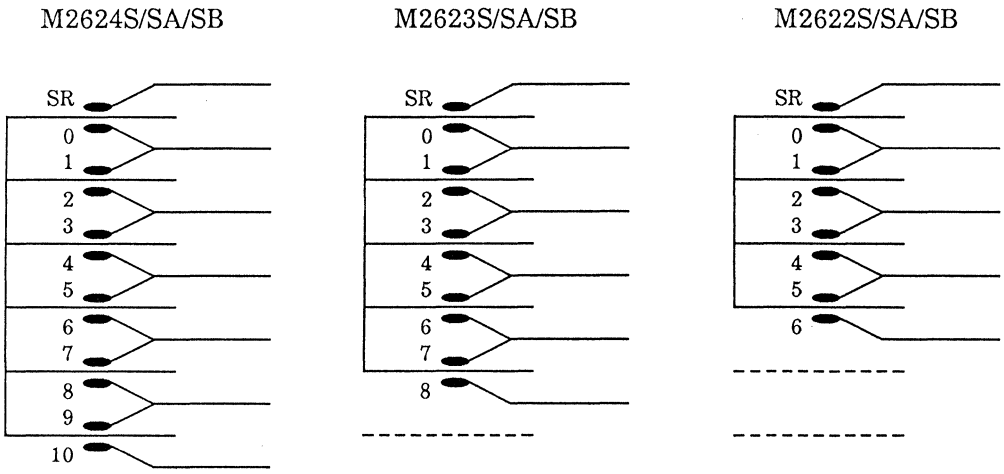

Figure 1.2 Disk/head configuration

(3) Spindle motor

The disks are turned by a direct-drive DC motor. The motor turns at 4400 rpm, ±0.5%. This precision is achieved through a feedback circuit which includes Hall-effect elements mounted in the motor assembly.

(4) Actuator

The actuator, which uses a rotary voice coil motor (VCM), consumes little power and generates little heat. The head assembly on the tip of the actuator arm is controlled by electrical feedback from servo information read out through the servo head.

Servo information is used as a control signal activating the actuator. It is used as track cross information in positioning, and track following information during data write/read. The actuator positions heads on the innermost landing zones over the disk and is locked by the mechanical lock when the power is off or the spindle motor is stopped.

(5) Air circulation (recirculation filter, breather filter)

The heads, disks, and actuator are hermetically sealed inside a disk enclosure (DE) to keep out dust and other pollutants.

The DE has a closed-loop air recirculation system. Using the movement of the rotating disks, air is continuously cycled through a filter. This filter will trap any dust generated inside the enclosure and keep the air inside the DE contaminant free. To prevent negative pressure in the vicinity of the spindle when the disks begin rotating, a breather filter is attached. The breather filter also equalizes the internal air pressure with the atmospheric pressure due to surrounding temperature changes.

(6) Read/write circuit

The read/write circuit uses LSIs and head ICs to prevent errors caused by external noise, thus increases reliability.

(7) Controller circuit

The controller circuit uses LSIs to increase the reliability and uses a high speed Micro Processing Unit (MPU) to increase the performance of the SCSI controller.

1.3 System Configuration

Figure 1.3 shows the system configuration. The IDDs are connected to the SCSI bus of host systems and are always operated as target. The IDDs perform input/ output operation as specified by SCSI devices which operate as initiator.

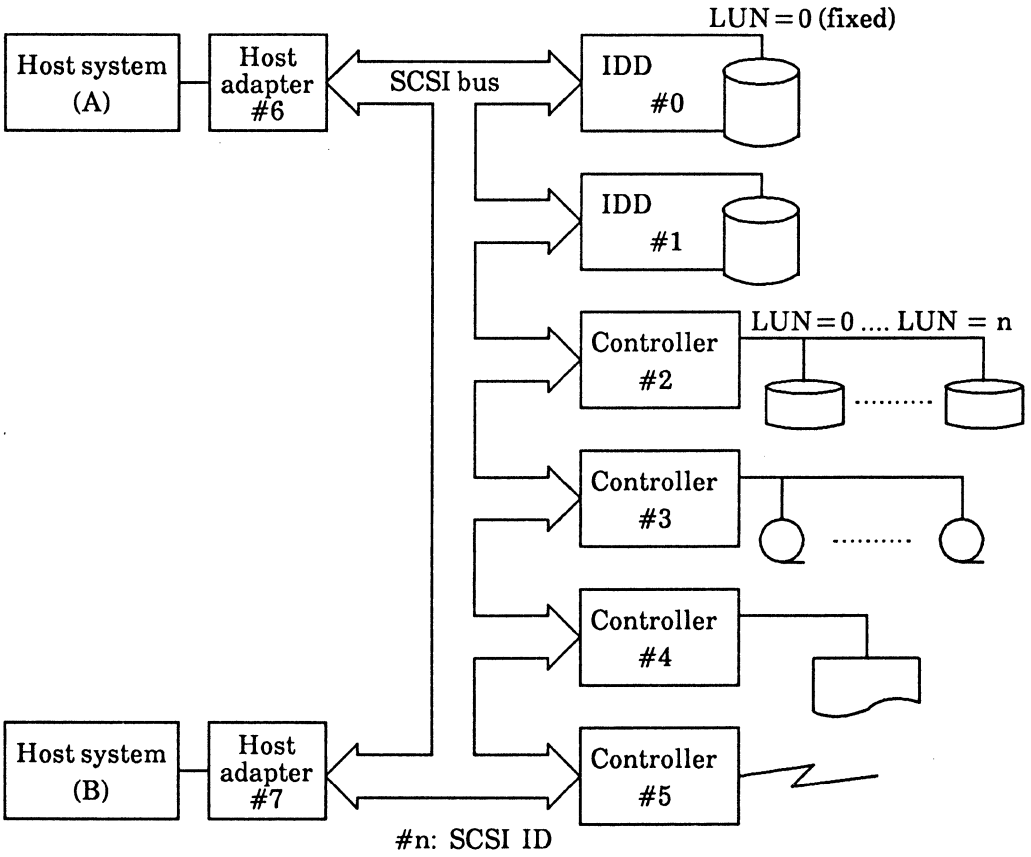

Figure 1.3 System configuration

(1) SCSI bus configuration

Up to eight SCSI devices can be connected to the SCSI bus, with any combination of the SCSI devices that operate as initiator and that operate as target.

For example, the system can be configured as multi-host system on which multiple host computers that operate as initiator or connected through the SCSI bus.

Using disconnect/reconnect function, concurrent input/output processing is possible on multi-SCSI devices.

(2) Addressing of peripheral device

Each SCSI device on the bus has its own unique address (SCSI ID:#n in Figure 1.4). For input/output operation, a peripheral device attached to the SCSI bus that operates as target is addressed in unit called as logical unit. A unique address (LUN: logical unit number) is assigned for each logical unit.

The initiator selects one SCSI device by specifying that SCSI ID, then specifies the LUN to select the peripheral device for input/output operation.

The IDD is constructed so that the whole volume of disk drive is a single logical unit, the selectable number of SCSI ID and LUN are as follows:

- SCSI ID: Selectable from 0 to 7 (switch selectable)
- LUN: 0 (fixed)

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CHAPTER 2 SPECIFICATIONS

This chapter describes specifications of the IDD and the functional specifications of the SCSI.

2.1 IDD Models

2.1.1 Model name and part number

Each model has a different data format, front panels, and mounting screw types when shipped. Table 2.1 shows the IDD model name and part number.
Data format can be changed by reinitializing with the user's system.

Table 2.1 IDD model/part number (1 of 2)

Model	Block length	Storage capacity	Front panel	Mounting screws	Part number	Remarks
M2622S	256 B	292.76 MB	Provided	M3	B03B-7195-B004A	
			None	M3	B03B-7195-B004A#P	
			Provided	#6-32UNC	B03B-7195-B004A#N	
			None	#6-32UNC	B03B-7195-B004A#NP	
M2622SA	512 B	330.17 MB	Provided	M3	B03B-7195-B014A	
			None	M3	B03B-7195-B014A#P	
			Provided	#6-32UNC	B03B-7195-B014A#N	
			None	#6-32UNC	B03B-7195-B014A#NP	
M2622SB	1,024 B	346.52 MB	Provided	M3	B03B-7195-B024A	
			None	M3	B03B-7195-B024A#P	
			Provided	#6-32UNC	B03B-7195-B024A#N	
			None	#6-32UNC	B03B-7195-B024A#NP	

Table 2.1 IDD model/part number (2 of 2)

Model	Block length	Storage capacity	Front panel	Mounting screws	Part number	Remarks
M2623S	256 B	376.72 MB	Provided	M3	B03B-7195-B005A	
			None	M3	B03B-7195-B005A#P	
			Provided	#6-32UNC	B03B-7195-B005A#N	
			None	#6-32UNC	B03B-7195-B005A#NP	
M2623SA	512 B	425.13 MB	Provided	M3	B03B-7195-B015A	
			None	M3	B03B-7195-B015A#P	
			Provided	#6-32UNC	B03B-7195-B015A#N	
			None	#6-32UNC	B03B-7195-B015A#NP	
M2623SB	1,024 B	446.77 MB	Provided	M3	B03B-7195-B025A	
			None	M3	B03B-7195-B025A#P	
			Provided	#6-32UNC	B03B-7195-B025A#N	
			None	#6-32UNC	B03B-7195-B025A#NP	
M2624S	256 B	460.69 MB	Provided	M3	B03B-7195-B006A	
			None	M3	B03B-7195-B006A#P	
			Provided	#6-32UNC	B03B-7195-B006A#N	
			None	#6-32UNC	B03B-7195-B006A#NP	
M2624SA	512 B	520.10 MB	Provided	M3	B03B-7195-B016A	
			None	M3	B03B-7195-B016A#P	
			Provided	#6-32UNC	B03B-7195-B016A#N	
			None	#6-32UNC	B03B-7195-B016A#NP	
M2624SB	1,024 B	547.03 MB	Provided	M3	B03B-7195-B026A	
			None	M3	B03B-7195-B026A#P	
			Provided	#6-32UNC	B03B-7195-B026A#N	
			None	#6-32UNC	B03B-7195-B026A#NP	

2.1.2 Function specifications

Table 2.2 shows the function specifications of the IDD.

Table 2.2 Function specifications (1 of 2)

Item			Specification		
			M2622	M2623	M2624
Unformatted capacity / drive	(* 1)		387.41 MB	498.10 MB	608.79 MB
Number of disks			4	5	6
Number of heads (data + servo)	(* 2)		7 + 1	9 + 1	11 + 1
Number of cylinders (user + CE + SA)	(* 1)		1,429 + 1 + 5		
Unformatted capacity / track			33274B to 41593B		
Rotational speed			4,400 rpm ± 0.5 %		
Average latency time			6.82 ms		
Positioning time	(* 3)	Minimum	3 ms		
		Average	12 ms		
		Maximum	25 ms typ.		
Start / Stop time	(* 4)	Start time	15 s max.		
		Stop time	30 s max.		
Recording code			1 / 7 RLL		
Recording density			46,383 BPI		
Track density			1,751 TPI		
Dimension (W × H × D)			101.6 mm × 41.3 mm × 146.0 mm with front panel : 104.1 mm × 43.8 mm × 151.3 mm		
Weight			Approx. 1.2 kg		
Power consumption			11 W typ.		
Interface			Single-Ended type SCSI Cable length : 6 m max.		
Data transfer rate	Disk drive		3.05 MB / s max.		
	SCSI (*5)	Async mode	3 MB / s max.		
		Sync mode	5 MB / s max.		

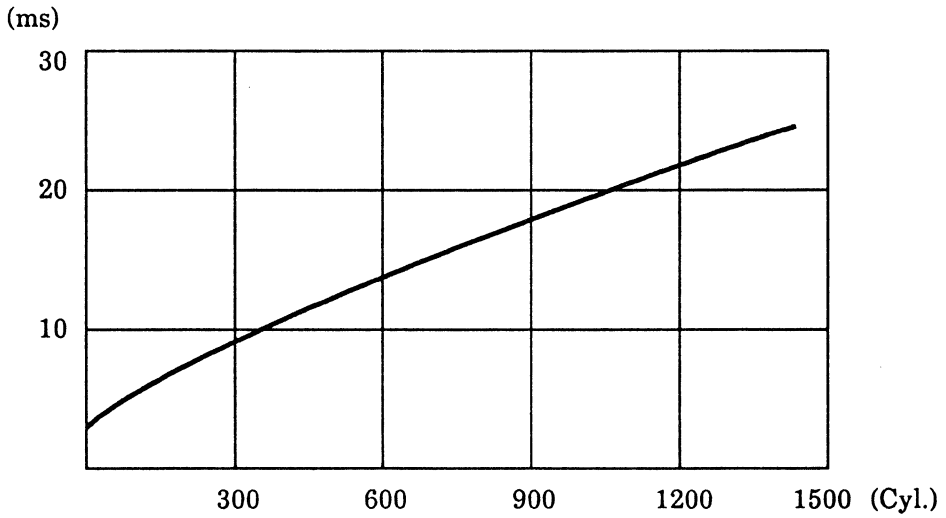
Table 2.2 Function specifications (2 of 2)

Item	Specification
Logical data block length (*1)	180 bytes to 4,096 bytes (fixed block length programable by every 2-byte at formatting)
SCSI command specification	ANSI X3.131 - 1986 and CCS (Rev. 4 B) Supports a part of SCSI-2 command FUJITSU unique command
Data buffer	60 KB × 4 FIFO ring buffer Read-Ahead cache feature provided

(*1) The formatted capacity can be changed by changing the logical block length and using spare sector space. See Chapter 3 for the further information.

(*2) The number of user cylinders indicates the max., and includes the alternate cylinder. The number of user cylinders and alternate cylinders can be specified at format of the IDD.

(*3) The positioning time is as follows:



(*4) The start time is the time from power on or start command to when the IDD is ready, and stop time is the time for disks to completely stop from power off or stop command.

(*5) The maximum data transfer rate may be restricted to the response speed of initiator and by transmission characteristics.

2.1.3 Environmental specifications

Table 2.3 lists environmental and power requirements.

Table 2.3 Environmental/power requirements

Items		Specifications
Temperature (*1)	Environment at operating	5 to 45°C (41 to 113°F)
	Environment at non-operating	−40 to 60°C (−40 to 140°F)
	DE surface at operating	60°C or less 55°C or less (variable span)
	Gradient	15°C / hr (59°F / hr) or less
Relative humidity	Operating	20 to 80%RH
	Non-operating	5 to 95%RH
	Max. wet bulb	29°C (No condensing)
Vibration	Operating	Less than 0.5G (5 to 250 Hz)
	Non-operating (*2)	Less than 2.0G (5 to 250 Hz)
Shock	Operating	Less than 5G (10 ms max.)
	Non-operating	Less than 50G (10 ms max.)
Altitude (above sea level)	Operating	0 to 3,000 m
	Non-operating	0 to 12,000 m
Power requirements	Input voltages (*3)	+ 12VDC ± 5% 0.5 A (Average) 2.5 A (Peak)
		+ 5VDC ± 5% 1.0 A (Average) (*5)
	Ripple (*4)	+ 5 V 50 mVp-p, + 12 V 100 mVp-p

(*1) For detail condition, see Section 4.1.

(*2) At power-off state after installation

(*3) Input voltages are specified at the connector.

(*4) High frequency noise is less than 100 mVp-p.

(*5) The terminator power pin (SCSI connector) which supplies power to other terminators is not used (See Section 4.3).

2.1.4 Error rate

Errors detected during initialization and replaced by alternate block assignments are not included in the error rate. Data blocks to be accessed should be distributed over the disk medium equally.

(1) Unrecoverable error rate

Errors which cannot be recovered within 18 retries and ECC correction should not exceed 10 per 10^{15} bits. (*)

(2) Positioning error rate

Positioning errors which can be recovered by one retry should be 10 or less per 10^{7} seeks.

(3) Media defects

The number of allowable media defects are as follows. The maximum defect length is 8 bytes.

M2622 : 160 and less
M2623 : 210 and less
M2624 : 260 and less

(*) Retries at read errors are controlled by error recovery procedure of the IDD, which includes retries with head offset.

2.1.5 Reliability

(1) Mean Time Between Failures (MTBF)

MTBF of the IDD during its life time is 200,000 hours (operating: 24 hours/day, 7 days/week) after an initial 3-month period.

Note:

The MTBF is defined as:

$$\text{MTBF} = \frac{\text{Operating time (hours) at all field sites}}{\text{The number of equipment failures from all field sites}}$$

Failure of the equipment means failure that requires repair, adjustments, or replacement. Mishandling by the operator, failures due to bad environmental conditions, power trouble, host system trouble, cable failures, or other failures not caused by the equipment are not considered.

(2) Mean Time To Repair (MTTR)

MTTR is the average time taken by a well-trained service mechanic to diagnose and repair a drive malfunction. The drive is designed for a MTTR of 30 minutes or less.

(3) Service life

Overhaul of the drive is not required for the first five years or 20,000 power-on hours which ever earlier if handled correctly.

(4) Data security at power failure.

Integrity of the data on the disk is guaranteed against all forms of DC power failure except on blocks where a write operation is being performed. The above does not applied to formatting disks or assigning alternate blocks.

2.2 SCSI Function Specifications

Table 2.4 shows the SCSI functions provided with the IDD. Refer to the OEM manual: SCSI Physical Specifications and SCSI Logical Specifications for details.

Table 2.4 SCSI function specifications (1 of 11)

×: Supported, –: Not supported

SCSI	Electrical requirements	Single-Ended type	×
		TERMPWR signal supply/demand function	× (jumper selectable)
	Connector	Non-shielded (100 mil pitch)	× (keyed)
		Shielded	–
	Data bus parity		× (jumper selectable)
	Bus arbitration function		×
	Disconnection/Reconnection function		×
	Addressing	SCSI ID number	0-7 (switch selectable)
		LUN (Logical unit number)	0 (Fixed)
	Data transfer	Asynchronous mode	× 3 MB/s nominal
		Synchronous mode	× (jumper selectable) 5 MB/s max.
		Extended data bus mode	–
	Data buffer		60 KB × 4 FIFO ring type
	Data block length (logical data length = physical data length)		256 to 4,096 bytes (Fixed by even-numbered bytes specified at format)

Table 2.4 SCSI function specifications (2 of 11)

VU: FUJITSU unique function,
×: Supported, –: Not supported

1-byte message	COMMAND COMPLETE		(00)	×
	SAVE DATA POINTER		(02)	×
	RESTORE POINTERS		(03)	×
	DISCONNECT	(TARG → INIT)	(04)	×
		(INIT → TARG)	(04)	–
	INITIATOR DETECTED ERROR		(05)	×
	ABORT		(06)	×
	MESSAGE REJECT		(07)	×
	NO OPERATION		(08)	×
	MESSAGE PARITY ERROR		(09)	×
	LINKED COMMAND COMPLETE		(0A)	×
	LINKED COMMAND COMPLETE WITH FLAG		(0B)	×
	BUS DEVICE RESET		(0C)	×
	ABORT TAG		(0D)	–
	CLEAR QUEUE		(0E)	–
	INITIATE RECOVERY		(0F)	–
	RELEASE RECOVERY		(10)	–
	TERMINATE I/O PROCESS		(11)	–
	IDENTIFY		(80-FF)	×
	Disconnect Privilege (DiscPriv)Bit			×
	Logical Unit Target (LUNTAR) Bit			–
2-byte message	SIMPLE QUEUE TAG		(20)	–
	HEAD OF QUEUE TAG		(21)	–
	ORDERED QUEUE TAG		(22)	–
	IGNORE WIDE RESIDUE		(23)	–

Table 2.4 SCSI functional specifications (3 of 11)

VU: FUJITSU unique function,
×: Supported, –: Not supported

Extended message	MODIFY DATA POINTER (01-00)	–
	SYNCHRONOUS DATA TRANSFER REQUEST (01-01)	× (jumper selectable)
	EXTENDED IDENTIFY (01-02)	–
	WIDE DATA TRANSFER REQUEST (01-03)	–
	UNIT ATTENTION [VU] (01-80)	–
	HALT I/O [VU] (01-81)	–
	DIAGNOSTIC CONTROL [VU] (01-82)	–
Command (Group 0)	TEST UNIT READY (00)	×
	REZERO UNIT (01)	×
	REQUEST LOG [VU] (02)	–
	REQUEST SENSE (03)	×
	FORMAT UNIT (04)	×
	FmtData (Format Data) =0	×
	Initialization data pattern [VU]	×
	Interleave factor	× (Non-interleaved)
	Defect list by block address =0	×
	Defect list by block address ≠0	×
	Defect list by byte length from index =0	×
	Defect list by byte length from index ≠0	×
	Defect list by physical sector address =0	×
	Defect list by physical sector address ≠0	×
	CmpLst (Complete List)	×
	FOV (Format Options Valid)	×
	DPRY (Disable Primary)	×
	DCRT (Disable Certification)	×
	STPF (Stop Format)	–
	IP (Initialization Pattern)	–
	DSP (Disable Saving Parameters)	–
	Immed (Immediate)	–

Table 2.4 SCSI functional specifications (4 of 11)

VU: FUJITSU unique function,
×: Supported, –: Not supported

Command (Group 0)	READ DEFECT LIST [VU] (05)	–
	REASSIGN BLOCKS (07)	×
	READ (08)	×
	WRITE (0A)	×
	SEEK (0B)	×
	NO OPERATION [VU] (0D)	×
	SET FILE MASK [VU] (0F)	–
	INQUIRY (12)	×
	EVPD (Enable Vital Product Data)	× (jumper selectable)
	Standard INQUIRY data	× (36-byte length)
	VPD Page 0: VPD page code list	×
	VPD Page 80: Device serial No.	×
	READ DEVICE CHARACTERISTICS [VU] (13)	–
	PRIORITY RESERVE [VU] (14)	×

Table 2.4 SCSI Functional specifications (5 of 11)

VU: FUJITSU unique function,
×: Supported, –: Not supported

Command (Group 0)	MODE SELECT	×
	PF (page format)	× (set value ignored)
	Page 1: Read/Write Error Recovery	× (12B: Savable)
	AWRE (Automatic Write Reallocation Enabled)	× (Changeable)
	ARRE (Automatic Read Reallocation Enabled)	× (Changeable)
	TB (Transfer Block)	× (Changeable)
	RC (Read Continuous)	–
	EER (Enable Early Recovery)	× (Changeable)
	PER (Post Error)	× (Changeable)
	DTE (Disable Transfer on Error)	× (Changeable)
	DCR (Disable Correction)	× (Changeable)
	Retry Count for Read Recovery	× (Changeable)
	Correctable Bit Length on ECC	× (Unchangeable)
	Head Offset Count	–
	Data Strobe Offset Count	–
	Retry Count for Writing	× (Changeable)
	Time Limit on Recovery Processing	–
	Page 2: Disconnect/Reconnect	× (16B: Savable)
	Buffer Full Ratio	× (Changeable)
	Buffer Empty Ratio	× (Changeable)
	Bus Inactivity Limit	× (Unchangeable)
	Disconnect Time Limit	–
	Connect Time Limit	–
	Max. Burst Length	–
	DTDC (Data Transfer Disconnect Control)	–

Table 2.4 SCSI functional specifications (6 of 11)

VU: FUJITSU unique function,
×: Supported, –: Not supported

Command (Group 0)	MODE SELECT	
	Page 3: Format Parameters	× (24B: Savable)
	Tracks / Zone	× (Unchangeable)
	Alternate Sectors / Zone	× (Changeable)
	Alternate Tracks / Zone	× (Unchangeable)
	Alternate Tracks / Drive	× (Changeable)
	Sectors / Track	× (Unchangeable)
	Data Bytes / Physical Sector	× (Changeable)
	Interleave Factor	× (Non-Interleaved)
	Track Skew Factor	× (Unchangeable)
	Cylinder Skew Factor	× (Unchangeable)
	SSEC / HSEC (Soft Sector / Hard Sector)	× (Unchangeable)
	RMB (Removable)	× (Unchangeable)
	SURF (Surface)	× (Unchangeable)
	Page 4: Drive Parameters	× (24B: Savable)
	Number of Cylinders	× (Changeable)
	Number of Heads	× (Unchangeable)
	"Write Precompensation" Starting Cylinder	–
	"Reduced Write Current" Starting Cylinder	–
	Drive Step Rate	–
	Landing Zone Cylinder	–
	RPL (Rotational Position Locking)	× (Changeable)
	Rotation Synchronous Offset	–
	Media Rotational Speed	× (Unchangeable)
	Page 7: Verify Error Recovery	× (12B: Savable)
	EER (Enable Early Recovery)	× (Changeable)
	PER (Post Error)	× (Changeable)
	DTE (Disable Transfer on Error)	× (Changeable)
	DCR (Disable Correction)	× (Changeable)

Table 2.4 SCSI functional specifications (7 of 11)

VU: FUJITSU unique function,
×: Supported, –: Not supported

Command (Group 0)	Retry Count on Verify	× (Changeable)
	Correctable Bit Length on ECC	× (Unchangeable)
	Time Limit on Recovery Processing	–
	MODE SELECT	
	Page 8: Caching Parameters	× (12B: Savable)
	MS (Multiple Select)	–
	WCE (Write Cache Enable)	× (Changeable)
	RCD (Read Cache Disable)	× (Changeable)
	Demand Read Retention Priority	–
	Write Retention Priority	–
	Disable Prefetch Block Number	× (Unchangeable)
	Min. Prefetch	–
	Max. Prefetch	× (Unchangeable)
	Max. Prefetch Ceiling Block Number	× (Unchangeable)
	Page 21: Additional Error Recovery [VU]	× (4B: Savable)
	DCED (Disable Command Execution Delay)	× (Changeable)
	PSER (Post SCSI Error)	× (Changeable)
	RPR (Rounded parameter report)	× (Changeable)
	Retry Count on Seek Error	× (Changeable)
	EOR (Enable Overrun Report Flag)	–
	Retry Count on Overrun	–
	Page 22: Reconnect Timing [VU]	× (4B: Savable)
	Reconnect Timing on Read	–
	Reconnect Timing on Write	–
	RESERVE UNIT (16)	×
	3rd Party Reserve Function	×
	Extent Reserve Function	–
	Superseding Reserve Condition Function	×

Table 2.4 SCSI functional specifications (8 of 11)

VU: FUJITSU unique function,
×: Supported, –: Not supported

Command (Group 0)	RELEASE UNIT (17)	×
	3rd Party Release Function	×
	Extent Release Function	–
	COPY (18)	–
	MODE SENSE (1A)	×
	DBD (Disable Block Descriptor)	×
	Page 0 (Non-Parameter Transfer)	×
	START/STOP UNIT (1B)	×
	Immed (Immediate)	×
	RECEIVE DIAGNOSTIC RESULTS (1C)	×
	SEND DIAGNOSTIC (1D)	×
	PF (Page Format)	× (Set value ignored)
	Self Test (Self Test)	×
	DevOfL (Device Offline)	–
	UnitOfL (Unit Offline)	×
	Page 0: Specifiable Page Code list	×
	Page 40: Logical/Physical Address Exchange	×
	Page 80: Condition Report in Mode Select [VU]	×
	Page 81: Device Statistic Information [VU]	×
	PREVENT/ALLOW MEDIUM REMOVAL (1E)	–
Command (Group 1)	SEARCH BLOCK HIGH [VU] (20)	–
	SEARCH BLOCK EQUAL [VU] (21)	–
	SEARCH BLOCK LOW [VU] (22)	–
	READ CAPACITY (25)	×
	PMI (Partial Medium Indicator)	×
	READ EXTENDED (28)	×
	WRITE EXTENDED (2A)	×

Table 2.4 SCSI functional specifications (9 of 11)

VU: FUJITSU unique function,
×: Supported, –: Not supported

Command (Group 1)	SEEK EXTENDED (2B)	×
	WRITE & VERIFY (2E)	×
	BytChk (Byte Check)	–
	VERIFY (2F)	×
	BytChk (Byte Check)	×
	SEARCH DATA HIGH (30)	–
	SEARCH DATA EQUAL (31)	–
	SEARCH DATA LOW (32)	–
	SET LIMITS (33)	×
	PRE-FETCH (34)	–
	SYNCHRONIZE CACHE (35)	–
	LOCK/UNLOCK CACHE (36)	–
	READ DEFECT DATA (37)	×
	Block Address Format	×
	Bytes Distance Format from Index	×
	Physical Sector Address Format	×
	COMPARE (39)	–
	COPY & VERIFY (3A)	–
	WRITE BUFFER (3B)	×
	Mode='000' (Header & Data Mode)	×
	Mode='001' (Header & Data Mode with Address)	×
	Mode='010' (Data Mode)	×
	Mode='100' (Download Microcode)	–
	Mode='101' (Download Microcode and Save)	–

Table 2.4 SCSI functional specifications (10 of 11)

VU: FUJITSU unique function,
×: Supported, –: Not supported

Command (Group 1)	READ BUFFER (3C)	×
	Mode='000' (Header & Data Mode)	×
	Mode='001' (Header & Data Mode with Address)	×
	Mode='010' (Data Mode)	×
	Mode='011' (Descriptor Mode)	×
	READ LONG (3E)	×
	CORRCT (Corrected)	×
	WRITE LONG (3F)	×
Command (Group 2)	CHANGE DEFINITION (40)	–
	WRITE SAME (41)	×
	LBdata (Logical Block Data)	×
	PBdata (Physical Block Data)	–
	LOG SELECT (4C)	–
	LOG SENSE (4D)	–
	MODE SELECT EXTENDED (55)	–
	MODE SENSE EXTENDED (5A)	–
Command (Group 6)	DIAGNOSTIC WRITE DATA [VU] (C1)	–
	DIAGNOSTIC READ DATA [VU] (C2)	–
	FORMAT ID [VU] (C4)	–
	SPACE ID & READ DATA [VU] (C6)	–
	DISPLACED ID [VU] (C8)	–
	READ ID [VU] (CA)	–
	DIAGNOSTIC FORMAT ID [VU] (CD)	–
	DIAGNOSTIC READ ID [VU] (CE)	–
	WRITE RAM [VU] (D1)	–
	READ RAM [VU] (D2)	–
	RECOVER DATA [VU] (D8)	–
	RECOVER ID [VU] (DA)	–

Table 2.4 SCSI functional specifications (11 of 11)

VU: FUJITSU unique function,
×: Supported, –: Not supported

Command Processing	Slipped Defect Sector Function	×
	Command Link Function	×
	Relative Block Addressing Function	–
	Command Stack Function (queuing without tag)	×
	Command with Tag Queuing feature	–
	CA (Contingent Allegiance)	– (sense is kept for each INIT)
	ECA (Extended Contingent Allegiance)	–
	Async. Event Notification (AEN) feature	–
	Read-Ahead Cache feature	×
	Cache Control feature	–
	DPO (Disable Page Out)	–
	FUA (Force Unit Access)	–
Status	GOOD	×
	CHECK CONDITION	×
	CONDITION MET	–
	BUSY	×
	INTERMEDIATE	×
	RESERVATION CONFLICT	×
	COMMAND TERMINATED	–
	QUEUE FULL	–
Sense Data	Non-Extended Type	–
	Extended Type	× (48 Bytes Length)
CCS (Common Command Set) Standard		× (Rev. 4. B)

CHAPTER 3 DATA FORMAT

This chapter explains data space definition, logical data block addressing, and defect management on the IDD.

3.1 Data Space

The IDD manages the entire data storage area divided into the following three data spaces.

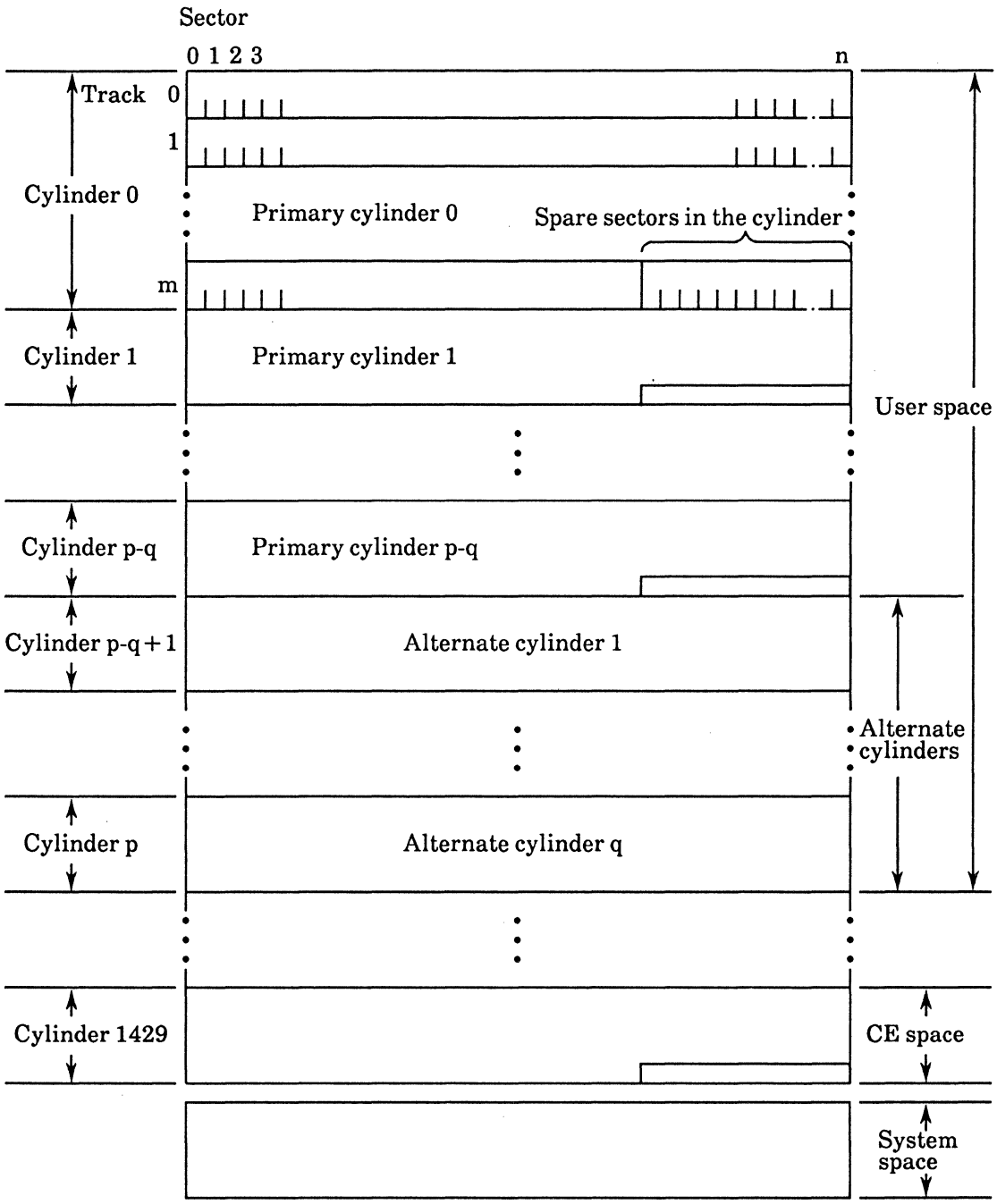
- User space: Storage area for user data
- CE space: Reserved area for diagnostic purposes
- System space: Area for exclusive use of IDD itself

The user space and the CE space allow a user access by specifying data. These two spaces have the same data format and defect management method and can be accessed with the logical data block addressing method described in Section 3.2. The system space is accessed inside the IDD at power-on or during the execution of a specific command, but the user cannot directly access the system space.

3.1.1 Cylinder configuration

The IDD allocates cylinders to the user space, CE space, and system space. Figure 3.1 is the cylinder configuration.

Spare areas (alternate areas) for defective sectors are provided in the user space and the CE space. Several sectors in the last track of each cylinder and several cylinders (alternate cylinders) in the user space are allocated as alternate areas according to the user's assignment (MODE SELECT command). See Subsection 3.1.2 for details.



*1 Spare sectors on the last track in each cylinder are not necessarily placed at the end of the track because of a track skew or a cylinder skew. (Details are explained in Section 3.1.3.)

Figure 3.1 Cylinder configuration

Apart from the above logical configuration, the IDD intends to increase the storage capacity by dividing all cylinders into four zones and changing a recording dencity of each zone.

Table 3.1 lists the zone partition and its track capacity.

Table 3.1 Zone partition and track capacity

Zone	I	II	III	IV
Cylinder	0 to 606	607 to 847	848 to 1157	1158 to 1434
Byte/track	41593	39263	36834	33274

(1) User space

The user space is a storage area for user data. The data format on the user space (the length of data block and the number of data blocks) can be specified with the MODE SELECT command.

The default number of cylinders in the user space is 1429. The user, however, can select the number of cylinders to be allocated in the user space by specifying 1429 as the maximum and the number of alternate cylinders + 1 as the minimum. The user can also specify the number of logical data blocks to be placed in the user space with the MODE SELECT command. When the number of logical data blocks is specified, as many cylinders as required to place the specified data blocks are allocated in the user space.

A number starting with 0 is assigned to each cylinder required in the user space in ascending order. If the number does not reach 1429, the rest of the cylinders will not be used.

Alternate cylinders can be established in the user space by specifying parameters in the MODE SELECT command. Alternate cylinders will be used for alternate blocks when primary cylinders in the user space and spare sectors in the cylinder in the CE space are used up. See Subsections 3.1.2 and 3.3.2 for details.

(2) CE space

The CE space is an area for diagnostic purposes only and its data format is the same as that of the user space. The CE space consists of only 1 cylinder and cylinder No. 1429 is always assigned. The user cannot change the number of cylinders in the CE space or their positions.

The IDD reads or writes the data block in the CE space during the self-diagnostic test specified with the setting terminal (diagnostic mode) or a SEND DIAGNOSTIC command.

The specified block address is assigned to the data block in the CE space and it is possible to access the data block directly by a user program.

(3) System space

The system space is an area for exclusive use of the IDD itself and the following information are recorded. The length of the data block is always 512 bytes.

- Defect list (P list and G list)
- MODE SELECT parameter (saved value)
- Statistical information (log data)
- Controller control information

The above information are duplicated in several different locations for safety.

Note:

The system space is also called SA space.

3.1.2 Alternate spare area

The alternate spare area is provided in the last track of each primary cylinder in the user space, and in the last track of the cylinder and the alternate cylinder of the CE space. Each area size can be specified by the MODE SELECT command.

The spare area in each cylinder is placed at the end of the last track as shown in Figure 3.2 These spare sectors are located in the end of the track logically, not necessarily located at the end physically because of track skew or cylinder skew. (Details are explained on Subsection 3.1.3.)

The number of spare sectors per cylinder that can be specified is between 0 and 32. When the format of 32 sectors or less per track is used, a value that exceeds (the number of sectors per track-1 of zone IV) cannot be specified. The default value of number of space sectors per cylinder is 3.

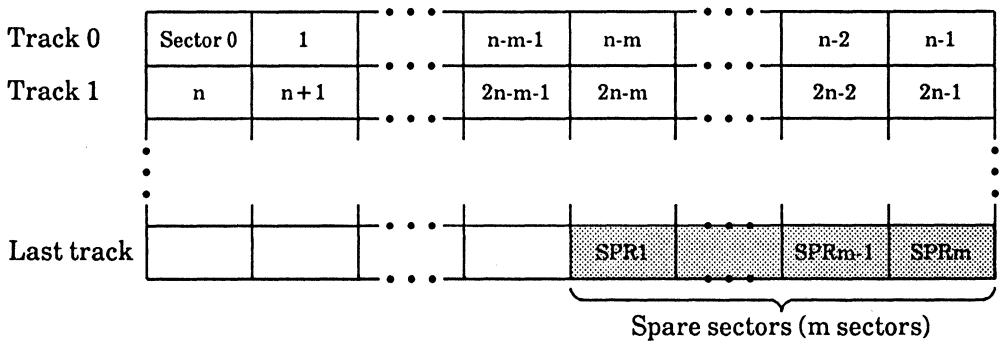


Figure 3.2 Spare area in cylinders

An alternate cylinder is used when spare sectors in a cylinder are used up or 0 is specified as the number of spare sectors in a cylinder. Several cylinders at the end of the user space are allocated as alternate cylinders as shown in Figure 3.3.

The number of alternate cylinders that can be specified is between 0 and 7. When 7 or less is specified as the number of cylinders in the user space, the value that exceeds (the number of cylinders in the user space-1) cannot be specified. The default value of number of alternate cylinders is 1.

The user space and the CE space share the alternate cylinders.

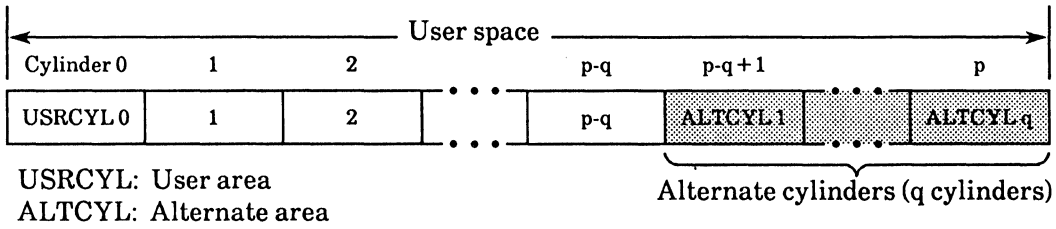


Figure 3.3 Alternate cylinder

Note:

Zero cannot be specified for both the number of spare sectors in each cylinder and the number of alternate cylinders.

3.1.3 Track format

(1) Physical sector allocation

Figure 3.4 shows the allocation of the physical sectors in a track. The length in bytes of each physical sector and the number of sectors per track vary depending on the logical data block length. The unused area (G4) exists at the end of the track in formats with most logical data block lengths.

The interval of the sector pulse (length of the physical sector) is decided by multiple of the servo clock of 40,960. The servo clock is not equal to the interval of the byte clock for each zone. Therefore, the physical sector length cannot be described with a byte length.

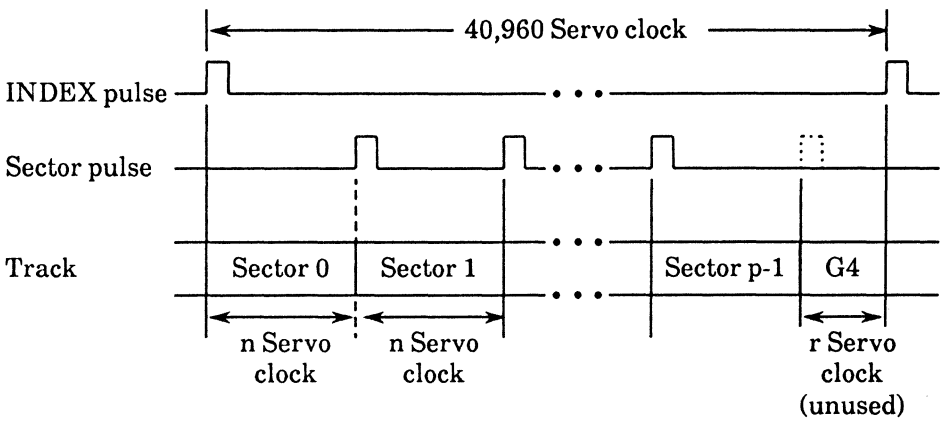


Figure 3.4 Track format

The physical sector length of each zone is decided by the number of servo clocks which is the nearest value to the "nominal physical sector length" less than the "nominal physical sector length".

Nominal physical sector length = (logical data block length + 70) +
(logical data block length + 70) × 0.01 + 6
unit: byte (round up under a decimal point)

Table 3.2 Track format configuration example (logical data block length = 512 bytes)

Zone	I	II	III	IV
Byte/track (byte)	41593	39263	36834	33274
Nominal physical sector length (byte)	594			
Actual sector length (byte)	593.03	593.35	593.52	593.83
Sector/track	70	66	62	56

(2) Track skew and cylinder skew

To avoid waiting for one turn involved in head and cylinder switching, the first logical data block in each track is shifted by the number of sectors (track skew and cylinder skew) corresponding to the switching time. Figure 3.5 shows how the data block is allocated in each track.

At the head switching location in a cylinder, the first logical data block in track t + 1 is allocated at the sector position which locates the track skew behind the sector position of the last logical data block sector in track t.

At the cylinder switching location, like the head switching location, the first logical data block in a cylinder is allocated at the sector position which locates the cylinder skew behind the last logical sector position in the preceding cylinder. The last logical sector in the cylinder is allocated when formatting, and is an unused spare sector.

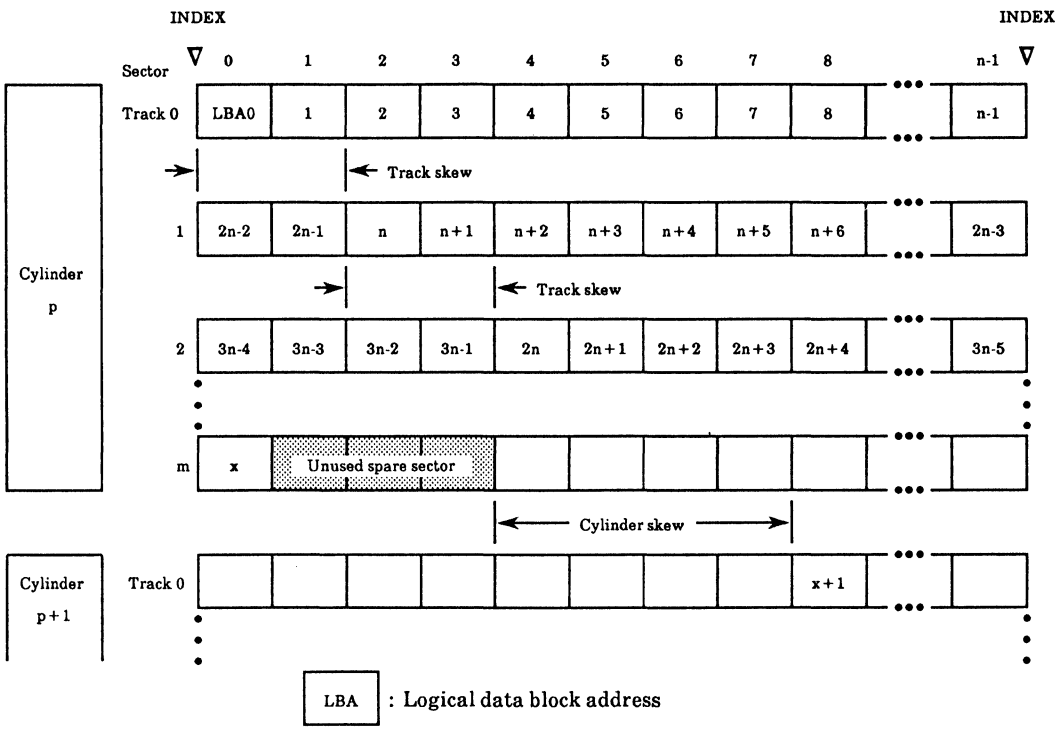


Figure 3.5 Track skew/cylinder skew

The number of physical sectors (track skew factor and cylinder skew factor) corresponding to the skew time varies depending on the logical data block length because the track skew and the cylinder skew are managed for individual sectors. The IDD automatically determines appropriate values for the track skew factor and the cylinder skew factor according to the specified logical data block length. The value can be read out by the MODE SENSE command after the track has been formatted. The typical logical track skew and cylinder skew factors of the data block length are shown in Table 3.3.

Table 3.3 Track skew and cylinder skew factor

Logical data block length	Track skew factor	Cylinder skew factor
256	18 Sectors	38 Sectors
512	10 Sectors	22 Sectors
1,024	6 Sectors	12 Sectors
2,048	3 Sectors	6 Sectors
4,096	2 Sectors	3 Sectors

3.1.4 Sector format

Each sector on the track consists of an ID field, a data field, and a gap field which separates them.

Figure 3.6 and Table 3.4 give sector format examples.

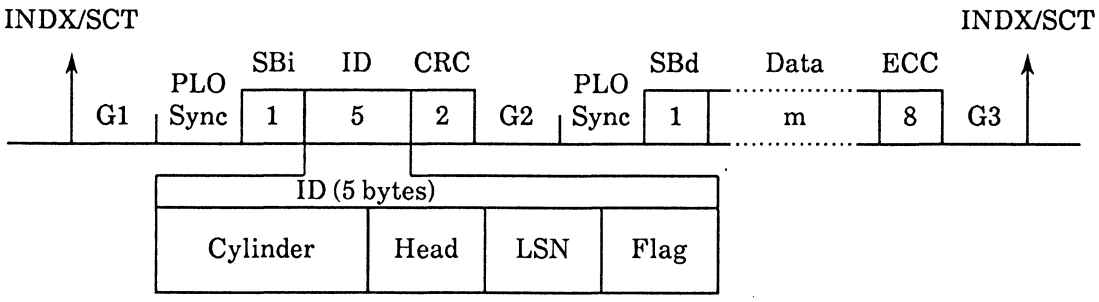


Figure 3.6 Normal sector format

Table 3.4 Normal sector format

Logical data block length			256	512	1024	2048	4096
Nominal physical sector length			336	594	1111	2146	4214
Normal sector format	G1		24				
	PLO Sync		12				
	SBi		1				
	ID		5				
	CRC		2				
	G2	ID PAD	2				
		SPLICE	1				
	PLO Sync		12				
	SBd		1				
	DATA		256	512	1024	2048	4096
	ECC		8				

Unit: byte (s)

Each sector on the track consists of the following fields:

(1) Gaps (G1, G2, G3)

The gap length at the time of formatting (initializing) is listed in Table 3.4. Pattern X'00' is written on the gap field.

(2) PLO Sync

In this field, pattern X'00' in the length in bytes listed in Table 3.4 is written.

(3) Sync Byte (SBi, SBd)

Pattern X'FE' is written on both the ID field and the data field.

(4) ID field

The ID field is 5 bytes long and indicates address information and the attributes of the sector. Details are listed in Table 3.5 and Figure 3.7.

(5) Data field

User data is stored in the data field of the sector. The length of the data field is equal to that of the logical data block which is specified with a parameter in the MODE SELECT command. Any even number between 256 and 4096 bytes can be specified as the length.

(6) CRC

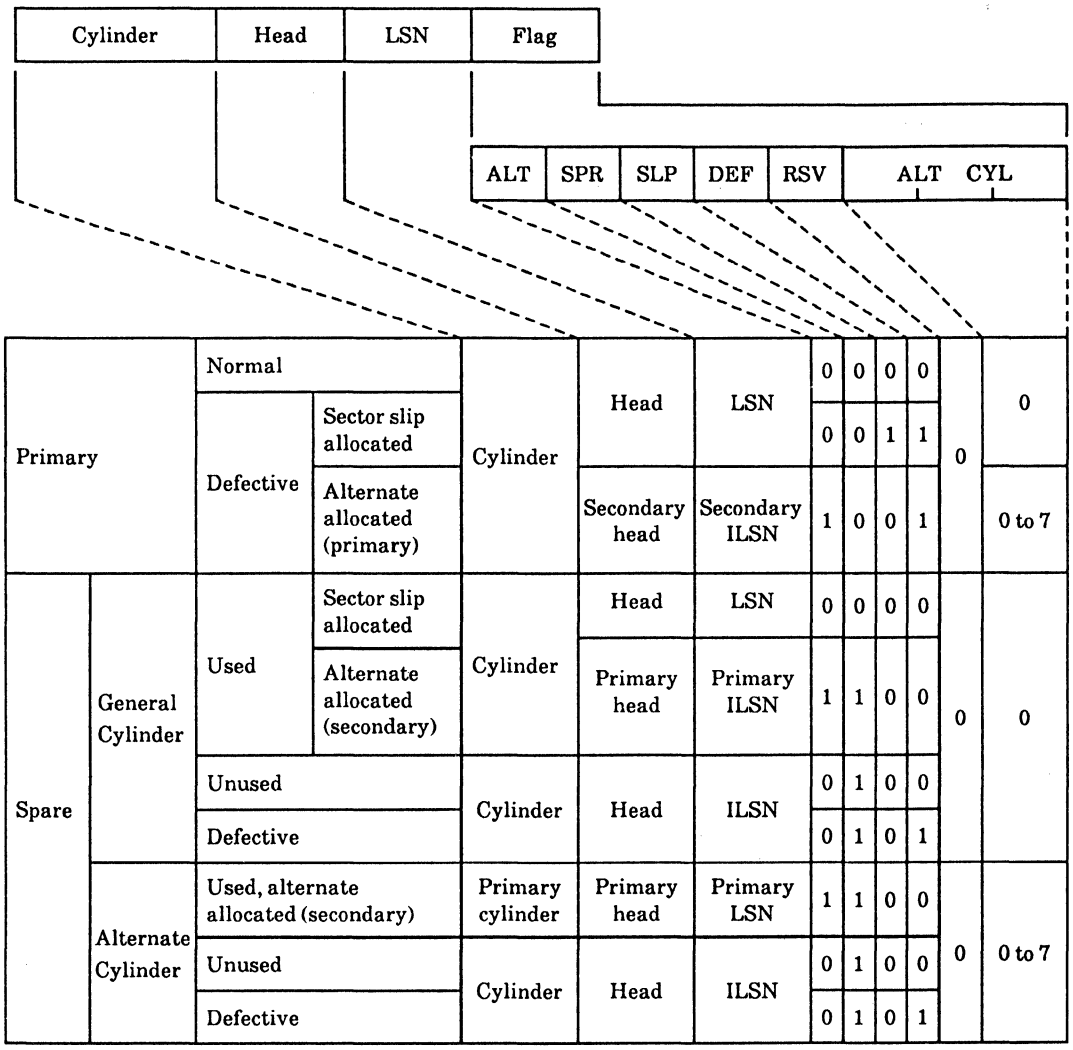
It is a 2-byte code to detect errors in the ID field. Single burst errors with lengths of up to 16 bits can be detected.

(7) ECC

It is a 8-byte error detection/correction code for the data field. It is possible to detect single burst errors with lengths of up to 44 bits or double burst errors with lengths of up to 10 bits and to correct single burst errors with lengths of up to 8 bits.

Table 3.5 ID field configuration

Byte	Bit	Name	Meaning	
0	7	0	Reserved	
	6	0		
	5	0		
	4	0		
	3	0		
	2	Cylinder 1024	Cylinder address	
	1	Cylinder 512		
	0	Cylinder 256		
1	7	Cylinder 128		
	6	Cylinder 64		
	5	Cylinder 32		
	4	Cylinder 16		
	3	Cylinder 8		
	2	Cylinder 4		
	1	Cylinder 2		
	0	Cylinder 1		
2	7	0	Reserved	
	6	0		
	5	0		
	4	0		
	3	Head 8	Head address	
	2	Head 4		
	1	Head 2		
	0	Head 1		
3	7	Logical sector 128	Logical sector address (LSN)	
	6	Logical sector 64		
	5	Logical sector 32		
	4	Logical sector 16		
	3	Logical sector 8		
	2	Logical sector 4		
	1	Logical sector 2		
	0	Logical sector 1		
4	7	Alternate Block	Indicates a block assigned an alternate block.	Flag
	6	Spare Block	Indicates a spare block.	
	5	Slip Block	Indicates a block treated by sector slip.	
	4	Defective block	Indicates a defective block.	
	3	0	Reserved	
	2	Alternate Cylinder 4	Indicates the alternate cylinder number.	
	1	Alternate Cylinder 2		
	0	Alternate Cylinder 1		



Primary		Normal		Cylinder	Head	LSN	0	0	0	0	0	0
		Defective	Sector slip allocated				0	0	1	1		
			Alternate allocated (primary)		Secondary head	Secondary ILSN	1	0	0	1		0 to 7
Spare	General Cylinder	Used	Sector slip allocated	Cylinder	Head	LSN	0	0	0	0	0	0
			Alternate allocated (secondary)		Primary head	Primary ILSN	1	1	0	0		
		Unused		Cylinder	Head	ILSN	0	1	0	0		
		Defective					0	1	0	1		
	Alternate Cylinder	Used, alternate allocated (secondary)		Primary cylinder	Primary head	Primary LSN	1	1	0	0	0	0 to 7
		Unused		Cylinder	Head	ILSN	0	1	0	0		
		Defective					0	1	0	1		

LSN: It is a serial number which is assigned to a subsequent logical block, beginning with 0 for the first logical block in the track. The same value is assigned to the defective sectors that receive sector slip treatment and the sectors to be allocated under sector slip treatment. Therefore, the serial number next to the LSN differs from the case that there is no defective block. The maximum number of the LSN in the track differs depending on the number of defective sectors that receive sector slip treatment in the track.

ILSN: It is a logical block number in the track given on the assumption that there is no defective sector in the track. The block number is not affected by sector slip treatment. This number is also assigned to the spare sectors in the general cylinder with subsequent number from the primary sector. The ILSN is equal to the physical sector number because the alternate cylinder does not receive a skew or sector slip treatment.

Figure 3.7 ID field format

3.1.5 Format capacity

The size of the usable area for storing user data on the IDD (format capacity) varies according to the logical data block or the size of the spare sector area. Table 3.6 lists examples of the format capacity when the typical logical data block length and the default spare area are used. The following is the general formula to calculate the format capacity.

[Format capacity] = [number of sectors per track × number of tracks (heads) − number of alternate spare sectors per cylinder] × [number of cylinders in user space − number of alternate cylinders] × [logical data block length]

The following formula must be used when the number of logical data blocks are specified with the parameter in the MODE SELECT command.

[Format capacity] = [logical data block length] × [number of logical data blocks]

The logical data block length, the maximum logical block address, and the number of the logical data blocks can be read out by a READ CAPACITY command or a MODE SENSE command after initializing the disk medium.

Table 3.6 Format capacity

Model	Number of data heads	Data block length	Number of user block	Number of CE blocks	Total number of spare sectors	Format capacity (MB)
M2622S	7	256	1143611	690	4977	292.76
M2623S	9	256	1471581	888	5175	376.72
M2624S	11	256	1799551	1086	5373	460.69
M2622SA	7	512	644868	389	4676	330.17
M2623SA	9	512	830340	501	4788	425.13
M2624SA	11	512	1015812	613	4900	520.10
M2622SB	7	1024	338394	200	4487	346.52
M2623SB	9	1024	436302	258	4545	446.77
M2624SB	11	1024	534210	316	4603	547.03

Note:

Total number of spare sectors is calculated by adding the number of spare sectors in each primary cylinder and the number of sectors in the alternate cylinders.

3.2 Logical Data Block Addressing

Independently of the physical structure of the disk drive, the IDD adopts the logical data block addressing as a data access method on the disk medium. The IDD relates a logical data block address to each physical sector at formatting. Data on the disk medium is accessed in logical data block units. The INIT specifies the data to be accessed using the logical data block address of that data.

The logical data block addressing is a function whereby individual data blocks are given addresses of serial binaries in each drive. The difference between the user space and the CE space is in the logical data block address specification method.

(1) Block address of user space

The logical data block address number is consecutively assigned to all of the data blocks in the user space starting with 0 to the first data block.

The IDD treats sector 0, track 0, cylinder 0 as the first logical data block. The data block is allocated in ascending order of addresses in the following sequence:

① Numbers are assigned in ascending order to all sectors in the same track.

② By following step ①, numbers are assigned in ascending order of tracks to all sectors in each track in the same cylinder except the last track.

③ By following step ①, numbers are assigned to all sectors in the last track except the spare sectors.

④ After completing steps ① through ③ for the same cylinder, this allocation is repeated from track 0 in the next cylinder and on to the last cylinder (cylinder p-q in Figure 3.1) except for the alternate cylinders in ascending order of cylinder numbers.

When the logical data block is allocated, some sectors (track skew and cylinder skew) shown in Figure 3.5 are provided to avoid waiting for one turn involving head and cylinder switching at the location where the track or the cylinder is physically switched.

See Subsection 3.3.2 for defective/alternate block treatment and the logical data block allocation method in case of defective sectors exist on the disk.

(2) Block address of CE space

The logical data block address of the data block in the CE space is in 32 bits and is represented in binaries without consecutive symbols starting from X'80000000' (for example, X'80000001', X'80000002' ···) with the most significant bit 1. Therefore, the logical data block in the CE space cannot be accessed by a group 0 command which allows only 21-bit addressing.
The data block allocation orders are the same as that for the user space. However, the last sector except the spare sectors on the last track in the cylinder is the last data block in the CE space because there is only one cylinder in the CE space.

(3) Alternate area

Alternate areas in the user space and the CE space (spare sectors in the cylinder and alternate cylinders) are not included in the above logical data block addresses. Access to sectors which are allocated as an alternate block in the alternate area is made automatically by means of IDD sector slip treatment or alternate block treatment (explained in Subsection 3.3.2), so the user does not have to worry about accessing the alternate area. The user cannot access with specifying the data block on the alternate area explicitly.

3.3 Defect Management

3.3.1 Defect list

Information of the defect location on the disk is managed by the defect list. The following are defect lists which the IDD manages.

- P list (Primary defect list): This list consists of defect location information available at the disk drive shipment and is recorded in a system space. The defects in this list are permanent, so the INIT must execute the alternate block allocation using this list when initializing the disk.

- D list (Data defect list): This list consists of defect location information specified in a FORMAT UNIT command by the INIT at the initialization of the disk. This information is recorded in the system space of the disk drive as the G list. To execute the alternate block allocation, the FORMAT UNIT command must be specified.

- C list (Certification defect list): This list consists of location information on defective blocks which are detected by the verifying operation (certification) of the data block after the initiation when executing the FORMAT UNIT command. The IDD generates this information when executing the FORMAT UNIT command, and the alternate block allocation is made upon the defective block. This information is recorded in the system space of the disk drive as the G list.

- G list (Growth defect list): This list consists of defective logical data block location information specified in a REASSIGN BLOCKS command by the INIT, information on defective logical data blocks assigned alternate blocks by means of IDD automatic alternate block allocation, information specified as the D list, and information generated as the C list. They are recorded in the system space on the disk drive.

The INIT can read out the contents of the P and G lists by the READ DEFECT DATA command.

3.3.2 Alternate block allocation

The alternate data block is allocated to a defective data block (= sectors) in defective sector units by means of the defect management method inside the IDD.

The INIT can access all logical data blocks in the user space and the CE space, as long as there is no error.

Spare sectors to which alternate blocks are allocated can be provided in either "spare sectors in a cylinder" or "alternate cylinders". See Subsection 3.1.2 for details.

The INIT can specify the size and area for spare sectors by the MODE SELECT command at the time of the initialization of the disk.

Both of the following are applicable to the alternate block allocation.

- Sector slip treatment: Defective sectors are skipped and the logical data block corresponding to those sectors is allocated to the next physical sectors. This treatment is made on the same cylinder as the defective sector's and is effective until all spare sectors in that cylinder are used up.

- Alternate sector treatment: The logical data block corresponding to defective sectors is allocated to unused spare sectors in the same cylinder or unused spare sectors in the alternate cylinder.

The alternate block allocation is executed by the FORMAT UNIT command, the REASSIGN BLOCKS command, or the automatic alternate block allocation. Refer to OEM Manual SCSI Logical Specifications for details of specifications on these commands. The logical data block is allocated to the next physically continued sectors after the above sector slip treatment is made. On the other hand, the logical data block is allocated to spare sectors which are not physically consecutive to the adjacent logical data blocks. If a command which processes several logical data blocks is specified, the IDD processes those blocks in ascending order of logical data block.

(1) Alternate block allocation during FORMAT UNIT command execution

When the FORMAT UNIT command is specified, the allocation of the alternate block to those defective sectors included in the specified lists (P, G, or D) is continued until all spare sectors in the same cylinder are used up. When they are used up, unused spare sectors in the alternate cylinder are allocated to the subsequent sectors in the cylinder by means of alternate sector treatment. Figure 3.8 is examples of the alternate block allocation during the FORMAT UNIT command execution.

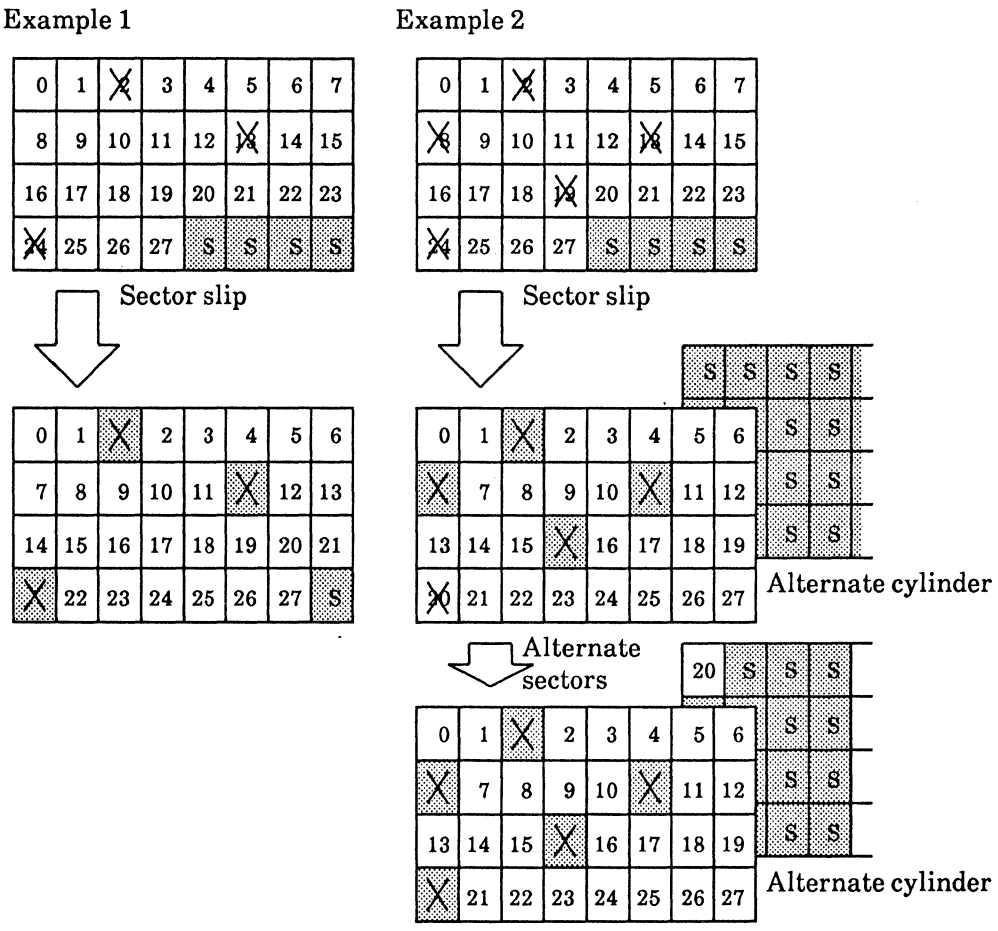


Figure 3.8 Alternate block allocation by FORMAT UNIT command

If the data block verifying operation (certification) is not permitted (DCRT flag = 0) in the FORMAT UNIT command, the IDD checks all initialized logical data blocks by reading them out after the above alternate block allocation is made to initialize (format) the disk. If a defective data block is detected during the check, the IDD generates the C list for defect location information and allocates the alternate block to the defective data block. This alternate block allocation is made by means of alternate sector treatment only like processing by the REASSIGN BLOCKS command even if unused spare sectors exists in the same cylinder.

(2) Alternate block allocation by REASSIGN BLOCKS command

When the REASSIGN BLOCKS command is specified, the alternate block is allocated to the defective logical data block specified by the initiator by means of alternate sector treatment. If there are unused spare sectors in the same cylinder as the specified defective logical data block, the alternate block is allocated to these unused spare sectors. However, the alternate block is allocated to unused spare sectors in the alternate cylinder when all spare sectors in the cylinder are used up.

Figure 3.9 is examples of the alternate block allocation by the REASSIGN BLOCKS command.

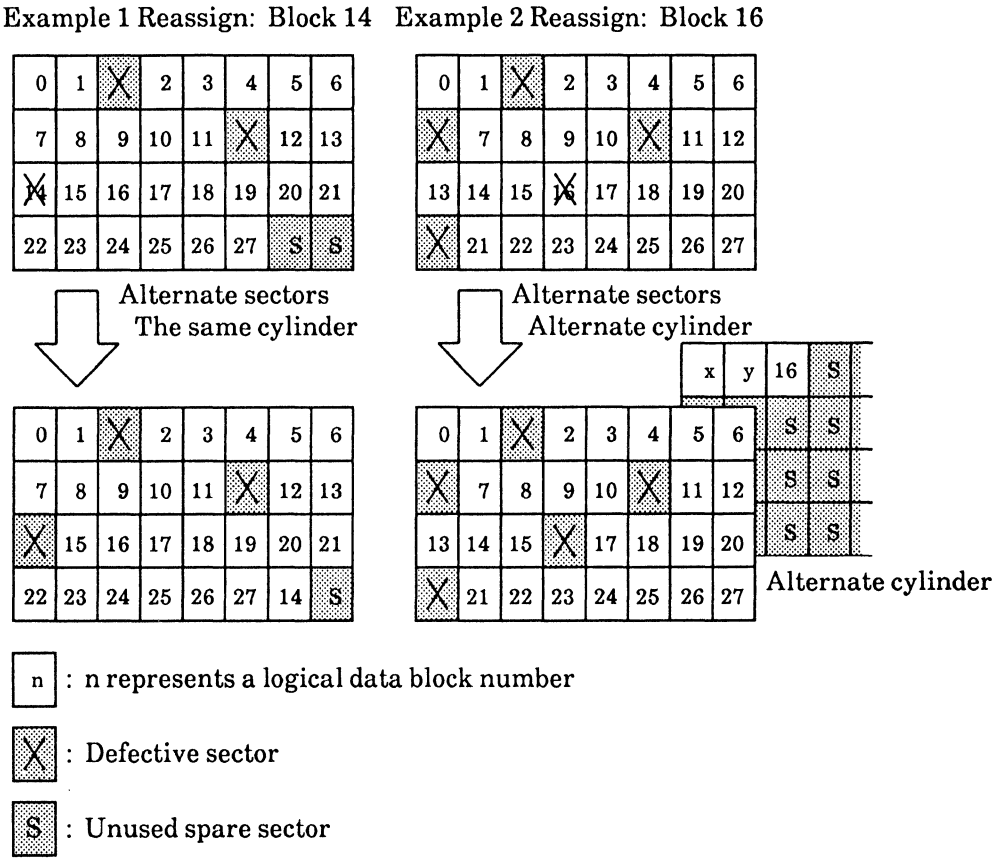


Figure 3.9 Alternate block allocation by REASSIGN BLOCKS command

(3) Automatic alternate block allocation

If the AWRE or ARRE flag in the MODE SELECT parameter permits the automatic alternate block allocation, the IDD automatically executes the alternate block allocation and data duplication on the defective data block detected during the WRITE, WRITE EXTENDED, WRITE AND VERIFY, READ, or the READ EXTENDED command. This allocation method is the same as with the REASSIGN BLOCKS command (alternate sector treatment.)

Note:

Automatic alternate block allocation is made only once during the execution of one command. If second defective block is detected, the alternate block assignment processing for the first defective block is executed but the alternate block assignment processing for the second one is not executed and the command being executed terminates with error. However, the initiator can recover the error by issuing the same command again.

When an error is detected in a data block in the data area, recovery data is rewritten and verified in automatic alternate block allocation during the execution of the READ or READ EXTENDED command. Alternate block allocation will not be made for the data block if recovery is successful.

Example: Even if the data error which is recoverable by the WRITE LONG command is simulated, automatic alternate block allocation will not be made for the data block.

CHAPTER 4 INSTALLATION REQUIREMENTS

This chapter describes the environmental, mounting, power supply, and connection requirements.

4.1 Environmental Requirements

The IDD must conform to the environmental requirements given in Subsection 2.1.3. When the IDD is operating, the ambient temperature measured 3 cm from the disk enclosure (DE) surface and from the PCA surface must satisfy the specified requirement. For the DE surface temperature at operating, the contact temperature at the measurement point shown in Figure 4.1 must satisfy the specified requirement.

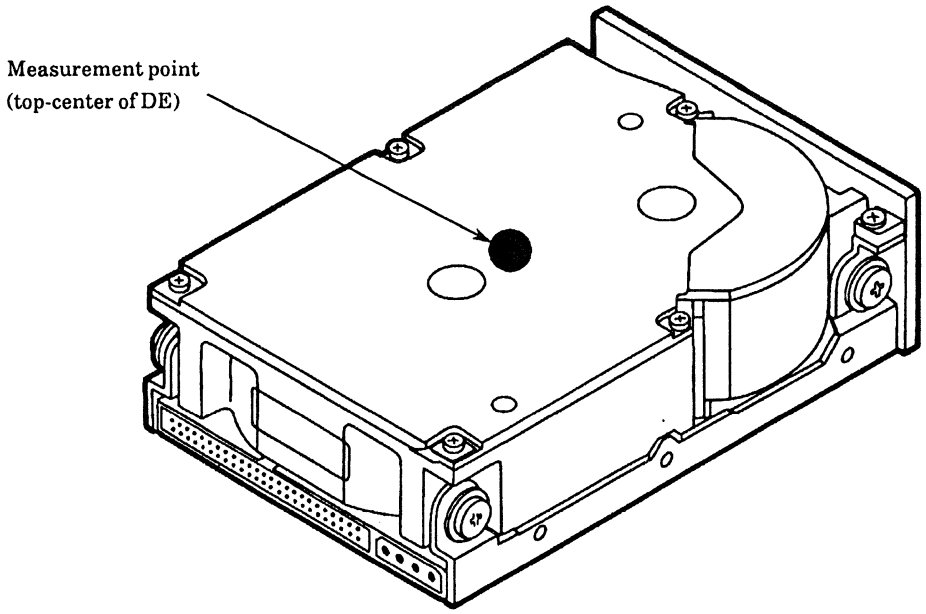


Figure 4.1 DE surface temperature measurement point

4.2 Mounting Requirement

4.2.1 Exterior dimensions

Figures 4.2 and 4.3 show the exterior dimensions of the IDD and the positions of the holes for the IDD mounting screws.

Note:

Dimensions are in mm.

(*) Between mounting screw holes on the bottom.

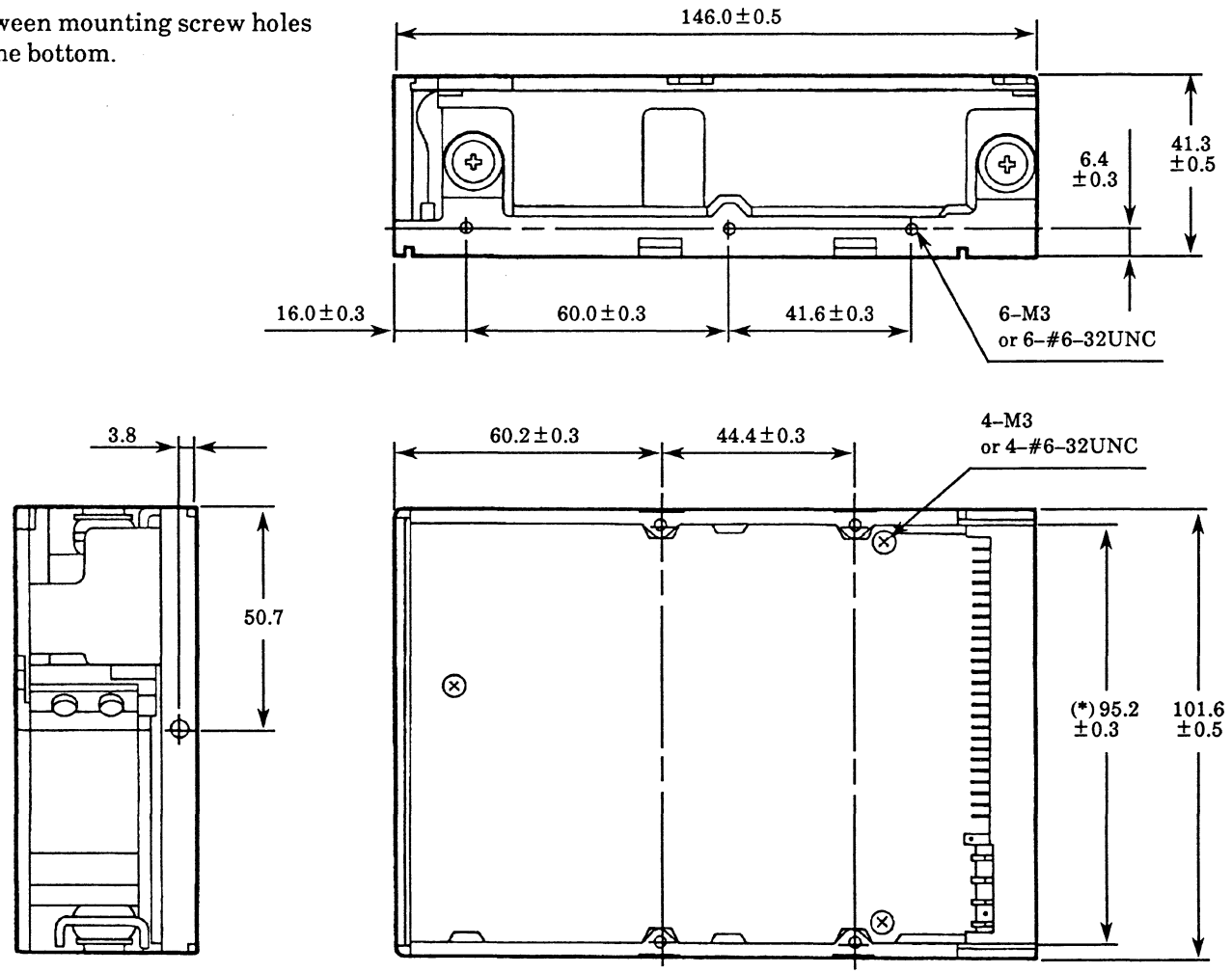


Figure 4.2 Exterior dimensions (M2624S without front panel)

(*) Between mounting screw holes on the bottom.

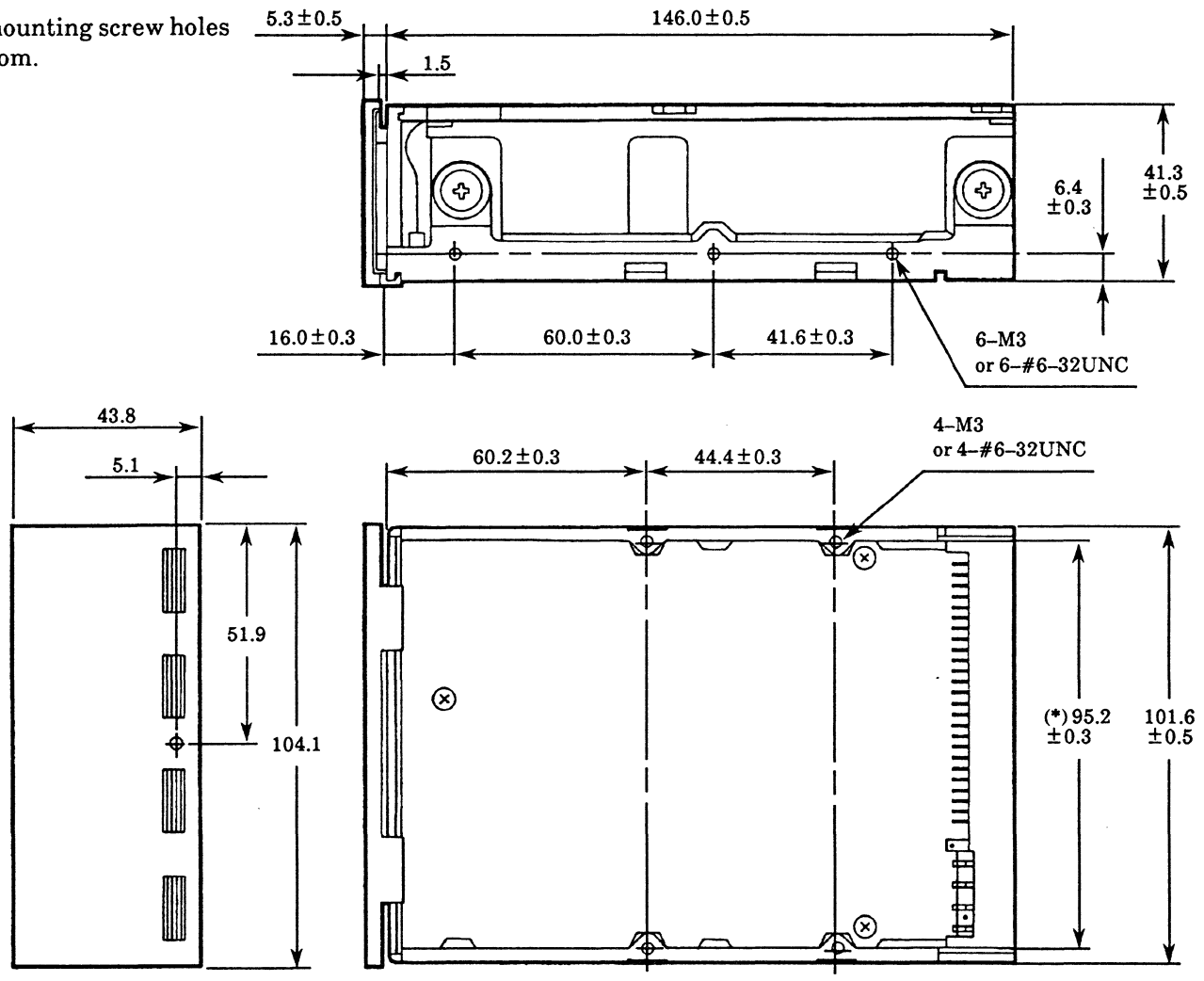
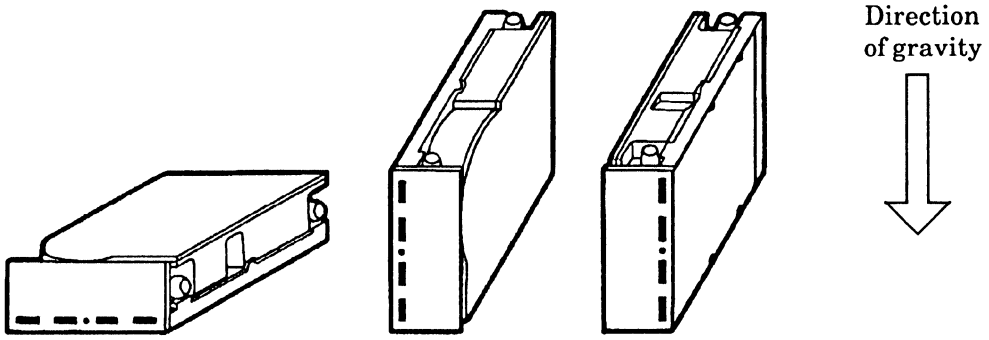


Figure 4.3 Exterior dimensions (M2624S with front panel)

4.2.2 Mounting

The permissible orientations of the IDD are shown in Figure 4.6, and the tolerance of the angle is ±5° from the horizontal plane.



(a) Horizontal (b) Vertical (c) Vertical

Figure 4.4 IDD orientation

4.2.3 Notes on mounting

(1) Mounting frame structure

The disk enclosure (DE) of the IDD serves as a signal ground (SG) and is insulated from the mounting frame (frame ground: FG). As this insulation is maintained after the IDD is mounted in the system, the following precautions must be followed.

Note:

Generally, SG and FG are connected at one point in the system enclosure. Therefore, use following procedure to maintain the insulation when mounting the IDD:

(a) Use the frame with an embossed structure or the like to avoid contact between the DE base and FG. Mount the IDD with making a gap of 2.5 mm or more between the IDD and the frame of the system.

(b) As shown in Figure 4.5, the inward projection of the screw from the IDD frame wall at the corner must be 4 mm or less.

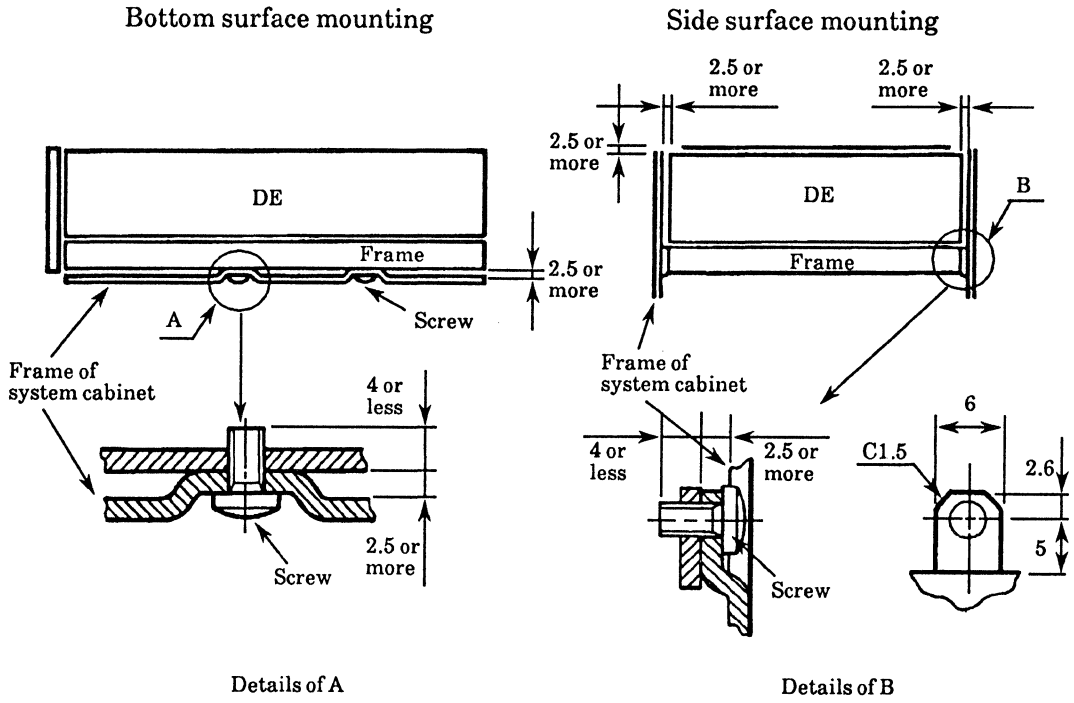
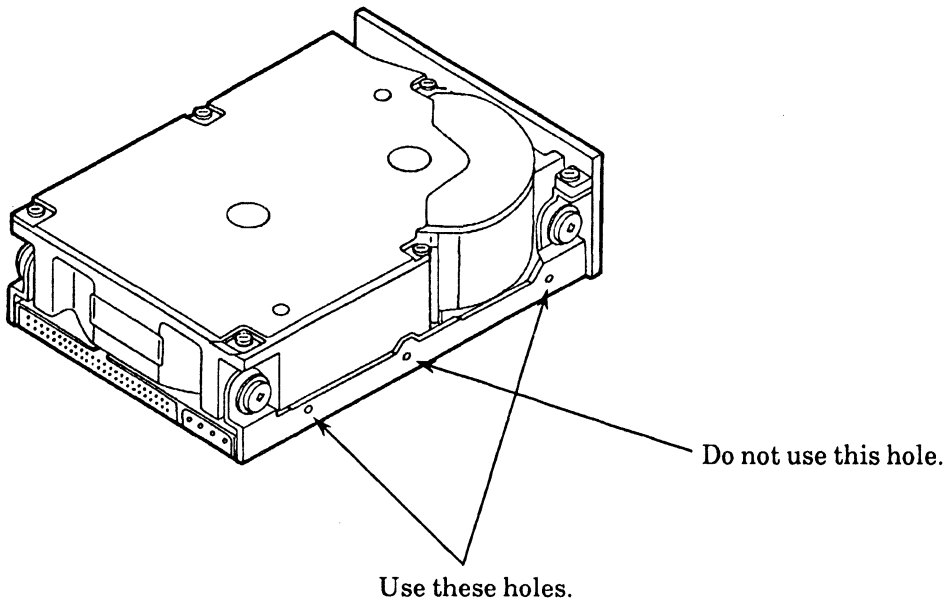


Figure 4.5 Mounting frame structure

Limitation of side-mounting

When the drive is mounted using side screw hole, use the following two screw holes. Do not use the center hole.



(2) Service clearance area

The service clearance area, or the sides which must allow access to the IDD for installation or maintenance, is shown in Figure 4.6.

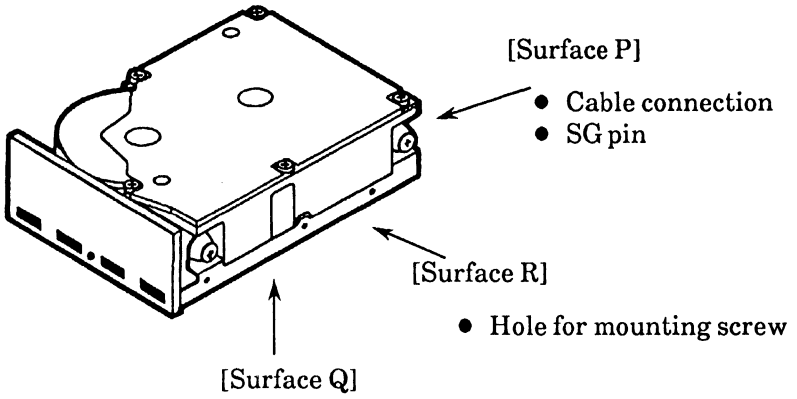


Figure 4.6 Service clearance area

(3) External magnetic field

The drive should not be installed near the ferromagnetic body like a speaker to avoid the influence of the external magnetic field.

4.3 Power Supply Requirement

(1) Allowable input voltage and current

The power supply input voltage measured at the power supply connector pin of the IDD (receiving end) must satisfy the requirement given in Subsection 2.1.3. (For other requirements, see Items (4) and (5) below.)

(2) Current waveform (reference)

Figure 4.7 shows the waveform of +12 VDC.

(a) At start of spindle motor rotation

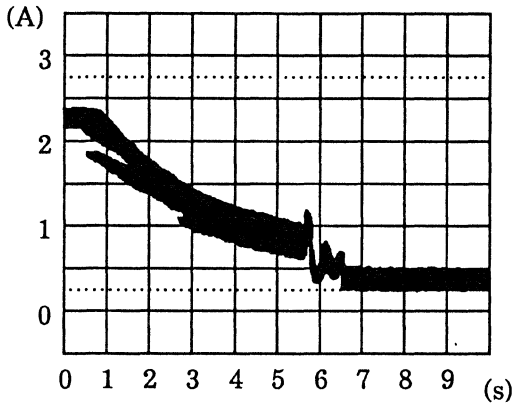


Figure 4.7 Current waveform (+12 VDC)

(3) Power on/off sequence

(a) The order of the power on/off sequence of +5 VDC and +12 VDC, supplied to the IDD, does not matter.

(b) In a system which uses the terminating resistor power supply signal (TERMPWR) on the SCSI bus, the requirements for +5 VDC given in Figure 4.8 must be satisfied between the IDD and at least one of the SCSI devices supplying power to that signal.

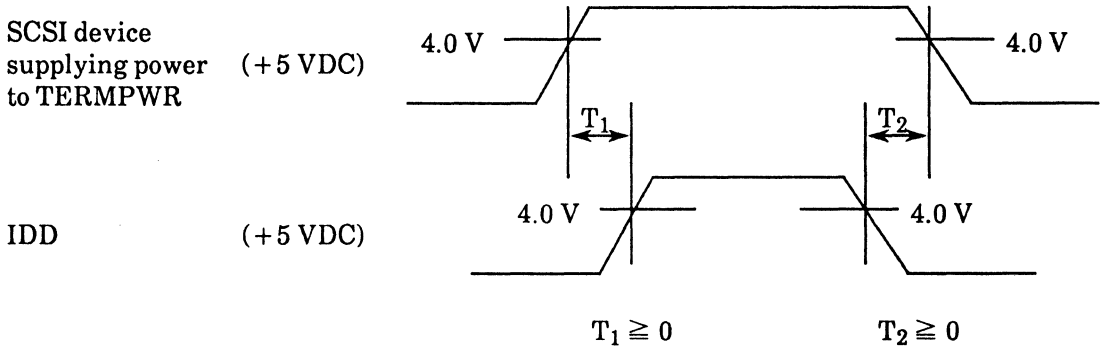


Figure 4.8 Power on/off sequence (1)

(c) In a system which does not use the terminating resistor power supply signal (TERMPWR) on the SCSI bus, the requirements for +5 VDC given in Figure 4.9 must be satisfied between the IDD and the SCSI device with the terminating resistor circuit.

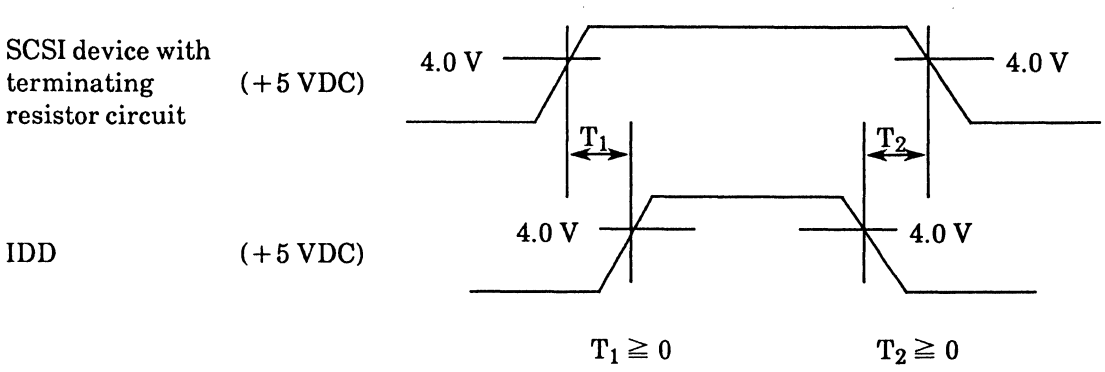


Figure 4.9 Power on/off sequence (2)

(d) Between the IDD and other SCSI devices on the SCSI bus, the +5 VDC power on/off sequence is as follows:

- In a system with its all SCSI devices designed to prevent noise from leaking to the SCSI bus when power is turned on or off, the power sequence does not matter if the requirement in (b) or (c) is satisfied.
- In a system containing an SCSI device which is not designed to prevent noise from leaking to the SCSI bus, the requirement given in Figure 4.10 must be satisfied between that SCSI device and the IDD.

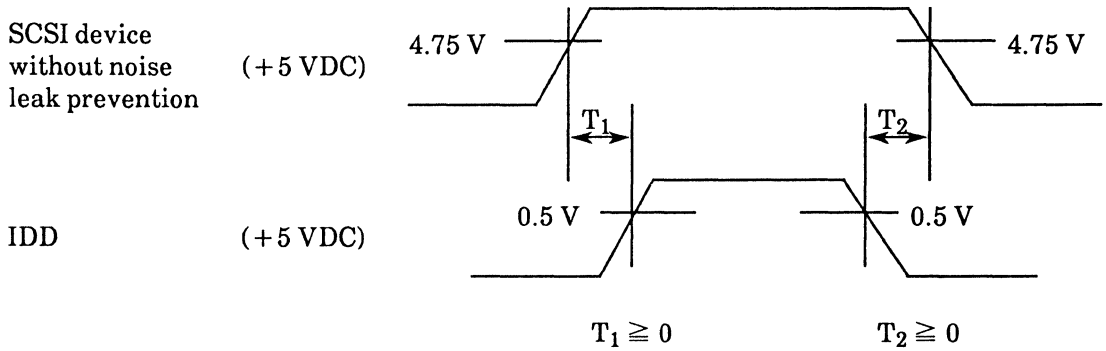


Figure 4.10 Power on/off sequence (3)

(4) Sequential starting of spindle motors

After power is turned on to the IDD, a large amount of current flows in the +12 VDC line when the spindle motor rotation starts. Therefore, if more than one IDD is used, the spindle motors should be started sequentially using one of the following procedures to prevent overload of the power supply unit. For how to set a spindle motor start control mode, see Subsection 5.3.2.

a. Issue START and STOP commands at 20-second intervals to start the spindle motors. For details of this command specification, refer to OEM Manual SCSI Logical Specifications.

b. Turn on the +12 VDC power in the power supply unit at 20-second intervals to start the spindle motors sequentially.

(5) Power supply to SCSI terminating resistor

If power for the terminating resistor is supplied from the IDD to other SCSI devices through the SCSI bus, the current-carrying capacity of the +5 VDC power supply line to the IDD must be designed with considering of an increase of up to 900 mA.

A method of power supply to the terminating resistor is selected with a setting terminal on the IDD. See Subsection 5.3.2 for this selection.

For the electrical condition of supplying power to the terminating resistor, refer to Subsection 1.4.2 in OEM Manual SCSI Physical Specifications.

(6) Noise filter

To eliminate AC line noise, a noise filter should be installed at the AC input terminal on the IDD power supply unit. The specification of this noise filter is as follows:

- Attenuation: 40 dB or more at 10 MHz
- Circuit construction: T-configuration as shown in Figure 4.11 is recommended.

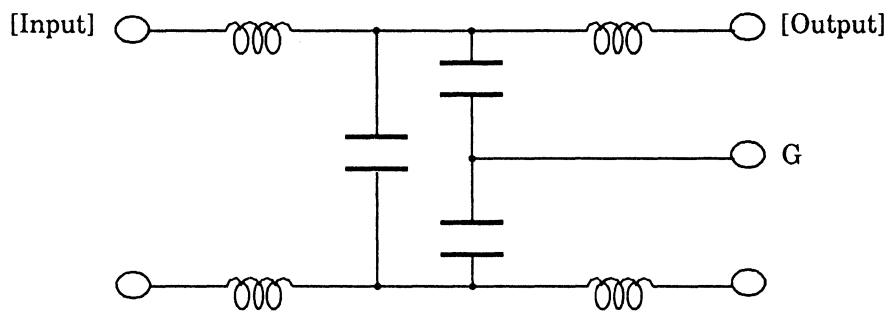


Figure 4.11 AC noise filter (recommended)

4.4 Connection Requirement

4.4.1 Connectors

Connectors and terminals for connection to the outside are installed on the IDD. Their positions are shown in Figures 4.12.

- Power supply connector
- SCSI connector
- SG terminal
- Connector for external operator panel
- Connector for spindle sync

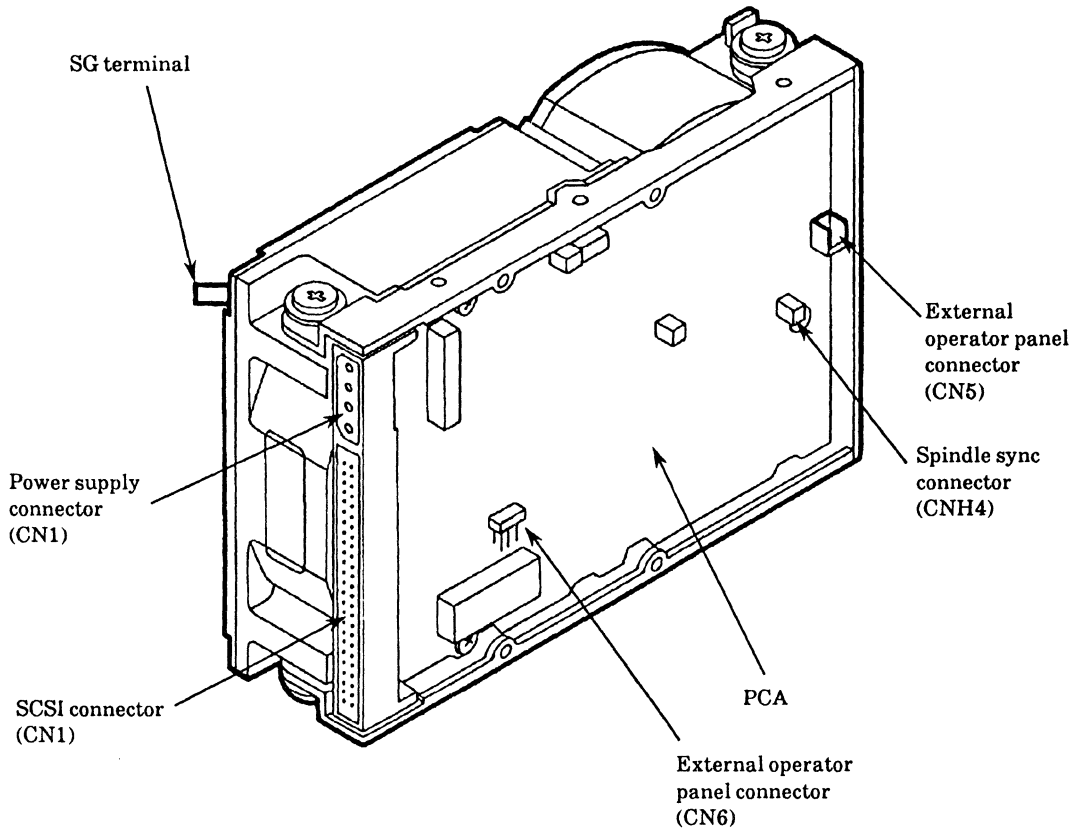
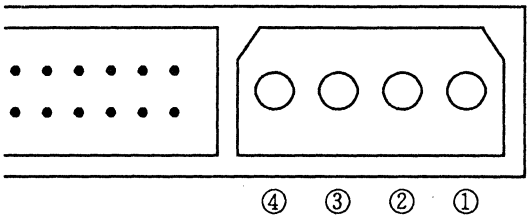


Figure 4.12 Positions of connectors (M2624S)

(1) Power supply connector

The shape and pin configuration of the DC power supply connector are shown in Figure 4.13.



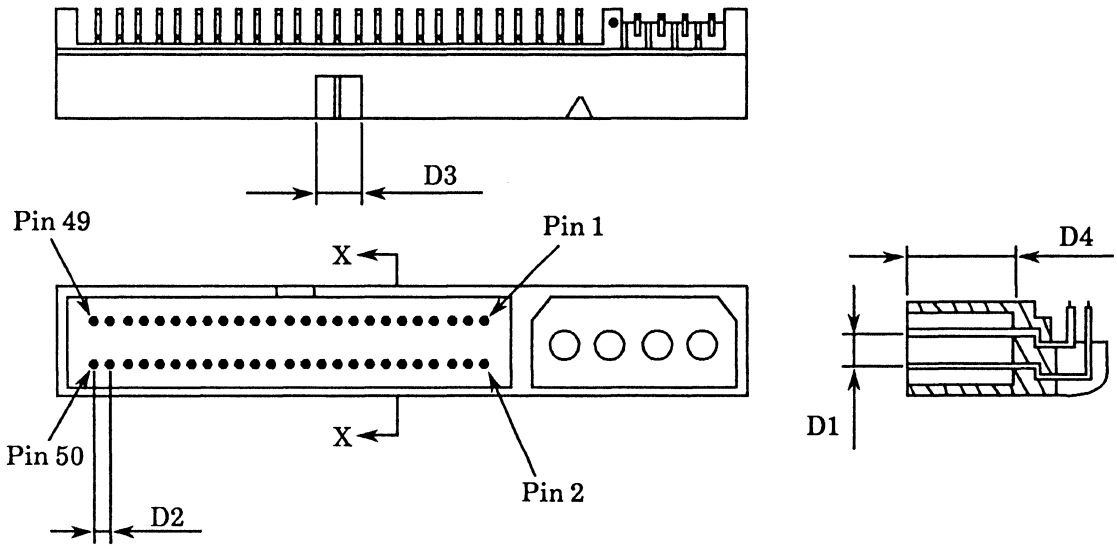
①	+12 VDC
②	+12 VDC Return (GND)
③	+5 VDC Return (GND)
④	+5 VDC

Figure 4.13 Power supply connector

(2) SCSI connector

The connector for the SCSI bus is an unshielded standard connector which has two rows of 25-pin spaced 2.54 mm (0.1 inch) apart. Figure 4.14 is a number of views of the connector. Figures 4.15 shows the signal assignment on the connector.

For details information on the physical/electrical requirements of the interface signals, refer to Sections 1.3 and 1.4 in OEM Manual SCSI Physical Specifications.



Symbol	mm	Inch	Remarks
D1	2.54	0.100	
D2	2.54	0.100	
D3	5.08	0.200	
D4	6.25	0.246	

The tolerance is ±0.127 mm (0.005 inch) unless otherwise specified.

Figure 4.14 SCSI interface connector

Pin number	Signal	Signal	Pin number
01	GND	–DB0	02
03	GND	–DB1	04
05	GND	–DB2	06
07	GND	–DB3	08
09	GND	–DB4	10
11	GND	–DB5	12
13	GND	–DB6	14
15	GND	–DB7	16
17	GND	–DBP	18
19	GND	GND	20
21	GND	GND	22
23	(Open)	(Open)	24
25	Open	TERMPWR (*1)	26
27	(Open)	(Open)	28
29	GND	GND	30
31	GND	–ATN	32
33	GND	GND	34
35	GND	–BSY	36
37	GND	–ACK	38
39	GND	–RST	40
41	GND	–MSG	42
43	GND	–SEL	44
45	GND	–C/D	46
47	GND	–REQ	48
49	GND	–I/O	50

*1 Terminating resistor power supply (jumper setup for input only, both input and output, or open)

Figure 4.15 Signal assignment on SCSI connector

(3) SG terminal

For DC ground, an SG terminal (Fastin-Faston tab) is mounted as shown in Figure 4.16.

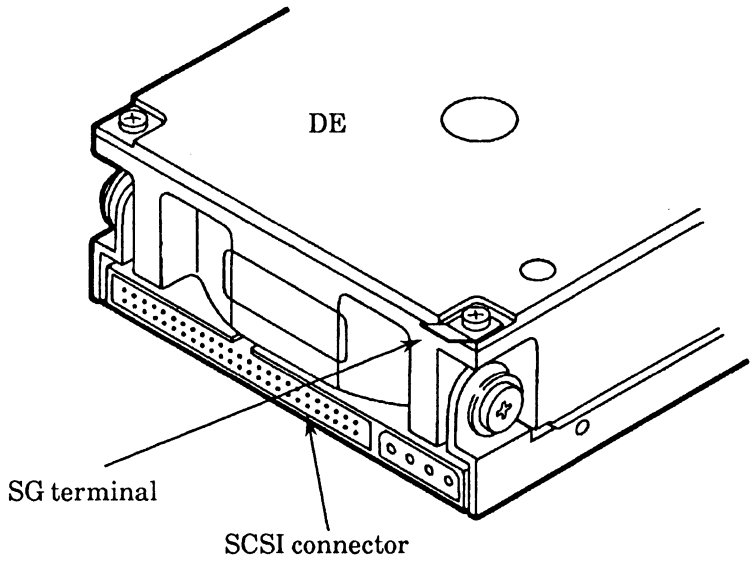
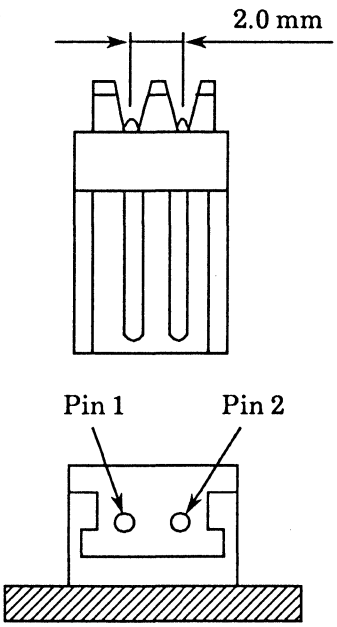


Figure 4.16 SG terminal

(4) Connector for external operator panel

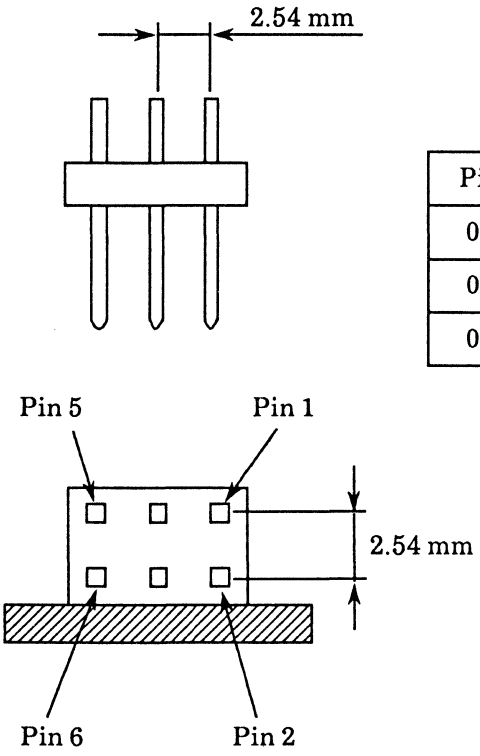
Two types of connectors for the external operator panel are provided on the IDD as shown in Figure 4.17. They allow connection of an external LED on the front panel, and an SCSI ID setting switch. For the recommended circuit of the external operator panel, see Subsection 4.4.3.

CN5



Pin	Signal
01	LED (V)
02	– LED

CN6



Pin	Signal	Signal	Pin
01	GND	– ID2	02
03	GND	– ID1	04
05	GND	– ID0	06

Figure 4.17 External operator panel connector

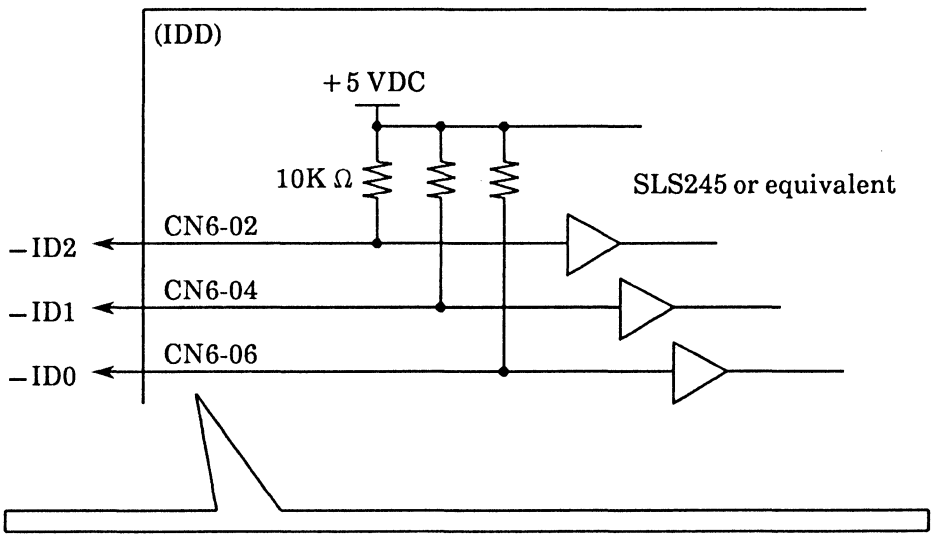
Notes:

1. When the external operator panel is not connected to CN6, CN6 should be opened. (default setting: open)

2. When the external operator panel is connected, pins of CNH7 corresponding to the signals set by the external operator panel should be opened.

(a) −ID2, −ID1, −ID0: Input signals

These signals are used for providing switches to set the SCSI ID of the IDD externally. The electrical requirements are given in Figure 4.18. For the recommended circuits, see Subsection 4.4.3.



Input level			SCSI ID
−ID2	−ID1	−ID0	
0 to 0.4 VDC	0 to 0.4 VDC	0 to 0.4 VDC	7
0 to 0.4 VDC	0 to 0.4 VDC	(Open)	6
0 to 0.4 VDC	(Open)	0 to 0.4 VDC	5
0 to 0.4 VDC	(Open)	(Open)	4
(Open)	0 to 0.4 VDC	0 to 0.4 VDC	3
(Open)	0 to 0.4 VDC	(Open)	2
(Open)	(Open)	0 to 0.4 VDC	1
(Open)	(Open)	(Open)	0

Figure 4.18 SCSI ID external input

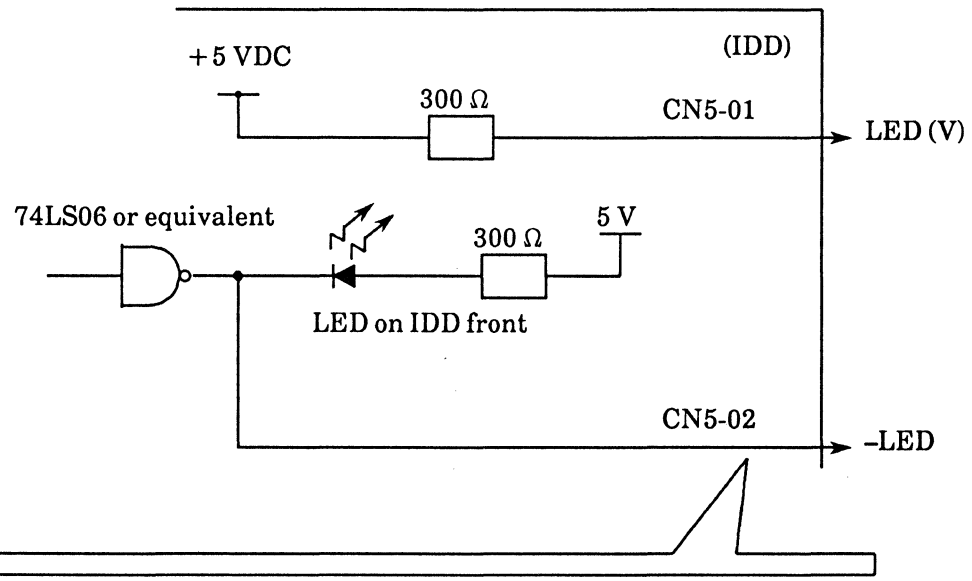
(b) – LED and LED (V) : Output signals

These signals actuate the external LED as same as LED on the front panel of the disk drive. The electrical requirements are given in Figure 4.19.

Notes:

1. The external LED is identical in indication to the LED on the front of the IDD. The indication can be changed with a setting terminal (see Subsection.5.3.2).

2. Any load other than the external LED (see Subsection 4.4.3) should not be connected to the LED (V) and – LED terminals.



Output level	Function
0 to 0.4 VDC (I_{OL} = 15 mA max.)	LED on
2.5 to 5.25 VDC	LED off

Figure 4.19 Output signal for external LED

4.4.2 Cable connection requirements

The requirements for cable connection between the IDD, host system, and power supply unit are given in Figure 4.20. Recommended components for connection are listed in Table 4.1.

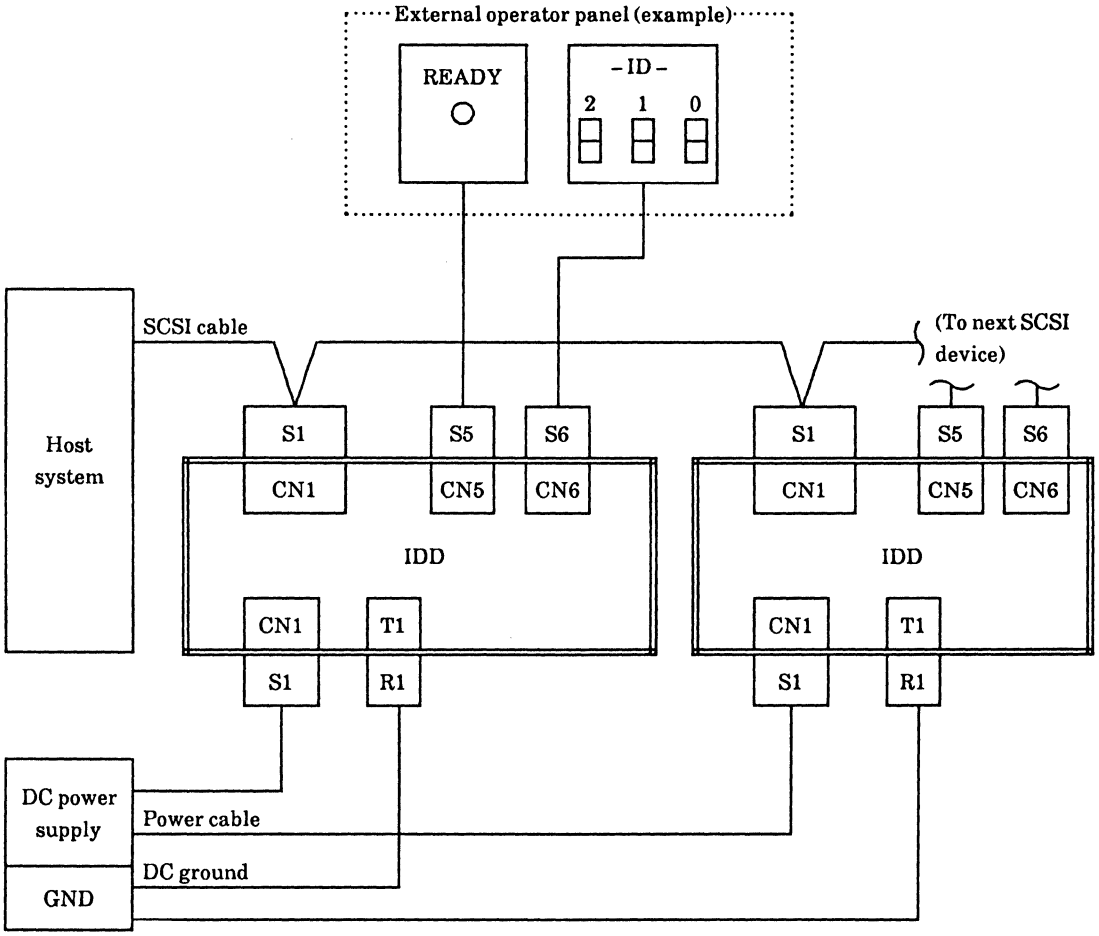


Figure 4.20 Cables connection

Table 4.1 Recommended components for connection

Category	Name	Model	Manufac-turer	Symbol in Figure 4.19
SCSI cable	Cable socket (closed-end type)	FCN-707B050-AU/B	Fujitsu Ltd.	S1
	Cable socket (through-end type)	FCN-707B050-AU/O	Fujitsu Ltd.	
	Signal cable	UL20184-LT25PX28AWG	Hitachi Cable, Ltd.	
		455-248-50	SPECTRA-STRIP	
Power supply cable	Cable socket	1-480424-0	AMP	S1
	Contact	170121-4	AMP	
	Cable	AWG18 ~ 24		
DC ground	Fastin-Faston receptacle	62187-1	AMP	R1
	Cable	AWG20		
External operator panel	Cable socket	608283302815000	ELCO	S5
	Contact	608283052330808 (AWG24 ~ 30)	ELCO	
		608283252330808 (AWG32)		
	Cable socket	FCN-723J 006/2	Fujitsu Ltd.	S6
	Contact	FCN-723J-AU/Q	Fujitsu Ltd.	
	Cable	AWG 28		

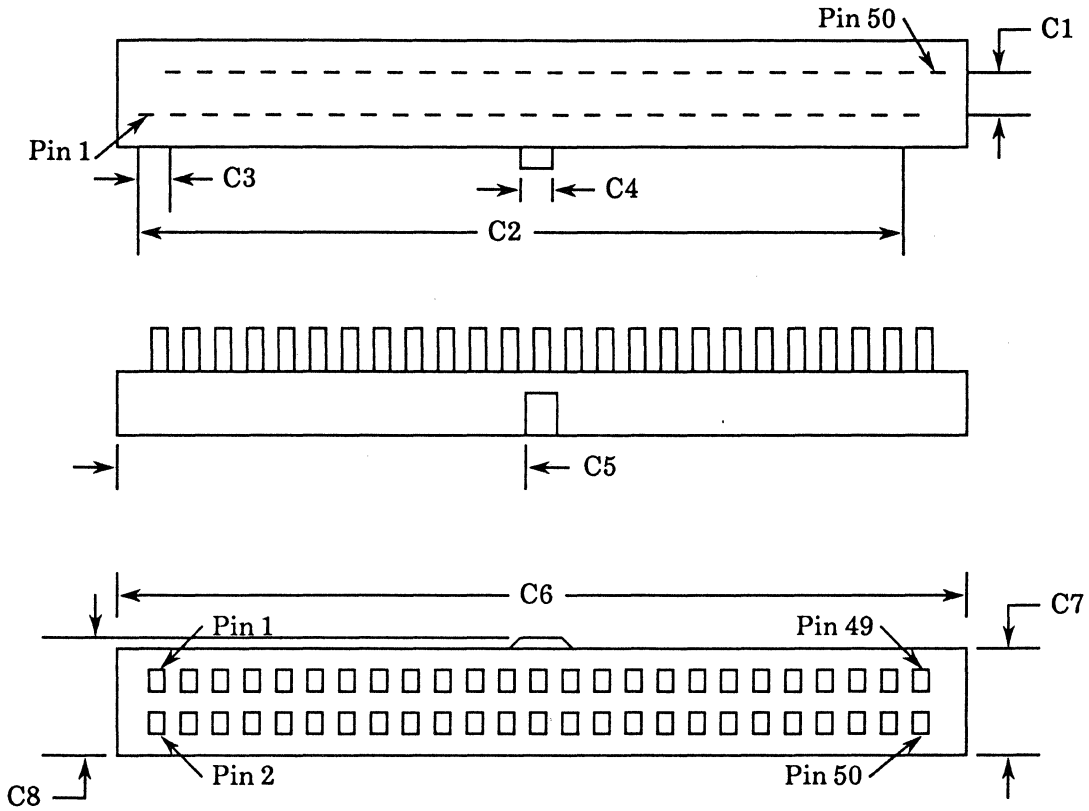
(1) SCSI cable

All SCSI devices on one bus are daisy-chained with an SCSI cable. A terminating resistor must be mounted in the SCSI device at each end of the SCSI cable.

Since an SCSI terminating resistor module is mounted in the IDD on shipment, it must be removed when the IDD is not connected at either end of the SCSI cable. Also, a method for power supply to the terminating resistor must be selected with the setting terminal on the IDD. For further details, see Section 5.3.

The maximum number of SCSI devices that can be connected to the SCSI bus is 8, including the host adapter, IDD, and other SCSI equipment.

The connector (socket) for the SCSI cable must be an unshielded 50-contact socket which has two rows of 25 contacts spaced at 2.54 mm (0.1 inch) apart. It should also have a key way to prevent insertion in the wrong direction (bump type connector). (See Figure 4.21)



Symbol	mm	Inch	Remark
C1	2.540	0.100	
C2	60.960	2.400	
C3	2.540	0.100	
C4	3.302	0.130	
C5	32.385	1.275	
C6	68.072	2.680	
C7	6.096	0.240	
C8	7.620	0.300	Max.

Note: The tolerance is ±0.127 mm (0.005 inch) unless otherwise specified.

Figure 4.21 SCSI cable connector

The maximum length of the SCSI cable is as follows. If more than one SCSI device is connected, the total cable length must not exceed the following.

- 6 m cable length

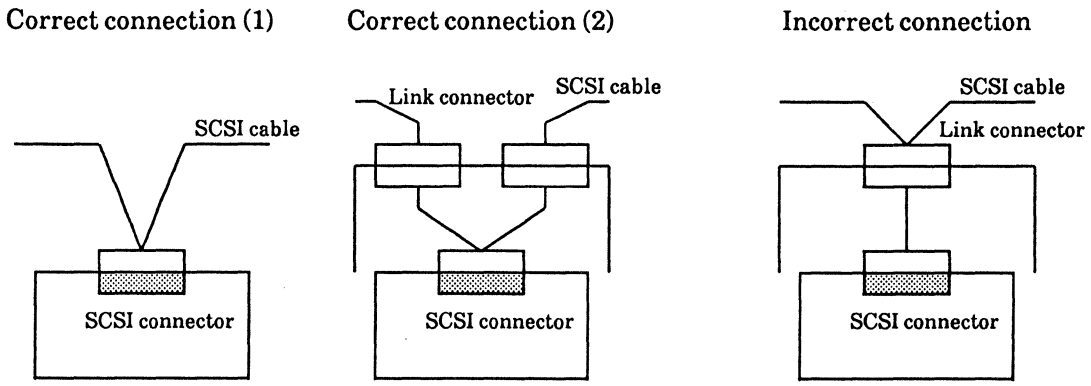
The use of a 25-pair twisted cable satisfying the following requirements is recommended.

① Conductor size: 28 AWG (American wire gauge) or bigger
② Characteristics impedance: 100 to 132 Ω

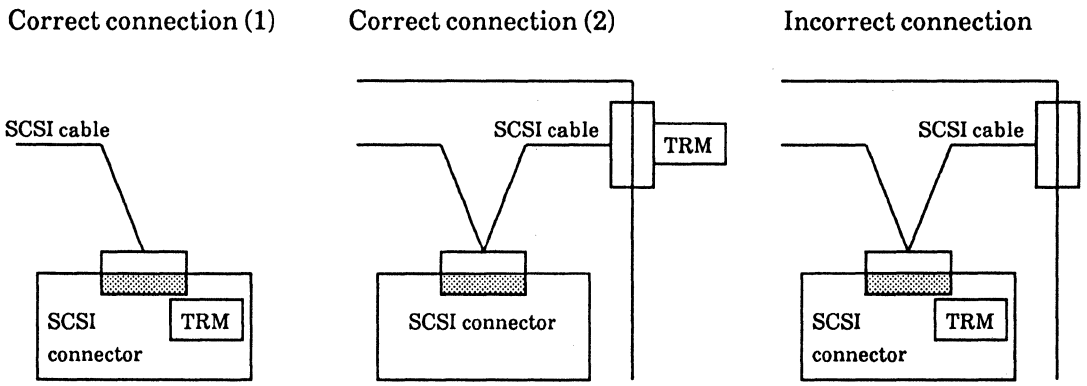
Each pair of wires in the 25-pair twisted cable must be connected to pins n and n + 1 (where n is an odd number) on the interface connector. Cables having an identical impedance must be used on the same SCSI bus to reduce signal reflection and maintain transmission characteristics.

When an SCSI device is connected to the SCSI cable except at either end of the cable, connection to the SCSI connector must be at a branchpoint of the cable. If an SCSI device is connected to one end of the SCSI bus, no cable should be connected after the last SCSI device except when the cable has a terminating resistor. (See Figure 4.22)

(A) Connection to a middle point of the cable



(B) SCSI cable termination



TRM: SCSI terminating resistor

Figure 4.22 Connection of SCSI cable

(2) Power cable

IDDs must be star-connected to the DC power supply (one to one connection) to reduce the influence of load variations.

(3) DC ground

A DC ground cable may or may not be installed depending on the system requirements (system installation environment, cabinet structure, power supply system). This cable is generally connected to the ground of the power supply unit. It is recommended to connect with a daisy chain (one by one connection).

(4) External operator panel

The external operator panel is installed only when required for the system. If it is unnecessary, pins 01 and 02 of CN5 and pins 1 to 6 of CN6: connector for the external operator panel on the IDD must be opened.

4.4.3 External operator panel

A recommended circuit of the external operator panel is shown in Figure 4.23. Since the external operator panel is not provided as an option, this panel must be fabricated at the user site referring to the recommendation if necessary.

Note:

Necessary switches and LEDs for system can be provided on the external operator panel with refering to the recommend circuit shown in Figure 4.23.

When the external operator panel is connected to CN6, pins of CNH7 corresponding to signals set by CN6 should be opened. For details information, see item (4) in Subsection 4.4.1 and Subsection 5.3.1.

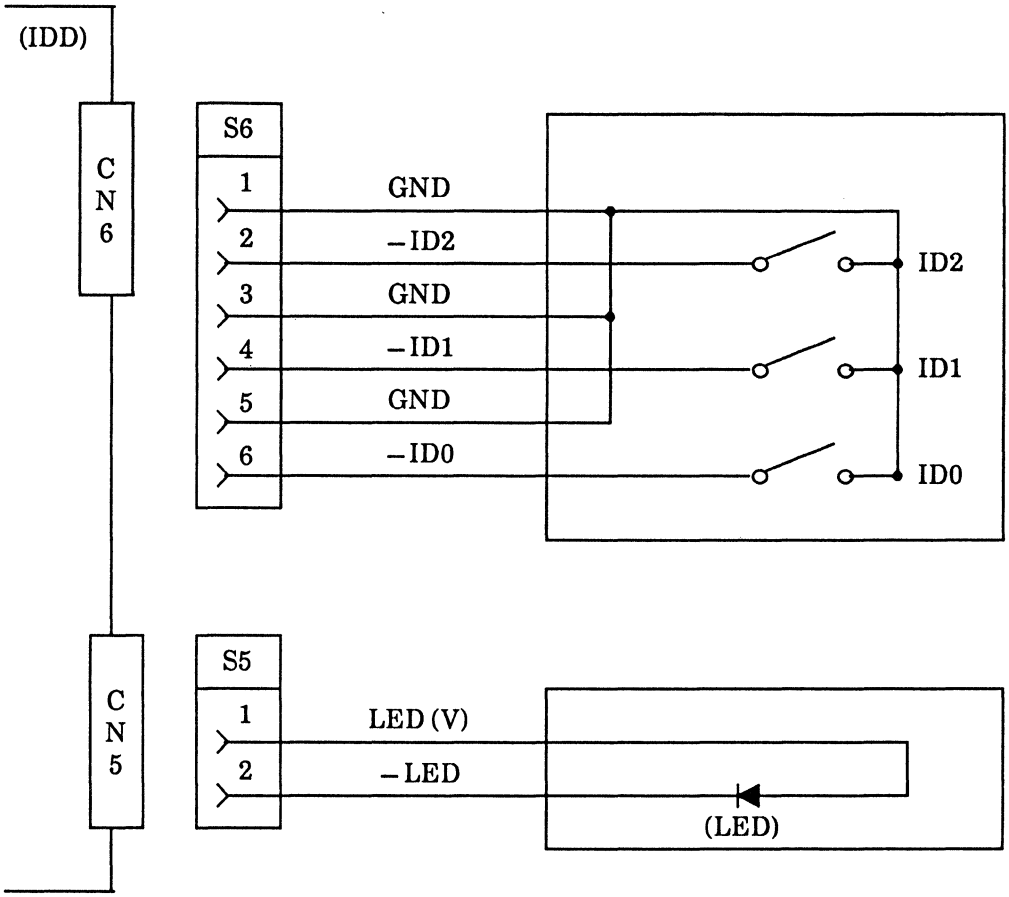


Figure 4.23 Example of external operator panel circuit

CHAPTER 5 INSTALLATION

This chapter describes the notes on handling drives, connections, setting switches and plugs, mounting drives, connecting cables, confirming drive operations after installation and preparation for use, and demounting drives.

5.1 Notes on Handling Drives

(1) General notes

a) Do not give the drive shocks or vibrations exceeding the value defined in the standard because it may cause critical damage to the drive. Especially be careful when unpacking.

b) Do not leave the drive in a dirty or contaminated environment.

c) Since static discharge may destroy the CMOS semiconductors in the drive, note the following after unpacking:

- Use an antistatic mat and body grounding when handling the drive.
- Hold the DE or mounting frame when handling the drive. Do not touch PCAs except for setting.

(2) Unpacking

a) Use a flat work area. Check that the "This Side Up" sign side is up. Handle the package on soft material such as a rubber mat, not on hard material such as a desk.

b) Be careful not to give excess pressure to the internal unit when removing cushions.

c) Be careful not to give excess pressure to the PCAs and interface connector when removing the drive from the antistatic bag.

d) Do not remove the sealing label or cover of the DE and screws.

(3) Installation

a) Do not connect or disconnect connectors or change terminal except CNH1 (offline self-diagnostics)/CNH7 (write protect) when power is turned on.

b) Do not move the drive when power is turned on or until the drive completely stops (for 30 seconds) after power is turned off.

(4) Packing

a) Store the drive in an antistatic vinyl bag with a desiccant (silica gel).

b) It is recommended to use the same cushions and packages as those at delivery. If those at delivery cannot be used, use a package with shock absorption so that the drive is free from direct shocks. In this case, fully protect the PCAs and interface connector so that they are not damaged.

c) Indicate "This Side Up" and "Handle With Care" on the outside of the package so that it is not turned over.

(5) Delivery

a) When delivering the drive, provide packaging and do not turn it over.

b) Minimize the delivery distance after unpacking and avoid shocks and vibrations with cushions. For the carrying direction at delivery, use one of the mount allowable directions in Subsection 4.2.2 (vertical direction is recommended).

(6) Storage

a) Provide vaporproof packaging for storage.

b) The storage environment must satisfy the requirements specified in Subsection 2.1.3 when the drive is not operating.

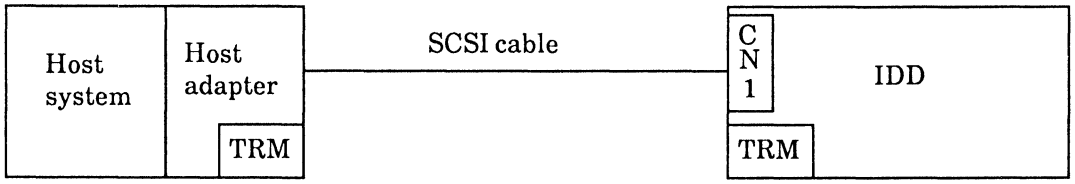
c) To prevent condensation, avoid sudden changes in temperature.

5.2 Connections

Figure 5.1 shows examples of connections between the host system and the IDD. Up to eight devices including the host adapter, IDD, and other SCSI devices can be connected to the SCSI bus in arbitrary combinations. Install a terminating resistor on the SCSI device connected to both ends of the SCSI cable.

See Section 4.4 for the cable connection requirements and power cable connections.

(1) Connecting one IDD



(2) Connecting more than one IDD (single host)

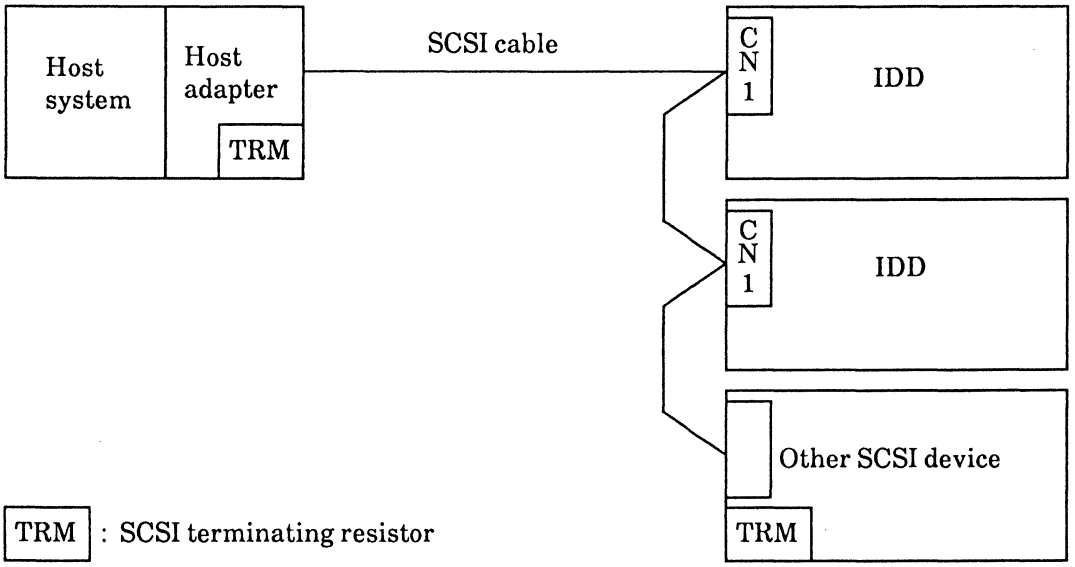
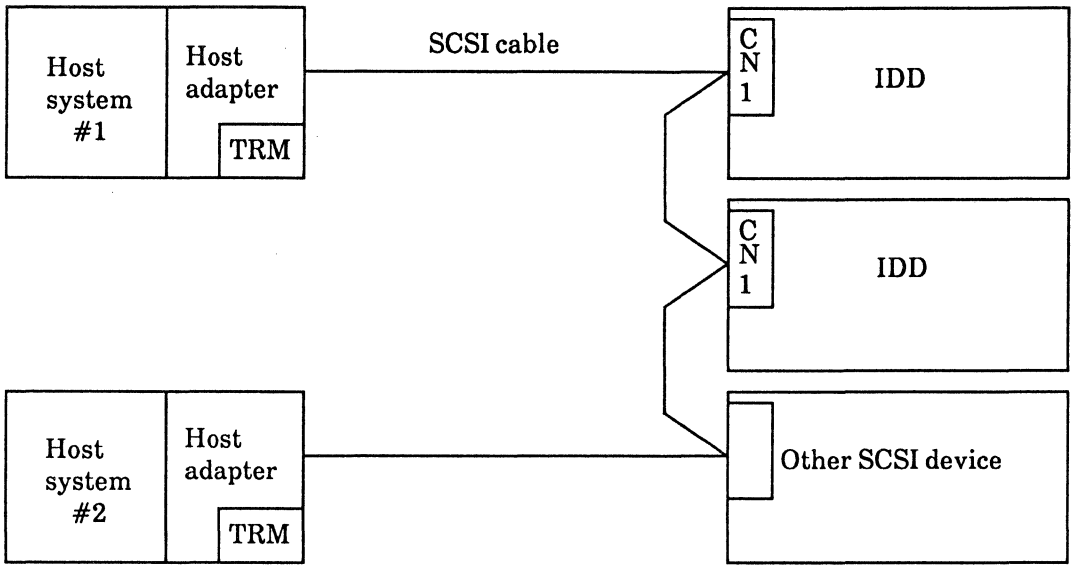


Figure 5.1 SCSI bus connections (1 of 2)

(3) Connectiong more than one IDD (multi-host)



TRM: SCSI terminating resistor

Figure 5.1 SCSI bus connections (2 of 2)

5.3 Setting Terminals

The user must set the following terminals and SCSI terminating resistor before installing the IDD in the system.

- Setting terminal: CNH1, CNH2, CNH7
- Setting terminal: CNH3
- SCSI terminating resistor

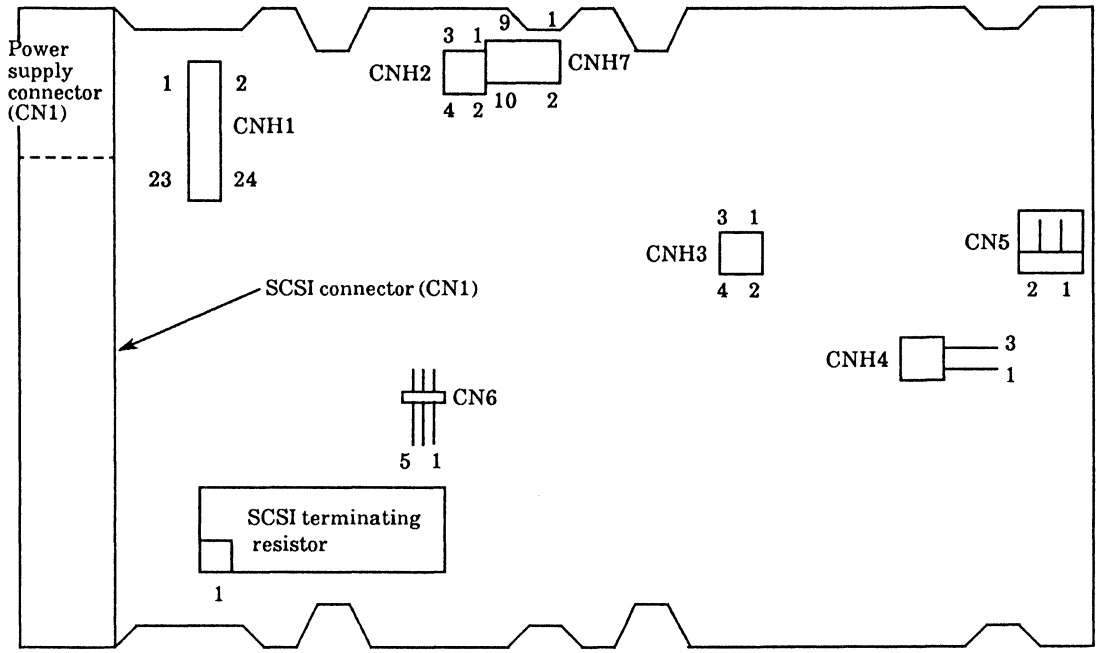
Figure 5.2 shows the setting terminal and the position of the SCSI terminating resistor module.

Notes:

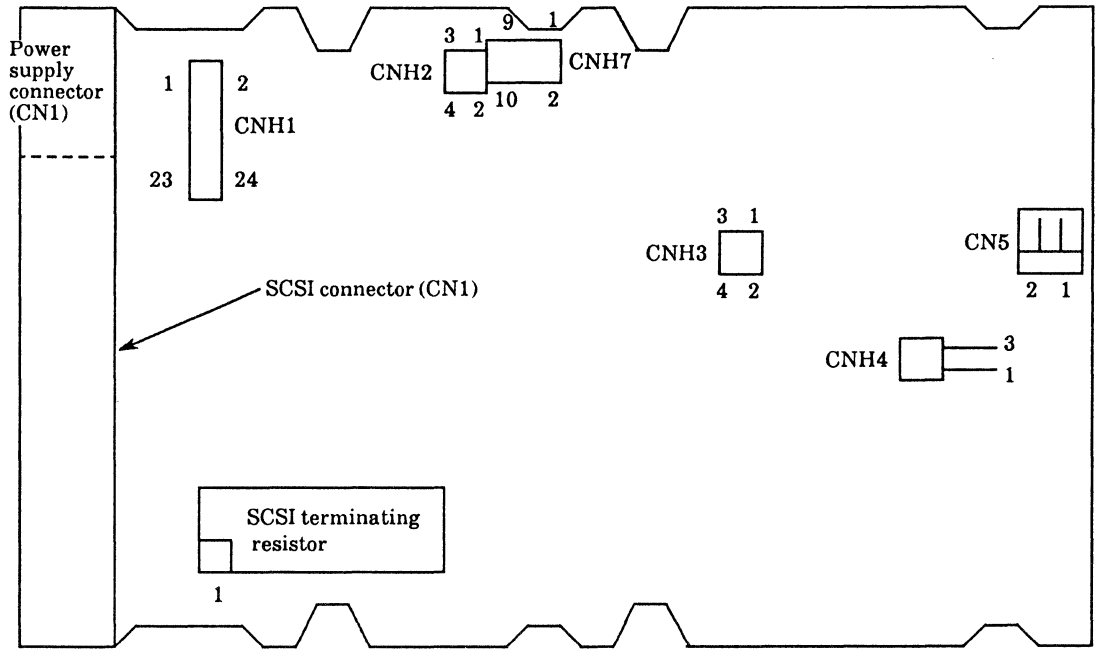
1. The user must not change the setting of terminals not described in this section. Do not change setting statuses set at factory shipment.

2. Do not change the setting of terminals except CNH1 (offline self-diagnostics)/CNH7 (write protect) or do not connect or disconnect the SCSI terminating resistor module when power is turning on.

3. To short the setting terminal, use the short plug attached when the device is shipped from the factory.



B17B-1790-0050A



B17B-1790-0030A/-0040A

Figure 5.2 Setting terminal and terminating resistor position

5.3.1 Setting terminals (CNH7)

Figure 5.3 shows the setting terminal and its setting at factory shipment.

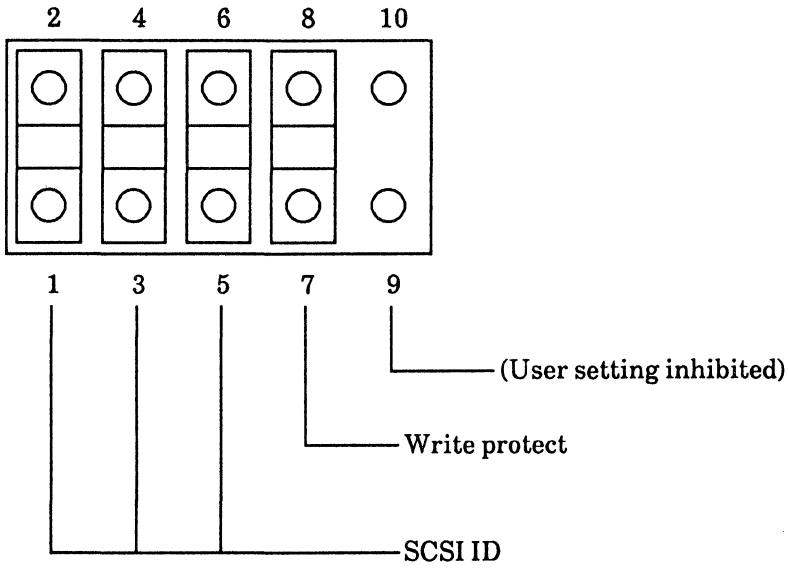


Figure 5.3 Setting terminals (CNH7)

Note:

"Short" and "Open" in the explanation of this section have following meaning.

Short: The short plug is mounted between specified pins.
Open: The short plug is removed from between specified pins.

(1) SCSI ID

Table 5.1 lists the IDD SCSI ID setting.

Table 5.1 SCSI ID setting (CNH7)

SCSI ID	5 - 6	3 - 4	1 - 2	
0	Open	Open	Open	
1	Open	Open	Short	
2	Open	Short	Open	
3	Open	Short	Short	
4	Short	Open	Open	
5	Short	Open	Short	
6	Short	Short	Open	
7	Short	Short	Short	(*1)

*1 Set at factory shipment.

Notes:

1. Set the SCSI ID so that there are no duplicates between SCSI devices on the same SCSI bus.

2. The priority of SCSI bus use in ARBITRATION phase is determined by SCSI ID as follows:

   7 > 6 > 5 > 4 > 3 > 2 > 1 > 0

(2) Write protect

Enabling or disabling write protect function is set by pin 7 - 8 of the setting terminal CNH7 as listed in Table 5.2. By setting this write protect function, writing into disk medium is inhibited.

Table 5.2 Write protect setting (CNH7)

Write protect	7 - 8	
Write operation is inhibited.	Open	
Write operation is enabled.	Short	(*1)

*1 Set at factory shipment.

5.3.2 Setting terminal (CNH1, CNH2)

Figure 5.4 shows the plug types and setting at factory shipment.

Note:

"Short" and "open" of the setting terminal are used with the meanings below in the explanations that follow:

Short: A short plug is set between specified pins.
Open: A short plug is removed from specified pins.

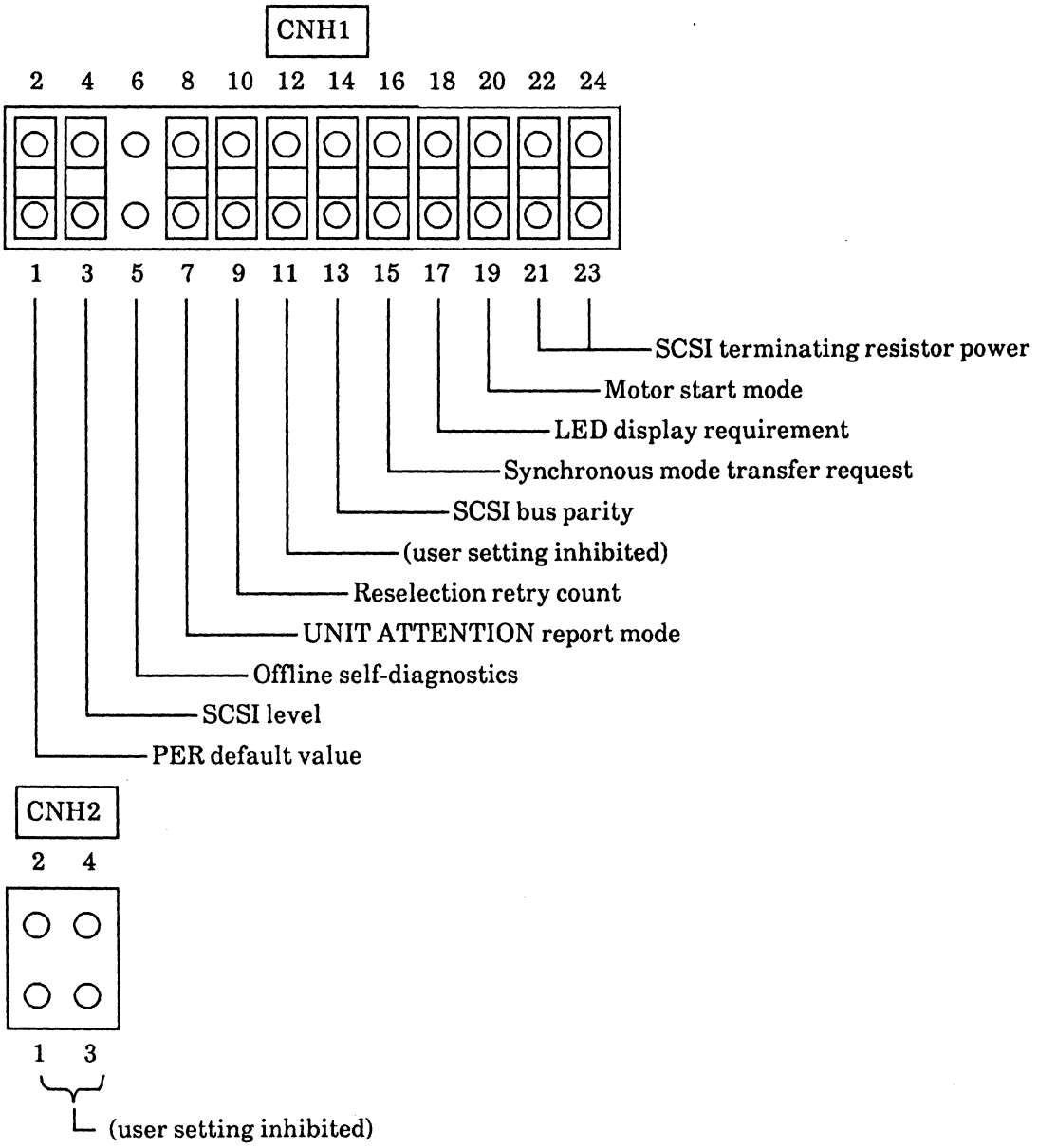


Figure 5.4 Setting terminal (CNH1, CNH2)

(1) SCSI terminating resistor power

Table 5.3 shows how to supply power to the IDD SCSI terminating resistor module and how to use TERMPWR lines on the SCSI bus. Figure 5.5 shows the configuration of the IDD SCSI terminating resistor circuit.

Table 5.3 Supplying power to SCSI terminating resistor (CNH1)

SCSI terminating resistor power supply	23-24	21-22	
Power is supplied to the terminating resistor from the IDD and TERMPWR pin. Power is supplied to the TERMPWR pin from the IDD.	Short	Short	(*1)
The TERMPWR pin is not used. Power is supplied to the IDD terminating resistor only from the IDD.	Open	Short	
Power is not supplied to the terminating resistor from the IDD. Power is supplied to the IDD terminating resistor only from the TERMPWR pin.	Short	Open	

*1 Set at factory shipment.

Note:

When the IDD connects to a position other than both ends of the SCSI cable, do not mount the terminating resistor module on the IDD.

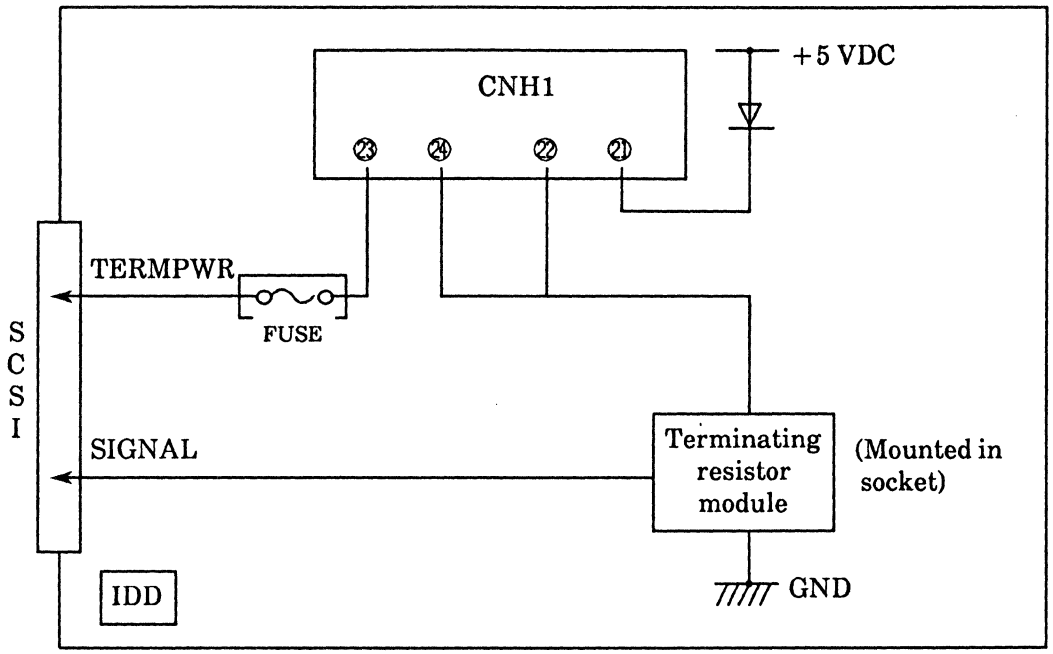


Figure 5.5 Configuration of SCSI terminating resistor circuit

Refer to Section 1.4 of OEM Manual SCSI Physical Specifications for further details.

(2) Motor start mode

Set how to start the IDD spindle motor according to Table 5.4. This setting only determines the operation mode when power is turned on. Stopping or restarting the spindle motor can be controlled with the START/STOP UNIT command for both modes.

Table 5.4 Motor start mode setting (CNH1)

Start timing of the spindle motor	19-20	
The motor is started immediately after power is turned on.	Short	(*1)
Starting the motor is controlled with the START/STOP command.	Open	

*1 Set at factory shipment.

Refer to Chapter 3 of OEM Manual SCSI Logical Specifications for further details of the START/STOP UNIT command.

(3) LED display requirement

Set the display requirements of the LED on the front panel or external operator panel (see Subsections 4.4.1 and 4.4.3) according to Table 5.5.

Table 5.5 LED display requirement setting (CNH1)

LED display requirement	17-18	
Light when the IDD operates.	Short	(*1)
Light when the IDD is ready.	Open	

* Set at factory shipment.

(4) Synchronous mode transfer request

Set whether synchronous mode data transfer request from the TARG is enabled according to Table 5.6. When the synchronous mode data transfer is enabled, the IDD responds the SYNCRONOUS DATA TRANSFER REQUEST message to the INIT that issues the first command after power-on.

Table 5.6 Synchronous mode transfer request setting (CNH1)

Synchronous mode transfer	15-16	
Enabled	Short	(*1)
Disabled	Open	

* Set at factory shipment.

Notes:

1. This setting does not affect asynchronous mode transfer.
2. When synchronous mode transfer request is disabled, the IDD operates as follows.
   - When the SYNCHRONOUS DATA TRANSFER REQUEST message is sent from the INIT, the IDD replys to that message and the DATA IN and the DATA OUT phases of the SCSI bus can be executed in synchronous mode.
   - The IDD does not send the SYNCHRONOUS DATA TRANSFER REQUEST message to the INIT.

3. The maximum data transfer rate in synchronous mode is determined when the SYNCHRONOUS DATA TRANSFER REQUEST message is exchanged between the IDD and INIT.

   The INIT must determine the parameter sent to the IDD when the message is exchanged in consideration of the signal transfer characteristics of the system SCSI bus and the data reception capacity of the INIT.

   The IDD can transfer up to 5 MB/s in synchronous mode. However, since the configuration of the SCSI bus and its transfer characteristics differ depending on the system, the maximum transfer rate in which data can be transferred in a stable condition must be determined for each system.

4. For reference, the IDD data transfer rate in synchronous mode and the restrictions on the system configuration of the SCSI bus are shown below.

   Remarks:

   The following values are rough standards. The values must be evaluated for each system.

Maximum transfer rate of the IDD (MB/s)	Maximum length of the SCSI cable (m)	Number of connectable SCSI devices
3 to 5	*	*
2.67 or less	6.0	8

* The maximum SCSI cable length and the number of connectable SCSI devices must be determined for each system.

Refer to Subsections 1.6.5 and 2.3.14 of OEM Manual SCSI Physical Specifications for the further details of the timing and message.

(5) SCSI bus parity

Set whether the parity bit check of the SCSI data bus is executed according to Table 5.7.

Table 5.7 SCSI bus parity setting (CNH1)

SCSI data bus parity check by the IDD	13-14	
Executed	Short	(*1)
Not executed	Open	

*1 Set at factory shipment.

(6) Reselection retry

Set the retry mode of the RESELECTION phase according to Table 5.8.

Table 5.8 Reselection retry setting (CNH1)

Retry count of RESELECTION phase	9-10	
10	Open	
∞ (unlimited)	Short	(*1)

* Set at factory shipment.

Refer to Section 1.6 and Chapter 3 of OEM Manual SCSI Physical Specifications for further details of the SCSI time monitoring feature.

(7) UNIT ATTENTION report mode

Sets the response method against the received command when the IDD keeps the UNIT ATTENTION condition (see Table 5.9). This mode is set for system requirement, however, it is recommended to use the SCSI standard setting (setting at factory shipment).

Table 5.9 UNIT ATTENTION report mode setting (CNH1)

IDD response under the UNIT ATTENTION condition	7-8	
For a command other than INQUIRY, REQUEST SENSE, or PRIORITY RESERVE the IDD responsed with the CHECK CONDITION status. (SCSI standard)	Short	(*1)
All received commands are executed normally. (The CHECK CONDITION status caused by the UNIT ATTENTION condition is not reported.)	Open	

*1 Set at factory shipment.

For details of the UNIT ATTENTION condition, refer to Section 1.5 of OEM Manual SCSI Logical Specifications.

(8) Offline self-diagnostics

Set starting/stopping the IDD offline self-diagnostics according to Table 5.10. The offline self-diagnostics tests the IDD controller functions and the basic read/write operation of the disk drive. See Section 6.1 for further details. In normal operations, this setting terminal must be opened.

Table 5.10 Offline self-diagnostics setting (CNH1)

Offline self-diagnostics	5 – 6	
Executed (diagnostic mode)	Short	
Stopped (normal operation mode)	Open	(*1)

*1 Set at factory shipment.

(9) SCSI level

1) Set the display contents of data posted to the initiator from the IDD with the INQUIRY command according to Table 5.11. Select one of the modes depending on the system software requirements.

2) When the SCSI-1/CCS mode is selected, parameters transferred by the MODE SENSE command are as follows.

a) Page code 3F (all pages equipped in the IDD are transferred.)

① Page 7 and page 8 are not transferred.

② Page 1, page 2 and page 4 are transferred with the specified length of CCS.

b) When the page 1, page 2 or page 4 is specified individually, it is transferred with the specified length of CCS.

c) When the page 7 or page 8 is specified individually, it is transferred with the specified length of SCSI-2.

d) For the recovery parameter of the VERIFY, the recovery parameter in page 1 is used.

3) When the SCSI-1/CCS mode is selected and the REQUEST SENSE command is issued with specifying the transfer byte length to 0, the IDD transfers the 4-byte sense data.

Table 5.11 SCSI level setting (CNH1)

Mode	INQUIRY data			INQUIRY VPD information	3 – 4	
	Byte 2, bits 2 to 0 (ANSI version)	Byte 3, bits 3 to 0 (Response data format)	Byte 7 (Provided function)			
SCSI-2 mode	'0, 1, 0' (SCSI-2)	'0, 0, 1, 0' (SCSI-2)	Indicates the function of the IDD for each bit.	Valid	Open	
SCSI-1/ CCS mode	'0, 0, 1' = ANSIX3.131 - 1986 (SCSI-1)	'0, 0, 0, 1' = ANSIX3T9.2/ 85 -52 (CCS)	All bits '0'	Invalid	Short	(*1)

*1 Set at factory shipment.

Refer to Chapter 3 of OEM Manual SCSI Logical Specifications for the details of the INQUIRY command, MODE SENSE command and REQUEST SENSE command.

(10) PER default values

Set the default value of the PER (post error) flag of the read/write error recovery parameter (page code = 1) and verify error recovery parameter (page code = 7) of the MODE SELECT parameter according to Table 5.12.

Table 5.12 PER default values setting (CNH1)

PER default value of the MODE SELECT parameter	1-2	
"0"	Short	(*1)
"1"	Open	

*1 Set at factory shipment.

Note:

The MODE SELECT parameter value specific to the user can be saved on the disk with the MODE SELECT command specification. There are no MODE SELECT parameter saved values on the IDD when the IDD is shipped from the factory. The value set with the terminal is used as the initial value of PER flag when there are no saved values. When a saved value is generated by the user, the IDD reads it when power is turned on and operates using that value and this setting is ignored.

Refer to Chapter 3 ot OEM Manual SCSI Logical Specifications for further details of the command.

5.3.3 SCSI terminating resistor

The SCSI terminating resistor module is installed in the IDD when the IDD is shipped from the factory. See Figures 5.2 and 5.3 for installation positions. The terminating resistor module is mounted in a socket and must be processed in one of followings.

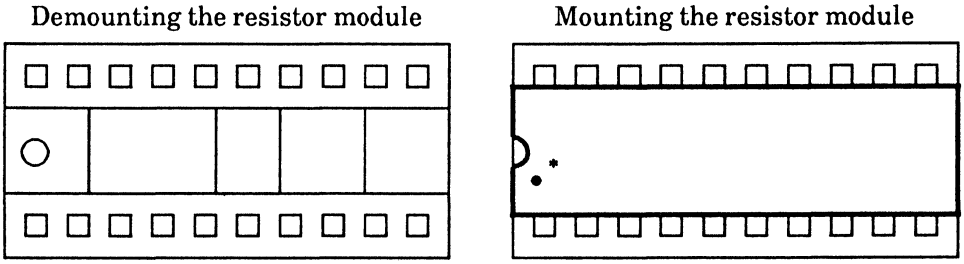
① When connecting the IDD to either end of the SCSI cable, do not demount the terminating resistor module.

② When connecting the IDD to a position other than both ends of the SCSI cable, demount terminating resistor module.

Notes:

1. When demounting the terminating resistor module, be careful not to damage the resistor module pins, mount socket, and contiguous parts.

2. When mounting the terminating resistor module, check the mounting direction and whether the module is fixed (see Figure 5.6).



*1 ● shows pin No. 1 of the resistor module.

Figure 5.6 SCSI terminating resistor module

5.4 Mounting Drives

5.4.1 Check before mounting

Check the setting of terminals and the SCSI terminating resistor module before mounting the drive in the system cabinet.

Table 5.13 Setting check list

		Check item	Setting position	Check
Setting Terminal (1)	1	SCSI ID	CNH7 5 - 6 3 - 4 1 - 2	☐ (SCSI ID = ____)
	2	Write protect	CNH7 7 – 8	☐ Short ☐ Open

		Check item	Setting position	Check
Setting terminal (2)	1	SCSI terminating resistor power	CNH1 23-24 CNH1 21-22	☐ Short ☐ Open ☐ Short ☐ Open
	2	Motor start mode	CNH1 19-20	☐ Short ☐ Open
	3	LED display requirement	CNH1 17-18	☐ Short ☐ Open
	4	Synchronous mode transfer request	CNH1 15-16	☐ Short ☐ Open
	5	SCSI bus parity	CNH1 13-14	☐ Short ☐ Open
	6	Reselection retry count	CNH1 9-10	☐ Short ☐ Open
	7	UNIT ATTENTION report mode	CNH1 7-8	☐ Short ☐ Open
	8	Offline self-diagnostics	CNH1 5-6	☐ Short ☐ Open
	9	SCSI level	CNH1 3-4	☐ Short ☐ Open
	10	PER default values	CNH1 1-2	☐ Short ☐ Open

		Check contents	Check	
Terminating resistor	1	Connection position of the drive on the SCSI bus	☐ Other than both ends of the connector	☐ Both ends of the connector
	2	SCSI terminating resistor module	☐ Unmounted	☐ Mounted

5.4.2 Mounting procedures

Since mounting the drive depends on the system cabinet structure, determine the work procedures considering the requirements specific to each system. The general mounting method and items to be checked are shown below.

See Sections 4.2 for the details of requirements for installing the IDD.

① With a system to which an external operator panel is mounted, if it is difficult to access the connector after the drive is mounted on the system cabinet, connect the external operator panel cable before mounting the drive.

② Fix the drive in the system cabinet with four mounting screws as follows:

- The drive has 10 mounting holes (both sides: 3 × 2, bottom: × 4). Fix the drive by using four mounting holes of both sides or the bottom.
- Use mounting screws whose lengths inside the drive mounting frame are 4 mm or less when the screws are tightened (see Figure 4.5).
- When mounting the drive, be careful not to damage parts on the PCAs.

③ Check that the DE (signal ground) does not touch the system cabinet chassis (frame ground). There must be a 2.5 mm or more space between the DE and chassis (see Figure 4.5).

5.5 Connecting Cables

Connect the IDD and system with the following cables. See Section 4.4 for further details of the requirements for IDD connector positions and connecting cables.

- Power cable
- SCSI cable
- DC ground cable (if required)
- External operator panel cable (if required)
- Spindle sync cable

The general procedures and notes on connecting cables are described below. Especially, pay attention to the inserting direction of each cable connector.

Warning

Check that system power is off before connecting or disconnecting cables. Do not connect or disconnect cables when power is on.

① Connect the DC ground cable (if required to decrease ground noise).

② Connect power cable.

③ Connect the external operator panel (if required for system).

④ Connect the SCSI cable.

⑤ Fix the cables so that they do not touch the DE and PCAs, or so that the smooth flow of the cooling air in the system cabinet is assured.

Notes:

1. Be careful of the insertion directions of the SCSI connectors. With the system in which terminating resistor power is supplied via the SCSI cable, if the power is turned on, the overcurrent protection fuse of the terminating resistor power supplier may be blown or the cable may be burnt if overcurrent protection is not provided.

   When the recommended parts listed in Table 4.1 are used, inserting the cables in the wrong direction can be prevented.

2. To connect SCSI devices, be careful of the connection position of the cable. Check that the SCSI device with the terminating resistor is the last device connected to the cable.

5.6 Confirming Operations after Installation and Preparation for Use

5.6.1 Confirming initial operations

This section describes the operation check procedures after power is turned on. Since the initial operation of the IDD depends on the setting of the motor start mode, check the initial operation by either of the following procedures:

(1) Initial operation in the case of setting so that motor starts at powering-on

① When power is turned on, the LED blinks an instant and the IDD executes initial self-diagnosis.

② If an error is detected in the initial self-diagnosis, the LED on the front panel blinks periodically.

Remark:

The spindle motor may or may not start rotating in this stage.

③ When the LED display requirements are set to "the IDD is ready", the LED on the front panel lights 15 seconds after power is turned on.

④ When the LED display requirements are set to "the IDD operates", the LED on the front panel remains off (when the initiator accesses the IDD via the SCSI bus, the LED lights).

(2) Initial operation in the case of setting so that motor starts with START/STOP command

① When power is turned on, the LED blinks an instant and the IDD executes initial self-diagnosis.

② If an error is detected in the initial self-diagnosis, the LED on the front panel blinks.

③ The spindle motor does not start rotating until the START/STOP UNIT command for the start is issued. The INIT needs to issue the START/STOP UNIT command to start the spindle motor by the procedure in Subsection 5.6.2.

④ The disk drive enters the READY status in 15 seconds after the START/STOP UNIT command is issued. At this time, the IDD reads "system information" from the system space on the disk.

⑤ When the LED display requirements are set to "the IDD is ready", the LED on the front panel lights as in step ④.

⑥ When the LED display requirements are set to "the IDD operates", the LED blinks during command execution.

(3) Check items at illegal operation

① Check that cables are mounted correctly.

② Check that power and voltages are supplied correctly (measure them with the IDD power connection position).

③ Check the setting of each setting terminal. Note that the initial operation depends on the setting of the motor start mode and LED display requirements.

④ If an error is detected in initial self-diagnosis the LED on the front panel blinks. In this case, it is recommended to issue the REQUEST SENSE command from the initiator (host system) to obtain information (sense data) for error analysis.

Notes:

1. When the LED display requirements are set to "the IDD is ready", the LED is turned off while the IDD continues command execution. However, since the LED is turned off for only one blink, the LED may seem to be turned on and off or not to be turned off at all.

2. When the LED display requirements are set to "the IDD operates", the LED lights during the IDD is executing a comand. However, in same commands, the lighting time is only an instant. Therefore, it seems that the LED blinks or the LED remains off.

3. Since the IDD has the automatic readjustment function of positioning (seek) control, it automatically executes the adjustment operations with seek at specific intervals from power on (first adjustment: 5 minutes after power on). The seek sound is heard during the adjustment but this does not indicate a drive error. Refer to Subsection 1.7.5 in OEM Manual SCSI Logical Specification for the automatic readjustment function of positioning control.

5.6.2 Checking SCSI connection

When the initial operation is checked normally after power is turned on, check that the IDD is connected to the SCSI bus from the host system. Although checking the connection depends on the structure of the host system, this section describes the general procedures.

(1) Checking procedure

Issuing the commands and determining the end statuses depends on the start mode of the spindle motor and UNIT ATTENTION report mode (specified with setting terminal). Figure 5.7 shows the recommended checking procedure for the mode that the motor starts when power is turned on. Figure 5.8 shows for the mode that the motor starts by the START/STOP command. In these recommended checking procedures, following items are checked.

Note:

Following steps ① to ⑤ correspond to ① to ⑤ in Figures 5.7 and 5.8.

① Issue the TEST UNIT READY command and check that the IDD is connected correctly to the SCSI bus and the initial operation after power is turned on ended normally.

② To control starting of the spindle motor from the host system, issue the START/STOP UNIT command to start the spindle motor.

③ Check the SCSI bus operations with the WRITE BUFFER and READ BUFFER commands. Use data whose data bus bits change to 0 or 1 at least once. (Example: Data with an increment pattern of X'00' to X'FF')

④ Read the setting of the terminals with the SEND DIAGNOSTIC and RECEIVE DIAGNOSTIC RESULTS commands and check the setting.

⑤ Start the IDD self-diagnostic test with the SEND DIAGNOSTIC command and check the basic operations of the controller and disk drive.

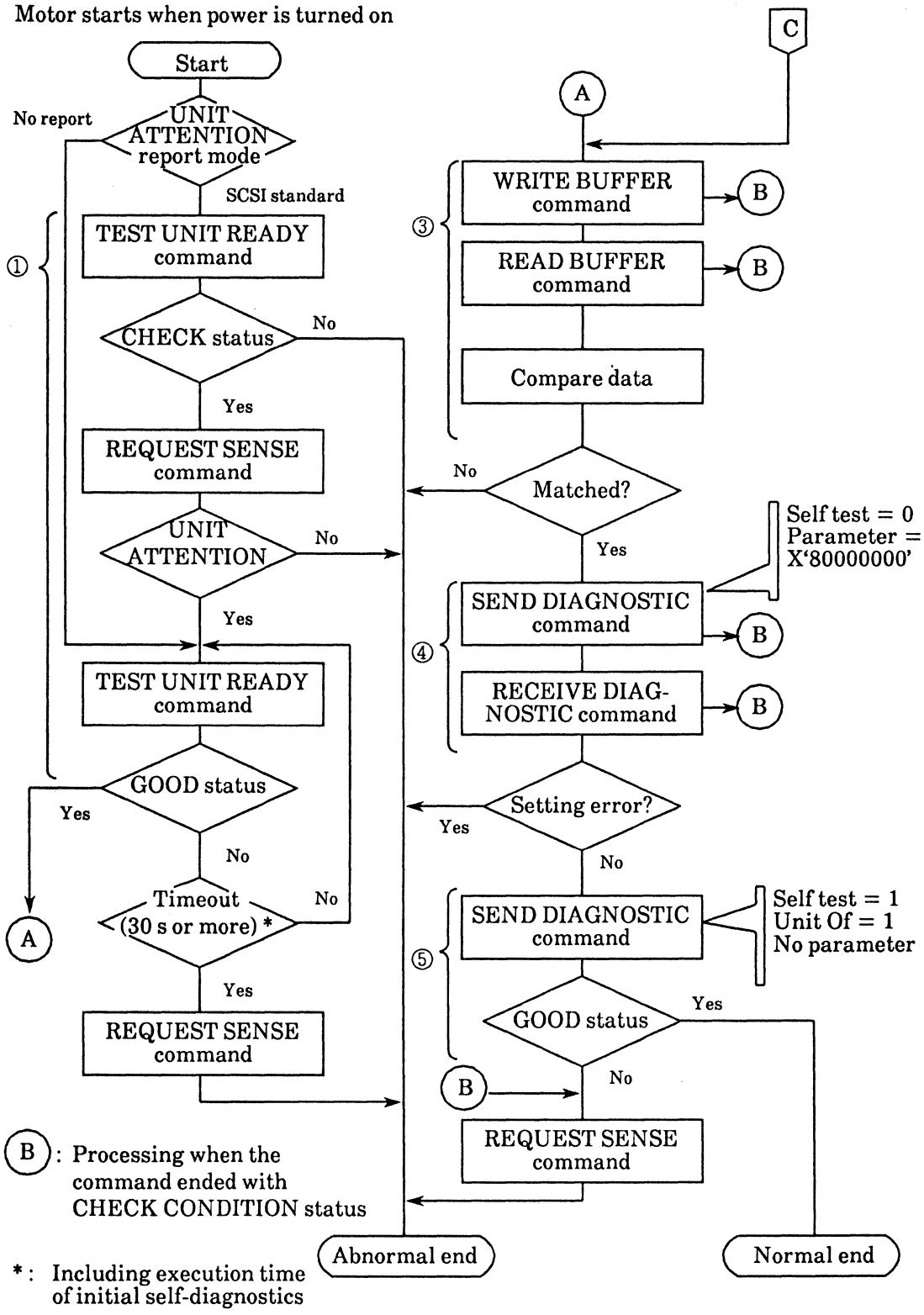
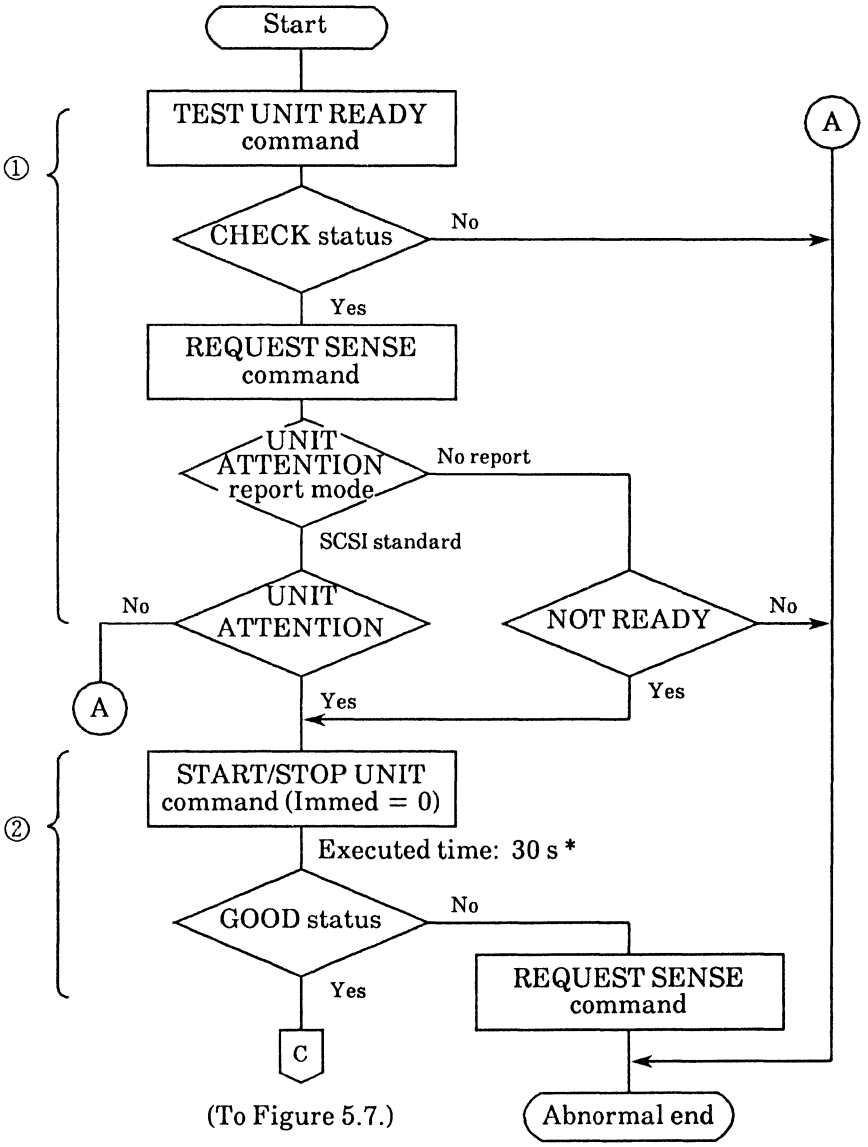


Figure 5.7 Checking the SCSI connection (A)

Motor starts by START/STOP command



*: Including executing time of initial self-diagnostics

Figure 5.8 Checking the SCSI connection (B)

(2) Checking at abnormal end

① When sense data can be obtained with the REQUEST SENSE command, analyze the sense data and retry recovery for a recoverable error. Refer to Chapter 4 of OEM Manual SCSI Logical Specifications for further details.

② Check the following items for the SCSI cable connection:

- All connectors including other SCSI devices are connected correctly.
- The terminating resistor is mounted on both ends of the cable.
- Power is connected to the terminating resistor.

③ Check the setting of the terminals. Note that the checking procedure of SCSI connection differs depending on the setting of the motor start mode and UNIT ATTENTION report mode.

5.6.3 Formatting

Since the disk drive is formatted with a specific (default) data format for each model (part number) when shipped from the factory, the disk need not be formatted (initialized) when it is installed in the system.

However, when the system needs data attributes different from the default format, all sides of the disk must be formatted (initialized) according to the procedures below.

The user can change the following data attributes at initialization:

- Logical data block length
- Number of logical data blocks or number of cylinders in the user space
- Alternate spare area size

This section outlines the formatting at installation. Refer to Chapters 3 and 5 of OEM Manual SCSI Logical Specifications for further details.

(1) MODE SELECT command

Specify the format attributes on the disk with the MODE SELECT command. The parameters are as follows:

a. Block descriptor

Specify the size (byte length) of the logical data block in the "data block length" field. To explicitly specify the number of logical data blocks, specify the number in the "number of data blocks" field. Otherwise, specify 0 in "number of data blocks" field. In this case, the number of logical data blocks after initialization is determined by the value specified in the format parameter (page code = 3) and drive parameter (page code = 4).

b. Format parameter (page code = 3)

Specify the number of spare sectors for each cylinder in the "alternate sectors/zone" field and specify the number of tracks for alternate cylinders (= number of alternate cylinders × number of disk drive heads) in the "alternate tracks/zone" field. It is recommended not to specify values smaller than the IDD default value in this field.

c. Drive parameter (page code = 4)

To explicitly specify the number of cylinders in the user space, specify the number in the "number of cylinders" field. Note that the number of alternate cylinders specified by the format parameter (page code = 3) is included in the number of cylinders in the user space. When the number of cylinders need not be specified, specify 0 or the default value in the "number of cylinders" field. In this case, either of the smaller value between the number of cylinders to allocate the number of logical data blocks specified in the "number of data blocks" field of the block descriptor or the maximum number of cylinders that can be used as the user space on the disk drive is allocated in the user space. When 0 is specified both in the "number of cylinders" field and the "number of data blocks" field of the block descriptor, the maximum number of cylinders that can be used as the user space on the disk drive is allocated in the user space.

(2) FORMAT UNIT command

Initialize all sides of the disk with the FORMAT UNIT command. The FORMAT UNIT command initializes all sides of the disk using the P lists, verifies data blocks after initialization, and allocates an alternate block for a defect block detected with verification. With initialization, the value specified in the "initializing data pattern" field of the CDB is written into all bytes of all logical data blocks. Only the position information of defect blocks detected with verification is registered in the G list. The specifications are as follows:

a. Specifying CDB

Specify 0 for the "FmtData" bit and the "CmpLst" bit on CDB, 000 for the "Defect List Format" field, and data pattern written into the data block at initialization for the "initializing data pattern" field.

b. Format parameter

When the values in step a. are specified with CDB, the format parameter is not needed.

5.6.4 Setting parameters

The user can specify the optimal operation mode for the user system environments by setting the following parameters with the MODE SELECT command:

- Error recovery parameter
- Disconnection/re-connection parameter
- Read caching parameter

With the MODE SELECT command, specify 1 for the "SP" bit on CDB to save the specified parameter value on the disk. This enables the IDD to operate by using the parameter value set by the user when power is turned on again. When the system has more than one INIT, different parameter value can be set for each INIT.

When the parameters are not set or saved with the MODE SELECT command, the IDD sets the default values for parameters and operates when power is turned on or after reset. Although the IDD operations are assured with the default values, the operations are not always optimal for the system. To obtain the best performance, set the parameters in consideration of the system requirements specific to the user.

This section outlines the parameter setting procedures. Refer to Chapter 3 of OEM Manual SCSI Logical Specifications for further details of the MODE SELECT command and specifying the parameters.

Notes:

1. At factory shipment of the IDD, the saving operation for the MODE SELECT parameter is not executed. So, if the user does not set parameters, the IDD operates according to the default value of each parameter.

2. The MODE SELECT parameter is saved for each SCSI ID of the INIT. When the SCSI ID of the INIT needs to be changed for system requirements, paremters must be set again. Also in the multi-INIT system, parameters must be set for each INIT.

3. Once parameters are saved, the saved value is effective unitl next saving operation is executed by the INIT having a same SCSI ID. For example, even if the initialization of the disk is performed by the FORMAT UNIT command, the saved value of parameters described in this section is not affected.

4. When the IDD, to which the saving operation has been executed on a system, is connected to another system, the user must pay attention to that the IDD operates according to the saved parameter value if the saving operation is not executed at installation.

5. The saved value of the MODE SELECT parameter is assumed as the initial value of each parameter after the power-on, the RESET condition, or the BUS DEVICE RESET message. The INIT can change the parameter value temporary (actively) at any timing by issuing the MODE SELECT command with specifying "0" to the SP bit in the CDB.

(1) Error recovery parameter

The following parameters are used to control operations such as IDD internal error recovery:

a. Read/write error recovery parameters (page code = 1)

Parameter	Default value
• AWRE: Automatic alternate block allocation at write operation	0 (disabled)
• ARRE: Automatic alternate block allocation at read operation	0 (disabled)
• TB: Uncorrectable data transfer to the INIT	1 (enabled)
• EER: Immediate correction of correctable error	1 (enabled)
• PER: Report of recovered error	0 (disabled) or 1 (enabled) Can be selected with the terminal.
• DTE: Stop of command processing at successful error recovery	0 (Processing is continued.)
• DCR: Suppression of ECC error correction	0 (Correction is enabled.)
• Retry count at read operation	18
• Retry count at write operation	18

b. Verify error recovery parameters (page code = 7)

Parameter	Default value
• ERR: Immediate correction of recoverable error	1 (enabled)
• PER: Report of recovered error	0 (disabled) or 1 (enabled) Can be selected with the terminal.
• DTE: Stop of command processing at successful error recovery	0 (Processing is continued.)
• DCR: Suppression of ECC error correction	0 (Correction is enabled.)
• Retry count at verification	18

c. Additional error recovery parameters (page code = 21)

Parameter	Default value
• DCED: Disable delay in the command execution start for IDD internal processing	0 (enabled)
• PSER: Report of recovered error on SCSI bus	0 (disabled)
• RPR: Report of rounded parameter at MODE SELECT command	0 (disabled)
• Retry count at seek error	2

Notes:

1. The user can arbitrarily specify the following parameters according to the system requirements:

   - AWRE
   - ARRE
   - TB
   - PER
   - DTE
   - PSER

2. The user also can arbitrarily specify parameters other than the above. However, it is recommended to use the default setting in normal operations.

3. The user must not set the DTE parameter to "1" except the special case.

(2) Disconnection/reconnection parameters

The following parameters are used to optimize the start timing of reconnection processing to transfer data on the SCSI bus at a read (READ or READ EXTENDED command) or write operation (WRITE, WRITE EXTENDED, or WRITE AND VERIFY command) of the disk. Refer to Chapter 2 of OEM Manual SCSI Logical Specifications for further details.

a. Disconnection/reconnection parameters (page code = 2)

Parameter	Default value
• Buffer full ratio	Length of a logical data block
• Buffer empty ratio	28 KB

Notes:

1. In a system without the disconnection function, these parameters need not be specified.

2. Determine the parameter values in consideration of the following performance factors of the system:

   - Time required for reconnection processing
   - Average data transfer rate of the SCSI bus
   - Average amount of processing data specified with a command

   Refer to Chapter 2 of OEM Manual SCSI Logical Specifications for how to obtain the rough calculation values for the parameter values to be set. It is recommended to evaluate the validity of the specified values by measuring performance in an operation status under the average system load requirements.

(3) Caching parameters

The following parameters are used to optimize IDD Read-Ahead caching operations under the system environments. Refer to Chapter 2 of OEM Manual SCSI Logical Specifications for further details.

a. Read caching parameters

Parameter	Default value
• RCD: Disabling Read-Ahead caching operations	0 (enabled)
• MS: Specifying the multipliers of "minimum prefetch" and "maximum prefetch" parameters	0 (specifying absolute value)
• Number of blocks for which prefetch is suppressed	X'FFFF'
• Minimum prefetch	X'0000'
• Maximum prefetch	X'0XXX' (Equivalent to 60 KB)
• Number of blocks with maximum prefetch restrictions	X'FFFF'

Notes:

1. When Read-Ahead caching operations are disabled with the setting terminal, these parameter settings have no meaning.

2. Determine the parameters in consideration of how the system accesses the disk. When the access form is not determined uniquely because of the processing method, the parameters can be re-set actively.

3. For sequential access, the effective access rate can be increased by enabling Read-Ahead caching operations. If access is mostly random access, generally, it is recommended to disable the Read-Ahead caching.

5.7 Dismounting Drives

Since dismounting the drive to check the setting terminals, change the setting, or change the drive depends on the structure of the system cabinet, the work procedures must be determined in consideration of the requirements specific to the system. This section describes the general procedures and notes on dismounting the drive.

CAUTIONS

1. *Dismount the drive after disconnecting system power. Do not remove mounting screws holding the cables and drive while power is on.*

2. *Do not move the drive until it completely stops (30 seconds after spindle motor is stopped with START/STOP UNIT command or after power is turned off).*

① Remove the power cable.

② Remove the SCSI cable.

③ When the external operator panel is mounted, remove the cable. If it is difficult to access the connector position, the cable may be removed after step ⑤.

④ Remove the DC ground cable.

⑤ Remove the four mounting screws securing the drive, then remove the drive from the system cabinet.

⑥ To store or transport the drive, keep it in an antistatic bag and provide packing (see Section 5.1).

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CHAPTER 6 DIAGNOSTICS AND MAINTENANCE

This chapter describes diagnostics and maintenance information.

6.1 Diagnostics

6.1.1 Self-diagnostics

The IDD has the following self-diagnostic function. This function checks the basic operations of the IDD.

- Initial self-diagnostics
- Offline self-diagnostics (setting terminal)
- Online self-diagnostics (SEND DIAGNOSTIC command)

Table 6.1 lists the contents of the tests performed with the self-diagnostics. For a general check of the IDD including the operations of the host system and interface, use a test program that runs on the host system (see Subsection 6.1.2).

Table 6.1 Self-diagnostic functions

Test contents	Initial self-diagnostics	Offline self-diagnostics	SEND DIAGNOSTIC command	
			Self Test = 1 Unit Offline = 0	Self Test = 1 Unit Offline = 1
Hardware function test	○	○	○	○
Seek test		○		○
Write/read test (CE space)		○		○

Note: ○ indicates the tests to be executed and arrows show the sequence of execution.

Brief test contents of self-diagnostics are as follows.

a. Handware function test

This test checks the basic operation of the controller section, and contains followoing test.

- EPROM (microcode is stored)
- Peripheral circuits of microprocessor (MPU)
- Memory (RAM)
- Data buffer

b. Seek test

This test checks the positioning operation of the disk drive using several seek modes (2 points seek, 1 position sequential seek, etc.). The positioning operation is checked with confirming the physical address information by reading the ID field from the data block on track 0 after completion of the seek operation to the target cylinder.

c. Write/read test

This test check the write/read function by using the CE space of the disk drive. 2 types of diagnostic pattern (first: repeating X'BBBA645A27BB', second: repeating X'00') are used in this test. After writing the diagnostic pattern into all logical data blocks in the CE space, the data block is read and then the data pattern are compared to check that the writing and reading operations are correctly performed.

(1) Initial self-diagnostics

When power is turned on, the IDD starts initial self-diagnostics. The initial self-diagnostics checks the basic operations of the hardware functions.

If an error is detected in the initial self-diagnostics, the LED on the drive front panel blinks. In this status, the IDD posts CHECK CONDITION status to all I/O operation requests other than the REQUEST SENSE command. When CHECK CONDITION status is posted, the INIT should issue the REQUEST SENSE command. The sense data obtained with the REQUEST SENSE command details the error information detected with the initial self-diagnostics.

Even if CHECK CONDITION status and sense data are posted, the LED continues blinking. Only when the SCSI bus is reset, the BUS DEVICE RESET message is issued, or the power is turned off or re-turned on, this status can be cleared. When this status is cleared, the IDD executes the initial self-diagnosis again.

The IDD does not reply to the SCSI bus for up to 2 seconds after the initial self-diagnostics is started. After that, the IDD can accept the I/O operation request cotrrectly, but the received command, except the executable commands under the not ready state (such as INQUIRY, START/STOP UNIT), is terminated with the CHECK CONDITION status (NOT READY [=2]/logical unit not ready [=04-00]) during the interval from the spindle motor becomes stable to the IDD becomes ready. The executable command under the not ready state is executed in parallel with the initial self-diagnostics, or is stacked by the command stack feature and is executed after completion of the initial self-diagnostics. When the command that comes under the exception condition of the command stack is issued at that time, the IDD posts the BUSY status for the command. When the error is detected during the initial self-diagnostics, the CHECK CONDITION status is posted for all commands that were stacked during the initial self-diagnostics. For the command execution condition, refer to Section 1.4 and Subsection 1.7.4 in OEM Manual Logical Specifications.

(2) Offline self-diagnostics (setting terminal)

When the diagnostic mode is set on the terminal (CNH1) on the IDD (between pins 5 and 6: short), the IDD executes the hardware function test, seek (positioning) test and the data write/read test of the CE space as self-diagnostics.

If commands received from the SCSI bus are being executed or stacked before the diagnostic mode is set, the self-diagnostics is started after all command execution is terminated.

While the diagnostic mode is set, the self-diagnostics is repeated in the sequence of hardware function test → seek test → write/read test if the error is not detected. While the diagnostic mode is set, the IDD does not reply for the SCSI bus.

a. Error recovery during self-diagnostics

When the recoverable error is detected during the seek or write/read test of the offline self-diagnostics, the IDD performs the error recovery according to the default value (see Subsection 5.6.4) of the MODE SELECT parameters (read/write error recovery parameters, additional error recovery parameter).

When the detected error is recovered by the retry, the IDD continues or stops the self-diagnostics as follows according to the default value (selectable with setting terminal) of the PER flag.

PER	Operation of self-diagnostics
0	When the error is recovered, the self-diagnostics continues and the error is not reported.
1	When the error is recovered, the self-diagnostics contiues but it stops after completing all test till the write/read test even if diagnostic mode is set with the terminal. The error information indicates the contents of the recovered error lastly.

b. Error indication of self-diagnostics

The self-diagnostics stops when the unrecoverable error is detected during the consecutive tests. When the PER flag is set to 1 as a default value, the self-diagnostics also stops after completing the executing consecutive tests when the recovered error is detected. At this time, the LED on the front panel of the disk drive is blinking to indicate that a error is detected.

To collect the details information of the detected error, it is needed to release the diagnostic mode on the setting terminal (open between pins 5 and 6) and then issue the REQUEST SENSE command.

In the state that the error is being detected in the self-diagnostics, the CHECK CONDITION status is posted for all I/O operation requests except the REQUEST SENSE command even if the diagnostic mode is released on the setting terminal. When CHECK CONDITION status is posted, the INIT should issue the REQUEST SENSE command. The sense data obtained with the REQUEST SENSE command details the error information detected with the initial self-diagnosis.

The IDD status after CHECK CONDITION status and sense data are posted depends on the type of error detected.

a) When an error is detected in the seek test or write/read test, the LED stops blinking and the error status is cleared after sense data is read. The IDD returns to the normal operation status.

b) When an error is detected with the hardware function test, the error status is not cleared and the LED continues blinking even if sense data is read. Only when the SCSI bus is reset, the BUS DEVICE RESET message is issued or the power is turned off or re-turned on, this status can be cleared.

When this status is cleared, the IDD executes the initial self-diagnostics again (see Item (1)).

Notes:

1. When the offline self-diagnostics is executed, all data stored in the CE space on the drive before the execution is rewritten.

2. The offline self-diagnostics should be executed in the state that all accesses from the system to the IDD are inhibited. Because the IDD does not reply for the SCSI bus under the diagnostic mode, the unexpected illegal state may be detected in the system.

(3) Online self-diagnostics (SEND DIAGNOSTIC command)

The INIT can make the IDD execute self-diagnostics by issuing the SEND DIAGNOSTIC command.

The INIT specifies the execution of self-diagnostics by setting 1 for the SelfTest bit on the CDB in the SEND DIAGNOSTIC command and specifies the test contents with the UnitOfl bit.

When the UnitOfl bit on the CDB is set to 0, the IDD executes the hardware function test only once. When UnitOfl bit is set to 1, the IDD executes the hardware function test, seek (positioning) test, and data write/read test for the CE space only once.

When the self-diagnostics specified normally ends, the IDD posts GOOD status.

a. Error recovery during self-diagnostics

During the self-diagnostics specified by the SEND DIAGNOSTIC command, when the recoverable error is detected during the seek or the write/read test, the IDD performs the error recovery according to the MODE SELECT parameter value (read/write error recovery parameter, additional error recovery parameter) which the INIT specifies at the time of issuing the SEND DIAGNOSTIC command.

a) AWRE, ARRE and TB flags are not applied.

b) Error correction by ECC is performed according to the contents of the EER and DCR flags.

c) When the detected error is recovered by the retry or ECC, the result of the self-diagnostics is posted according to t he combination of PER and DTE flags as follows.

PER	DTE	Operation of self-diagnostics
0	0	The self-diagnostics continues when the error is recovered. The self-diagnostics terminates normally so far as the unrecoverable error is not detected.
0	1	- - - - (Unspecificable) - - - -
1	0	The self-diagnostics continues when the error is recovered. If the unrecoverable error is not detected, the consecutive tests are executed till last test but the self-diagnostics terminates with error. The error information indicates that of the last recovered error.
1	1	After the error recovery permitted by the parameter completes, the self-diagnostics stops at the time even if the error is recovered. The self-diagnostics with error and the error information indicates that of the detected error.

b. Reporting result of self-diagnostics and error indication

When all specified self-diagnostics terminate normally, the IDD posts the GOOD status for the SEND DIAGNOSTIC command.

When an error is detected in the self-diagnostics, the IDD terminates the SEND DIAGNOSTIC command with the CHECK CONDITION status. At this time only when an error is detected in the hardware function test, the LED on the front panel of the disk drive blinks.

The INIT should issue the REQUEST SENSE command when the CHECK CONDITION status is posted. The sense data collected by the REQUEST SENSE command indicates the detail information of the error detected in the self-diagnostics.

The IDD status after the CHECK CONDITION status is posted differs according to the type of the detected error.

a) When an error is detected in the seek or write/read test, the subsequent command can be accepted correctly. When the comnand other than the REQUEST SENSE and NO OPERATION is issued from the same INIT, the error information (sense data) is cleared.

b) When an error is detected in the hardware function test, the IDD posts the CHECK CONDITION status for all I/O operation request except the REQUEST SENSE command. The error status is not cleared and the LED on the front panel continues blinking even if the error information (sense data) is read. Only when the SCSI bus is reset, the BUS DEVICE RESET message is issued or the power is turned off or re-turned on, the status can be cleared. When this status is cleared, the IDD executes the initial self-diagnostics again (see item (1)).

Refer to Chapter 3 of OEM Manual SCSI Logical Specifications for further details of the command specifications.

Notes:

1. When the self-diagnostics is executed by specifying 1 for the UnitOfl bit, all data stored in the CE space is written.

2. When the SEND DIAGNOSTIC command terminates with the CHECK CONDITION status, the INIT must collect the error information using the REQUEST SENSE command. The RECEIVE DIAGNOSTIC RESULTS command cannot read out the error information detected in the self-diagnostics.

6.1.2 Test programs

The basic operations of the IDD itself can be checked with the self-diagnostic function. However, to check general operations such as the host system and interface operations in a status similar to the normal operation status, a test program that runs on the host system must be used.

The structure and functions of the test program depend on the user system requirements. Generally, it is recommended to provide a general input/output test program that includes SCSI devices connected to the SCSI bus and input/output devices on other I/O ports.

Including the following test items in the test program is recommended to test the IDD functions generally.

(1) Interface (SCSI bus) test

The operations of the SCSI bus and data buffer on the IDD are checked with the WRITE BUFFER and READ BUFFER commands.

(2) Basic operation test

The basic operations of the IDD are checked by executing self-diagnosis with the SEND DIAGNOSTIC command (see Subsection 6.1.1).

(3) Random/sequential read test

The positioning (seek) operation and read operation are tested in random access and sequential access modes with the READ, READ EXTENDED, or VERIFY command.

(4) Write/read test

By using a data block in the CE space, the write/read test can be executed with an arbitrary pattern for a disk drive in which user data is stored.

6.2 Maintenance Information

6.2.1 Maintenance requirements

(1) Preventive maintenance

Preventive maintenance such as replacing air filters is not required.

Warning

Do not open the DE in the field because it is completely sealed.

(2) Service life

No overhauls are required for the first five years or 200,000 hours when the environmental requirements and handling of the drive meets the specification.

(3) Parts that can be replaced in the field

The PCA cannot be replaced in the field. The DE cannot be replaced in the field.

(4) Service system and repairs

Fujitsu has the service system and repair facility for the disk drive. Contact Fujitsu representative to submit information for replacing or repairing the disk drive. Generally, the following information must be included:

- IDD model, part number (P/N), revision number, serial number (S/N), and date of manufacturing
- Error status
  - Date when the error occurred
  - System configuration
  - Environmental conditions (temperature, humidity, and voltage)
- Error history
- Error contents
  - Outline of inconvenience
  - Issued commands and specified parameters
  - Sense data
  - Other error analysis information

Warning

Save data stored on the disk drive before requesting repair. Fujitsu does not assume responsibility if data is destroyed during servicing or repair.

See Section 5.1 for notes on packing and handling when returning the disk drive.

6.2.2 Revision numbers

The revision number of the disk drive is represented with a letter and a number indicated on the revision label attached to the DE. Figure 6.1 shows the revision label format.

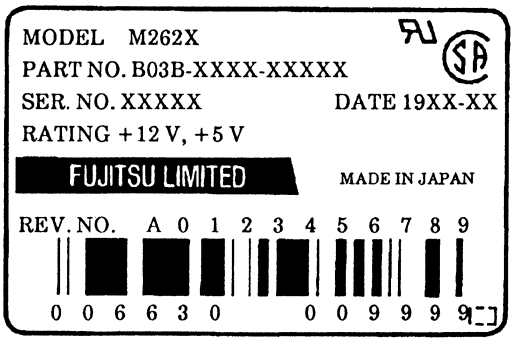


Figure 6.1 Revision label

(1) Indicating revision number at factory shipment

When the disk drive is shipped from the factory, the revision number is indicated by deleting numbers in the corresponding letter line up to the corresponding number with = (see Figure 6.2).

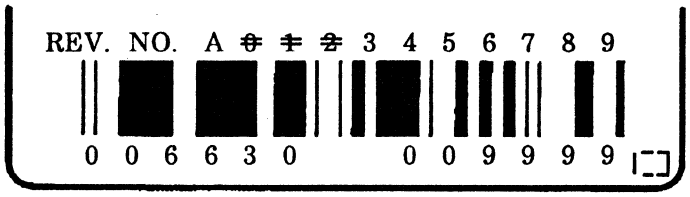
(2) Changing revision number in the field

To change the revision number because parts are replaced or other modification is applied in the field, the new level is indicated by enclosing the corresponding number in the corresponding letter line with = (see Figure 6.2).

Note:

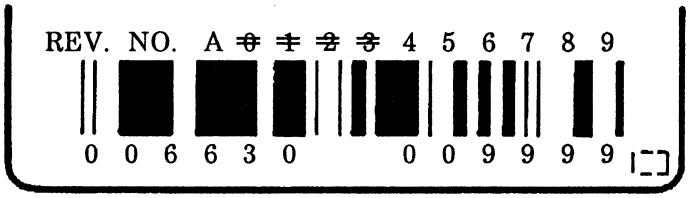
When the revision number is changed after the drive is shipped from the factory, Fujitsu issues "Engineering Change Request/Notice" in which the new revision number is indicated. When the user changes the revision number, the user should update the revision label as described in item (2) after applying the modification.

Revision number indication at factory shipment



⇨ Revision A2

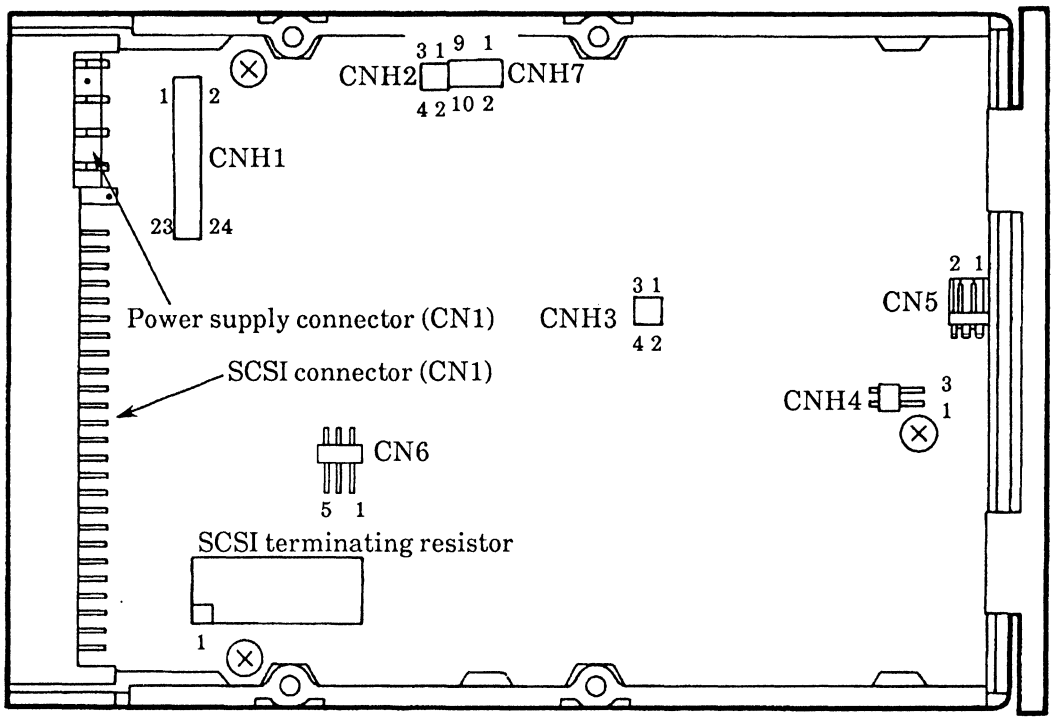
Revision number change at field



⇨ Revision A3

Figure 6.2 Indicating revision numbers

APPENDIX A POSITIONS OF CONNECTORS, PINS, AND TERMINATING RESISTOR



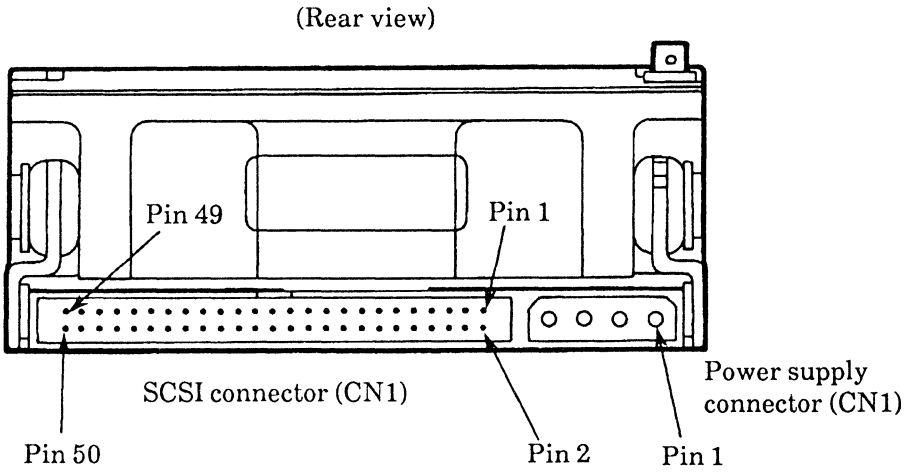


Figure A.1 Positions of connectors, pins, and terminating resistor

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APPENDIX B SETTING TERMINALS

Remark:

See Section 5.3 for setting requirements and notes on setting. Setting of pins 9 and 10 should not be changed by user (if changed, the IDD does not operate correctly).

Table B.1 Setting terminal: CNH7

Setting item	Pin position			Setting contents	
	5-6	3-4	1-2	SCSI ID	
SCSI ID	Open	Open	Open	0	
	Open	Open	Short	1	
	Open	Short	Open	2	
	Open	Short	Short	3	
	Short	Open	Open	4	
	Short	Open	Short	5	
	Short	Short	Open	6	
	Short	Short	Short	7	(*)
Write protect	7-8		Open	Disable write operation	
			Short	Enable write operation	(*)
———	9-10		Open	User setting inhibited	

* Setting at factry shipment.

Table B.2 Setting terminal: CNH2

Setting item	Pin position		Setting contents
For testing at factory	1-2	Open	} User setting inhibited
	3-4	Open	

Note:

The user must not be change CNH2 setting. (The IDD does not operate correctly when shorted)

Table B.3 Setting terminal: CNH1

Setting item	Pin position		Setting contents			
PER default value	1-2	Short	"0"			(*)
		Open	"1"			
SCSI level	3-4	Short	SCSI-1/CCS mode			(*)
		Open	SCSI-2 mode			
Offline self-diagnostics	5-6	Open	Stopped (normal operation mode)			(*)
		Short	Executed (diagnostic mode)			
UNIT ATTENTION report mode	7-8	Short	Reports the CHECK CONDITION status.			(*)
		Open	Not report the CHECK CONDITION status.			
Reselection retry	9-10	Short	Retry count = unlimited			(*)
		Open	Retry count = 10			
—	11-12	Short	(Reserved)			(*)
		Open				
SCSI bus parity	13-14	Short	Executed			(*)
		Open	Not executed			
Synchronous mode transfer request	15-16	Short	Enabled from TARG			(*)
		Open	Disabled from TARG			
LED display requirement	17-18	Short	Lights during operating			(*)
		Open	Lights during Ready			
Motor start mode	19-20	Short	Start by power-on			(*)
		Open	Start by the START/STOP UNIT command			
SCSI terminating resistor power	21-22	23-24	Connecting TERMPWR pin and terminating resistor	Connicting power to TERMPER pin	Connecting power to IDD terminating resistor	
	Short	Short	Yes	Yes	Yes	(*)
	Short	Open	No	No	Yes	
	Open	Short	Yes	No	No	

* Setting at factory shipment

APPENDIX C CONNECTOR SIGNALS ALLOCATION

Table C.1 SCSI connector: CN1

Pin number	Signal	Signal	Pin number
01	GND	–DB0	02
03	GND	–DB1	04
05	GND	–DB2	06
07	GND	–DB3	08
09	GND	–DB4	10
11	GND	–DB5	12
13	GND	–DB6	14
15	GND	–DB7	16
17	GND	–DBP	18
19	GND	GND	20
21	GND	GND	22
23	(Open)	(Open)	24
25	(Open)	TERMPWR (*1)	26
27	(Open)	(Open)	28
29	GND	GND	30
31	GND	–ATN	32
33	GND	GND	34
35	GND	–BSY	36
37	GND	–ACK	38
39	GND	–RST	40
41	GND	–MSG	42
43	GND	–SEL	44
45	GND	–C/D	46
47	GND	–REQ	48
49	GND	–I/O	50

*1 Terminating resistor power (jumper selectable: For input only, for input and output, or open)

Table C.2 Power connector: CN1

Pin number	Power type
1	+12 VDC
2	+12 VDC RETURN (GND)
3	+5 VDC RETURN (GND)
4	+5 VDC

Table C.3 External operator panel connector: CN5

Pin number	Signal
01	LED (V)
02	-LED

Table C.4 External operator panel connector: CN6

Pin number	Signal
01	GND
02	–ID2
03	GND
04	–ID1
05	GND
06	–ID0

Table C.5 Spindle sync connector: CNH4

Pin number	Signal
01	GND IN
02	SS IN
03	GND OUT
04	SS OUT

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