FUJITSU

M2611S/SA/SB
M2612ES/ESA/ESB
M2613ES/ESA/ESB
M2614ES/ESA/ESB

INTELLIGENT DISK DRIVES

OEM MANUAL

41FH5058E-02

REVISION RECORD		
Edition	**Date published**	**Revised contents**
01	Sep., 1990	
02	Oct., 1990	Pages 1-4, 1-5, 3-2, 3-6, 3-8, 3-10, 3-12, 3-13, 4-14, 5-8, 6-3, 6-4, 6-6, 6-7, 6-9, 6-10, 7-2, 7-9 to 7-11, 7-14, 7-15, 7-19, 7-22, 7-26, 7-29, 7-35, 7-38, 7-41, 7-46, 7-49, 7-50, 7-53, 7-56, 7-60, 7-61, 7-63, 7-64, 7-67 to 7-69, 7-72, 7-74, 7-75, 7-80, 7-83 to 7-96, 8-2, 8-5, 8-8, 8-12 revised.
Specification No.: 41FH5058E		

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PREFACE

This manual describes the M2614ES/ESA/ESB, M2613ES/ESA/ESB, M2612ES/ESA/ESB, and M2611S/SA/SB Intelligent Disk Drives which feature embedded SCSI controllers.

A detailed explanation of the M261XS/SA/SB series of the Intelligent Disk Drives, including specifications and functions is also provided.

This manual consists of the following:

Chapter 1 Outline

Describes the features and specifications of the M2614ES/ESA/ESB, M2613ES/ESA/ESB, M2612ES/ESA/ESB, and M2611S/SA/SB series of Intelligent Disk Drives.

Chapter 2 Configuration

Illustrates the mechanical and circuit configurations of the M261XES/ESA/ESB Intelligent Disk Drives.

Chapter 3 Installation

Describes the installation requirements such as mounting dimensions, cabling, and setting plugs.

Chapter 4 Host Interface

Includes SCSI control procedures and electrical requirements for interfacing with the host system and the Intelligent Disk Drives.

Chapter 5 Messages

Details the definition and functions of messages which are provided for protocol control of the SCSI.

Chapter 6 Data Format and Addressing

Describes the structure and organization of data on the disk medium and the methods by which the data is addressed.

Chapter 7 Commands

Describes the definition and the functions of commands implemented in the Intelligent Disk Drives.

Chapter 8 Status Bytes and Sense Data

Describes the status byte and sense data structure reported to the host system via the SCSI.

Chapter 9 Error Recovery

Describes the error recovery procedure taken by the controller.

Chapter 10 Diagnosis and Maintenance

Describes the diagnostic functions of the Intelligent Disk Drives and outlines maintenance features.

For more detailed information about the host interface (SCSI) and the functionality of the commands, to develop the host adapter for SCSI and the host software, refer to the following manual: SCSI FUNCTIONAL SPECIFICATIONS FOR INTELLIGENT DISK CONTROLLERS / INTELLIGENT DISK DRIVES (Specification No.B05P-2180-0011A)

The M2614ES/ESA/ESB, M2613ES/ESA/ESB, M2612ES/ESA/ESB, and M2611S/SA/SB Intelligent Disk Drives may be abbreviated to 'IDD', or referred to as 'drive', or 'device' in the following pages.

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CHAPTER 1 GENERAL DESCRIPTION

1.1 General

The M261XES/ESA/ESB intelligent disk drives (IDDs) are compact (3.5-inch microfloppy size), highly reliable fixed disk drives with embedded SCSI controllers.

The storage capacities (formatted) for the models are: 182.36 MB for the M2614ES/ESA/ESB, 136.60 MB for the M2613ES/ESA/ESB, 90.84 MB for the M2612ES/ESA/ESB, and 45.07 MB for the M2611S/SA/SB.

The controller is embedded within the drive form factor, and the interface to the host system is based on the SCSI (Small Computer System Interface) standard (ANSI X3.131 - 1986).

1.2 Features

(1) Compact size

Because the controller circuit is embedded in the IDD PCA, the IDD is extremely compact in size:

M2614ES/ESA/ESB, M2613ES/ESA/ESB, M2612ES/ESA/ESB
  101.6 mm (4.00 in.) (W) × 41.3 mm (1.63 in.) (H) × 146.0 mm (5.75 in.) (D)
M2611S/SA/SB
  101.6 mm (4.00 in.) (W) × 25.4 mm (1.00 in.) (H) × 146.0 mm (5.75 in.) (D)

(2) SCSI

The interface between the host system and the IDD meets SCSI standard. In addition the following extended features are provided:

- Arbitration
- Disconnection/reselection
- Synchronous data transfer with 2.5 MB/s maximum transfer rate

(3) Comprehensive command set which meets CCS requirements

All SCSI mandatory commands as well as extended commands are provided. The command set meets the SCSI CCS (Common Command Set for Direct Access Device) requirements.

These commands can manipulate data through logical block addressing independent of the physical characteristics of the IDD. This allows for maximum flexibility for future software development.

(4) Contiguous block processing

Standard commands allow up to 256 blocks to be processed consecutively. Extended commands allow up to 65,535 blocks to be processed consecutively.

The host system software can handle logically-continuous space without being aware of the physical boundaries because the switching between cylinders and tracks is automatically performed inside the IDD.

(5) Reserve and release functions

IDD can be exclusively accessed in multi-programming or multi-host system environments due to reserve and release functions.

(6) Ring buffer

To improve system throughput, the IDD contains a 24 KB ring buffer.

(7) Automatic data error correction and internal retry

If a recoverable error occurs, the IDD attempts to correct errors inside the IDD. Correctable data errors can be corrected in the data buffer so that error-free data is transferred to the host system.

(8) Sector slip

The sector slip method of assigning defect blocks in alternate sectors is utilized by the IDD to prevent unnecessary delays caused by latency or additional seeks.

(9) Diagnosis

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

(10) High reliability

The inline heads, disks, and positioners are completely sealed in the disk enclosure (DE), to prevent contamination, and the air inside the DE is kept clean by a breather filter and recirculation filter. These features increase reliability by reducing the chance of contamination.

(11) High speed positioning

A rotary voice coil motor is used to position the heads for high speed positioning.

(12) No preventive maintenance is necessary.

(13) Vertical or horizontal installation

The IDD may be installed in a system cabinet either vertically or horizontally; the PCA must be on the bottom.

(14) Low power consumption (Steady state)

The power consumption of the M2614, M2613 and M2612 is 10.4 W in steady state; the M2611 is 9.2 W. This low power consumption enables the unit to be used in a wide environmental temperature range (5°C to 45°C) without a cooling fan.

(15) Low noise and low vibration (Ready state)

The drives' low noise output, approx. 43 dB (M2611; 40 dB) (A-scale weighting), makes the M261XS/SA/SB series of IDD's ideal for office use.

The IDD has four rubber vibration isolators, which minimize the transfer of motion.

1.3 Specifications

1.3.1 Functional specifications

Table 1.1 shows the functional specifications of the IDD.

Table 1.1 Functional specifications

	M2614ES/ESA/ESB	M2613ES/ESA/ESB	M2612ES/ESA/ESB	M2611S/SA/SB
Total storage capacity Formatted (user area) (MB)	182.36	136.60	90.84	45.07
Storage capacity/track (512 B/block) (B)	17,408			
Number of disks Number of heads (R/W) Number of cylinders Number of tracks/cylinder	4 8 1334 8	3 6 1334 6	2 4 1334 4	1 2 1334 2
Number of blocks/track (default)	68 (256 bytes/block) - - - ES, S 34 (512 bytes/block) - - - ESA, SA 17 (1024 bytes/block) - - ESB, SB			
Recording density (BPI) Track density (TPI) Rotational speed (rpm) Average latency time (ms) Recording method	29,571 1,681 3,490 8.6 RLL (1/7)			
Positioning time** Min. (ms) Avg. (ms) Max. (ms)	8 20 36			10 25 42
Host interface Cable length (m)	Single-ended SCSI 6 max.			
Data transfer rate (MB/s)	Async mode : 1.50 max. Sync mode : 2.50 max.			
Command types	30 (Including 2 vender unique)			
Input voltage***	+12 V ±5%, 0.45 A (max. 2.0 A) + 5 V ±5%, 1.0 A			+12 V ±5%, 0.35 A (max. 1.5 A) + 5 V ±5%, 1.0 A
Ripple****	5 V 50mVp-p, +12 V 100 mVp-p			
External size Width × height × depth (mm)	101.6×41.3×146.0 (w/o panel dimensions) 104.1×43.8×151.3 (w/o front panel installed)			101.6×25.4×146.0 (w/o panel dimensions) 104.1×43.8×151.3 (w/o front panel installed)
Weight	1.0			0.6

Notes:

** : Including settling time
*** : Meets voltage tolerance for unit power supply connectors
**** : High frequency noise 100 mVp-p max.

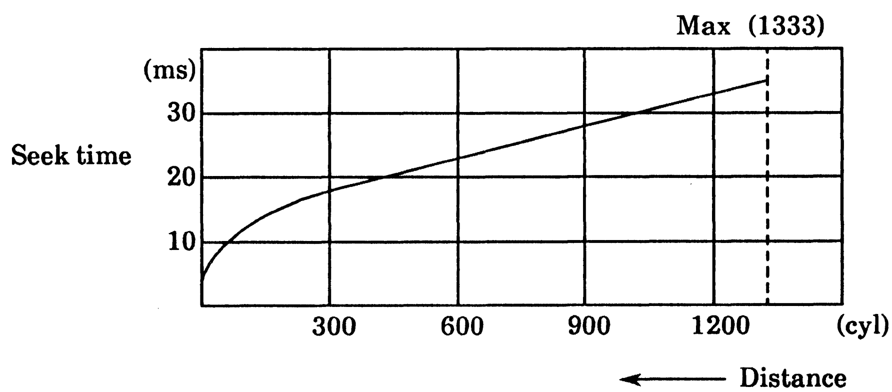
1.3.2 IDD order specifications

Table 1.2 lists models and part numbers.

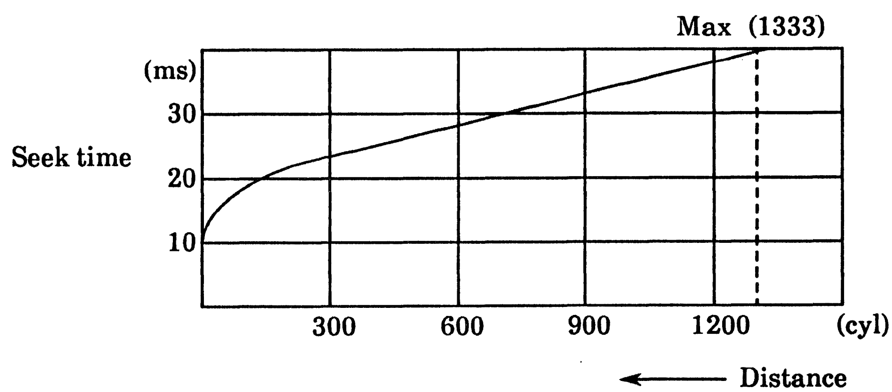
Table 1.2 Models and part numbers

Model name	Storage capacity (user area)	Part number	Mounting screw
M2614ES/ESA/ESB	182.36 MB	B03B-7055-B106A/B116A/B126A	M3
M2613ES/ESA/ESB	136.60	B03B-7055-B105A/B115A/B125A	M3
M2612ES/ESA/ESB	90.84	B03B-7055-B104A/B114A/B124A	M3
M2611S/SA/SB	45.07	B03-7065-B101A#D/B111A#D/ B121A#D	M3

1.3.3 Positioning time



M2614ES/ESA/ESB
M2613ES/ESA/ESB
M2612ES/ESA/ESB



M2611S/SA/SB

1.3.4 Start and stop time

Start time (time from when power is turned on until the IDD is ready) is 15 seconds or less, and stop time (time to completely stop when power is turned off) is 25 seconds or less.

1.4 Environmental Conditions

Temperature	Operating Non-operating Gradient	5°C to 45°C (Top Cover 5°C to 58°C) −40°C to 60°C 15°C/h or less
Relative humidity	Operating Non-operating Maximum Wet Bulb	20% to 80% RH 5% to 95% RH No condensation 29°C
Vibration	Operating (Note 1)	0.3 G (5 to 150 Hz) 0.5G (150 to 250 Hz) 2 min × 30 cycles (except resonance point) (sinusoidal waveform)
	Non-operating	0.5 G (5 to 150 Hz) 1.0 G (150 to 250 Hz) 2 min × 30 cycles (sinusoidal waveform) (power-off state after installation)
Shock (Note 2)	Operating Non-operating	5 G (maximum 10 ms) 50 G (maximum 10 ms)
Altitude above sea level	Operating Non-operating time	−60 m to 3,000 m 12,000 m maximum

Notes:

1. When IDD install solid structure.
2. When IDD install solid frame.

1.5 Power Requirements

(1) Input voltage tolerance and current

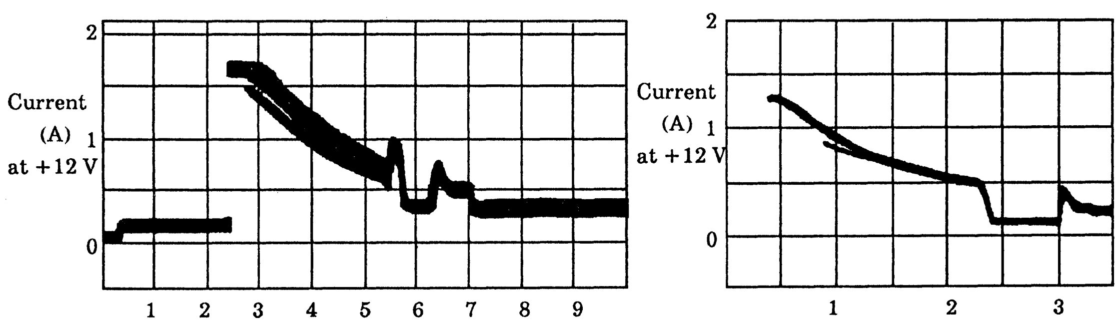
	Input voltage		Peak current	Average current
+ 12 V	+ 12 V ±5%	M2614ES/ESA/ESB M2613ES/ESA/ESB M2612ES/ESA/ESB	2.0 A max	0.45 A
		M2611S/SA/SB	1.5 A max	0.35 A
+ 5V	+ 5 V ±5%	M2614ES/ESA/ESB M2613ES/ESA/ESB M2612ES/ESA/ESB	—	1.0 A
		M2611S/SA/SB		1.0 A

(2) Power consumption

Steady state 10.4 W ··· M2614ES/ESA/ESB, M2613ES/ESA/ESB, M2612ES/ESA/ESB
9.2 W ··· M2611S/SA/SB

(3) Current waveforms

Figure 1.1 shows +12V current waveform of IDD (for reference)



Time (sec) M2614ES/ESA/ESB Power-on Curve

Time (sec) M2611S/SA/SB Power-on Curve

Figure 1.1 +12V current waveform

(4) Power on/off sequence

The voltages (+12 V, +5 V) to the drive need not be considered. The +5 voltage sequence between the SCSI connection circuits of the host system and the IDD is determined as follows:

① Follow the power supply sequence shown in Figure 1.2 if the TERMPWR pin (SCSI connector) which supplies power to the terminator is not used.

② Follow the power supply sequence shown in Figure 1.2 if the host system is not equipped with noise suppression feature which reduces noise to SCSI when power is turned on or off.

③ In cases other than ① and ②, the power supply sequence need not be considered.

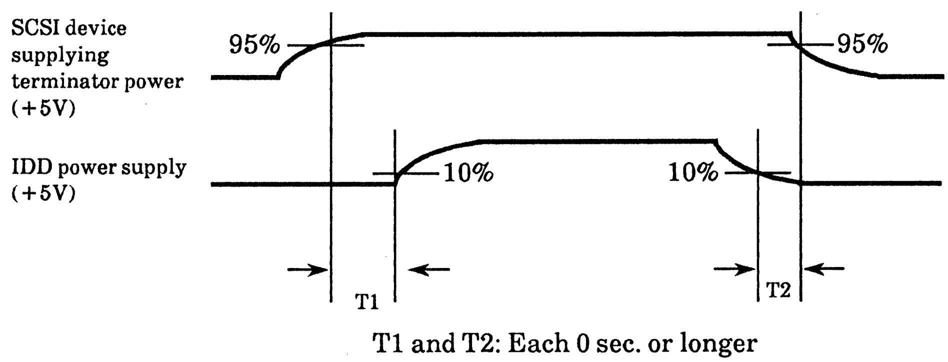
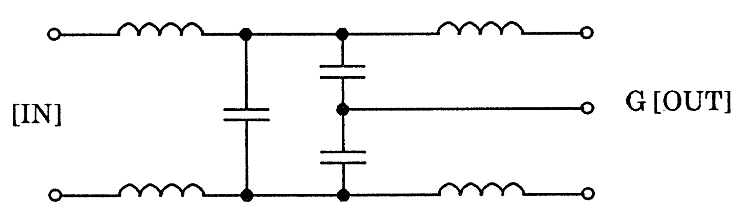


Figure 1.2 Power on/off sequence

(5) Others

To eliminate AC line noise, a noise filter of the specifications given below should be incorporated in the AC input terminal of the drive power supply.

Attenuation characteristics: 40 dB or greater at 10 MHz
Circuit configuration: T type shown below is recommended.



1.6 Reliability

(1) Mean Time Between Failures (MTBF)

The estimated MTBF of the IDD during its life time is 50,000 hours.

Note:

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

Operating time is the total time duration during which the power is ON.

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

(2) Mean Time To Repair (MTTR)

MTTR is the average time taken by a well-trained service mechanic to diagnose and repair a unit malfunction. IDD 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 the first 20,000 hour.

(4) Power loss

Integrity of the data on the disk is guaranteed against all forms of abnormal DC power failure except a power failure during writing.

1.7 Error Rate

Errors detected upon initialization and replaced by an alternate record are not included in the error rate.

(1) Non-recoverable error rate

Errors which cannot be recovered within 16 retries (IDD) and ECC correction should not exceed 10 errors per 10^{15} bits.

(2) Positioning error rate

The rate of positioning errors recoverable by one retry is 10 or less per 10^7 seeks.

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CHAPTER 2 CONFIGURATION

2.1 Mechanical Configuration

Figure 2.1 shows the outer view of the IDD. The IDD consists of disks, heads, spindle motor, actuator, cover, breather filter, recirculation filter, base, read/write preamplifier (PCA), and control (PCA).

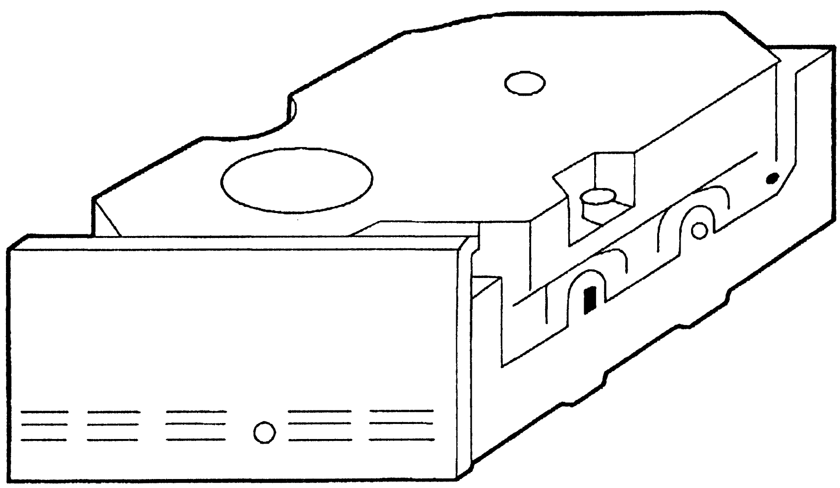

Figure 2.1 Outer view

(1) Disks

The disks used are sputtered metal media, and have an outer diameter of 95 mm and inner diameter of 25 mm. The M2614 uses four disks; the M2613, three; the M2612, two; and the M2611, one. The disks can endure for at least 10,000 starts and stops.

(2) Heads

The heads used are Whitney, contact start/stop heads and are in contact with the disks when the disks are not moving, but automatically float when disk rotation reaches nominal speed. There are 8 read/write heads in the M2614, 6 in the M2613, 4 in the M2612 and 2 in the M2611.

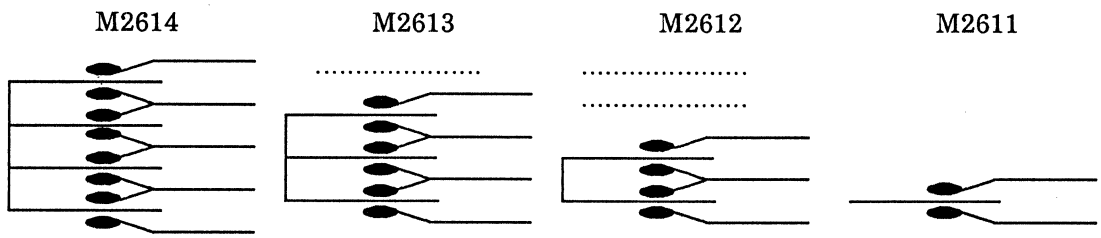

Figure 2.2 Disk/head configuration

(3) Spindle motor

The disks are turned by a direct-drive DC motor. The motor attains a very precise rotational speed of 3490 rpm, ±1%. This precision is achieved through a feedback circuit which includes Hall-effect elements mounted within the motor assembly.

(4) Actuator

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

(5) Air circulation

The heads, disks, and actuator are sealed inside a cover to keep out dust and other contaminants.

The head assembly has a closed-loop air recirculation system using the blower effect of the rotating disks to continuously cycle air through the recirculation filter. This filter traps any dust generated inside the enclosure. 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.

2.2 Circuit Configuration

Figure 2.3 shows IDD circuit configuration.

(1) 2 microprocessors

One microprocessor controls the host interface and drive interface, and another microprocessor is used for the drive control.

(2) Controller circuit

Important functions are listed below:

- Ring buffer (24 KB)
- SCSI protocol control and data transfer control
- Sector format control
- ID register
- SERDES
- ECC
- Error recovery and self diagnostic

(3) Read/write circuit

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

(4) Servo circuit (Embedded Servo)

The positioning and speed of the voice coil motor is controlled by the closed loop servo method, which performs feedback control based on sector servo information recorded on the each data surface.

(5) Spindle motor drive circuit

This circuit controls the rotational speed by comparing the output frequency of the Hall elements from the motor with the standard frequency generated by the crystal oscillator, so the rotational variation is very low.

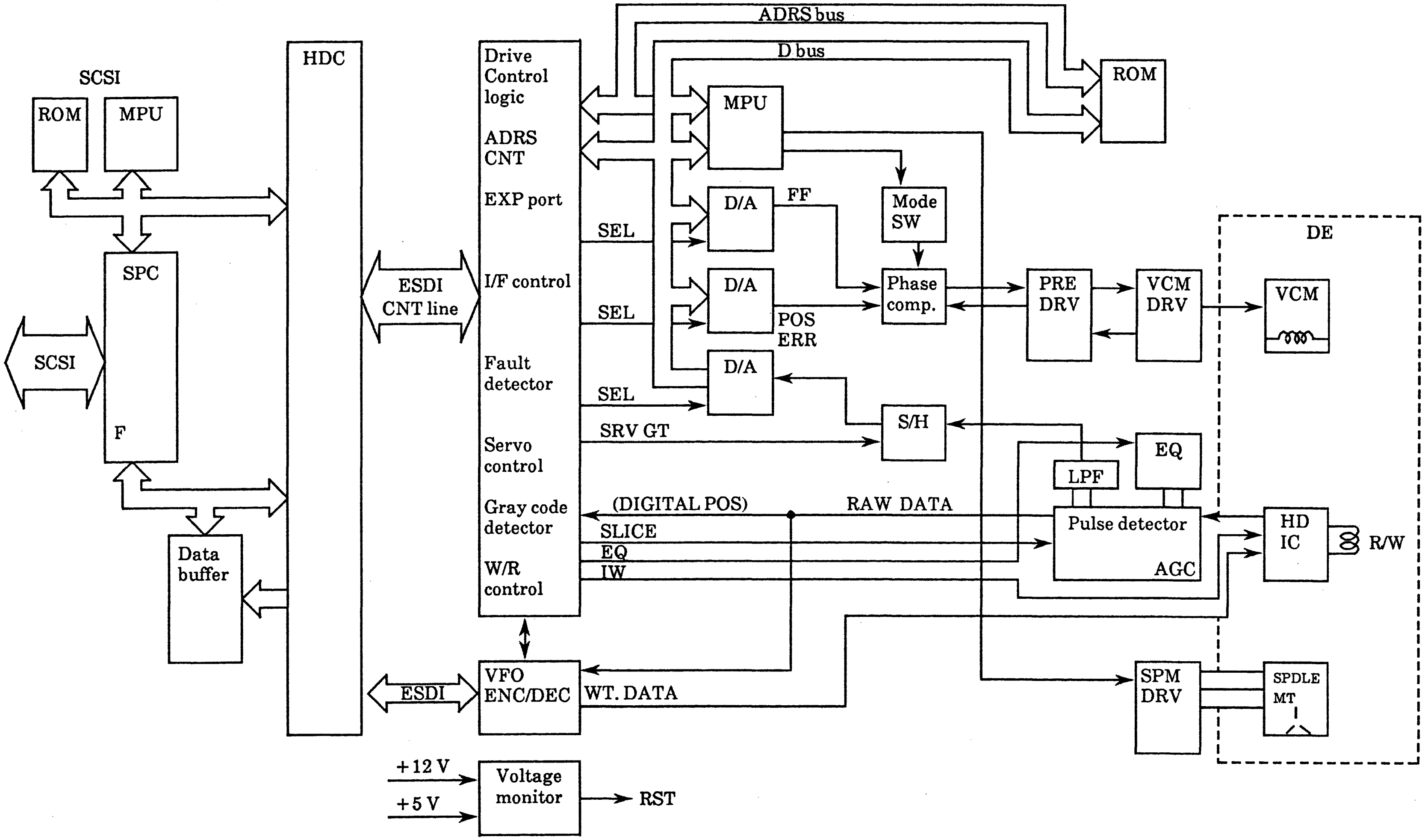

Fig. 2.3 IDD circuit configuration

2.3 System Configuration

Figure 2.4 is an example of one type of system configuration.

Host systems, IDDs, and other SCSI controllers can be connected (daisy-chained) to SCSI provided that the total number of SCSI devices connected does not exceed eight.

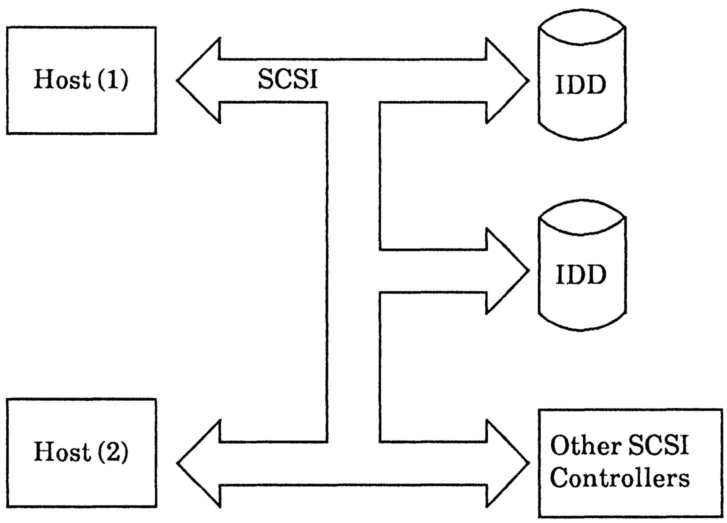

Figure 2.4 System configuration example

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CHAPTER 3 INSTALLATION

3.1 Outer Dimensions

Figures 3.1 and 3.2 show the outer dimensions and mounting dimensions. All dimensions are given in millimeters.

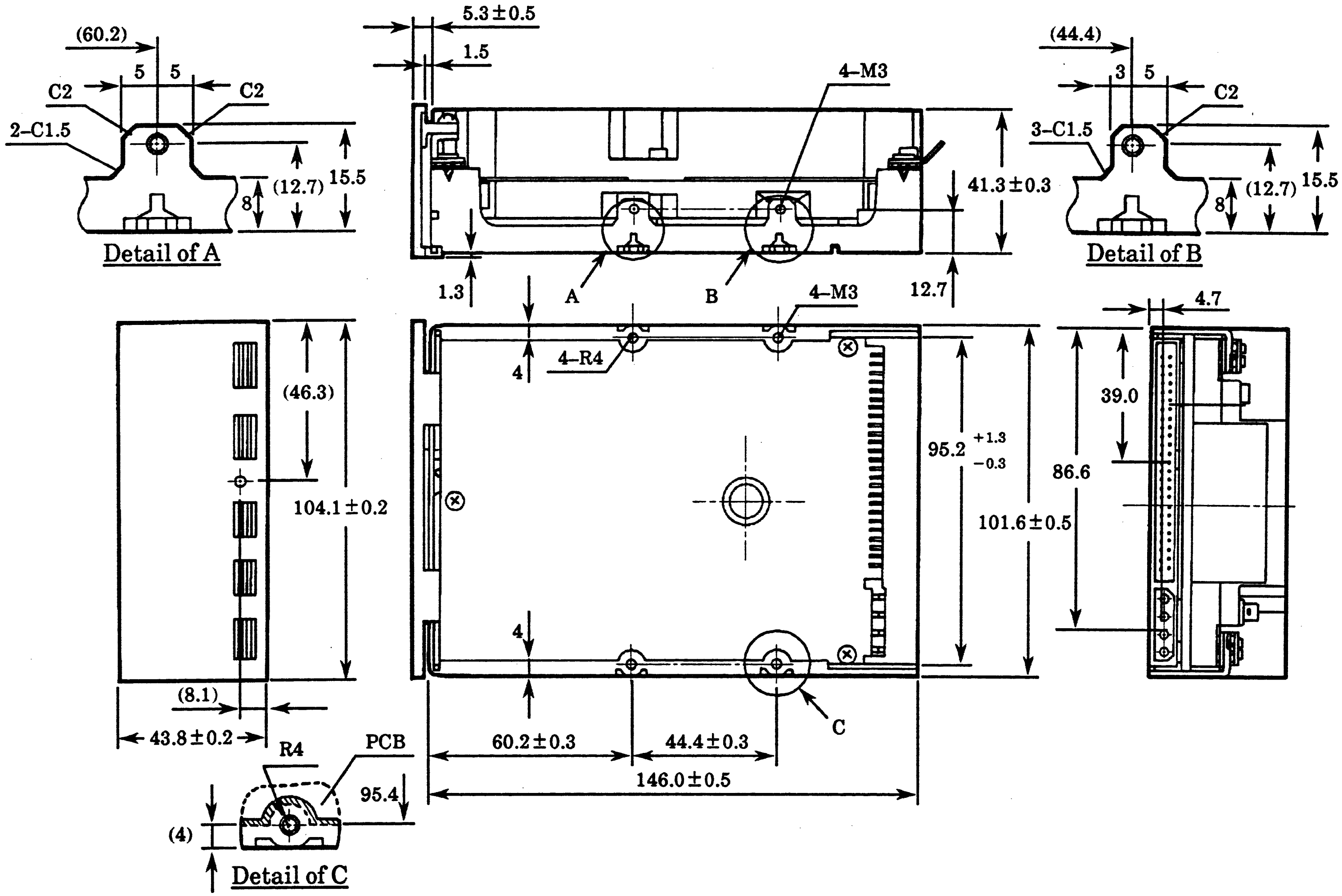


Figure 3.1 Outer dimensions (M2612/M2613/M2614)

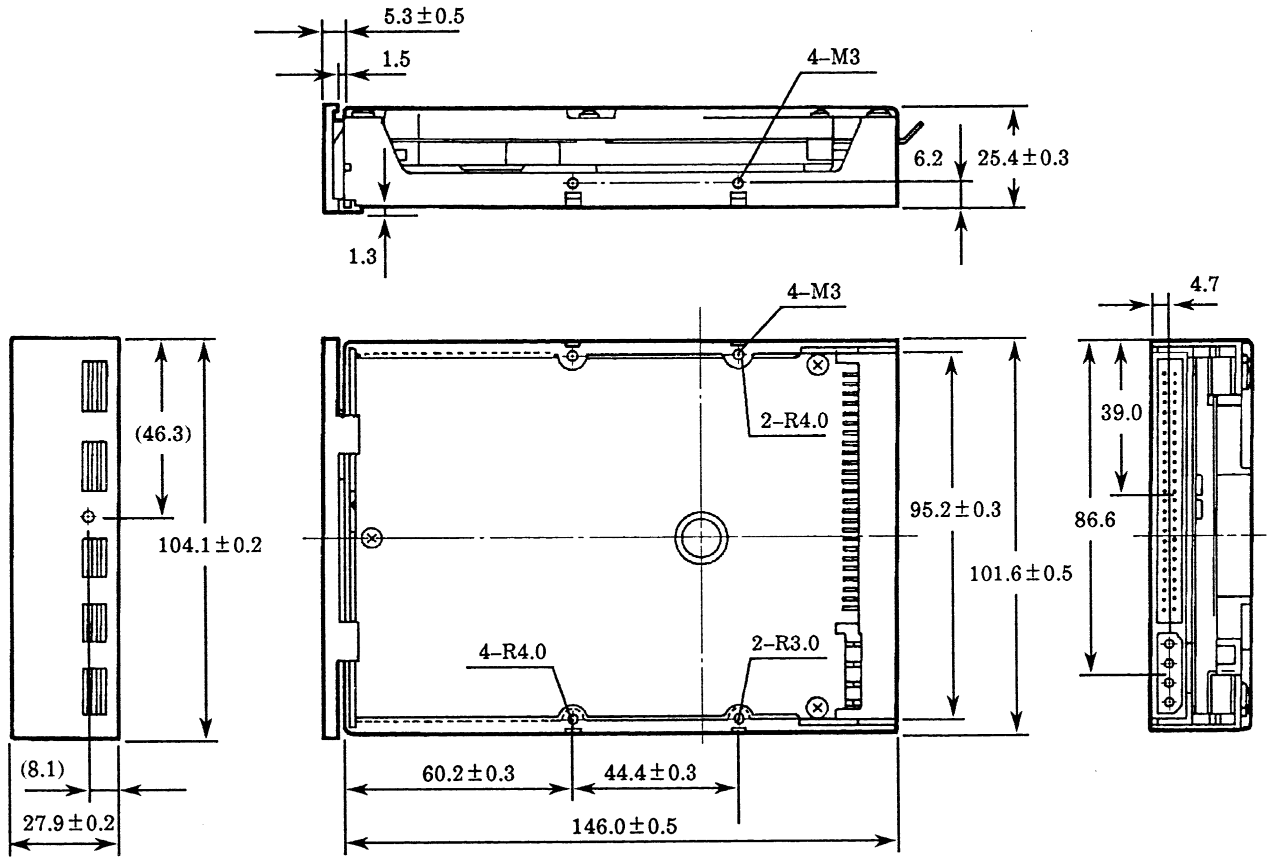
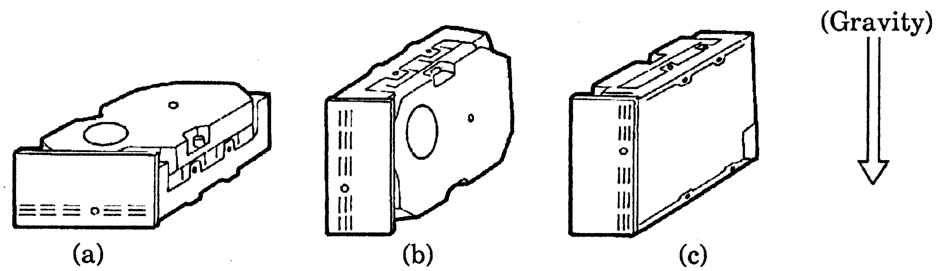


Figure 3.2 Outer dimensions (M2611)

3.2 Notes on Installation

(1) Installation direction



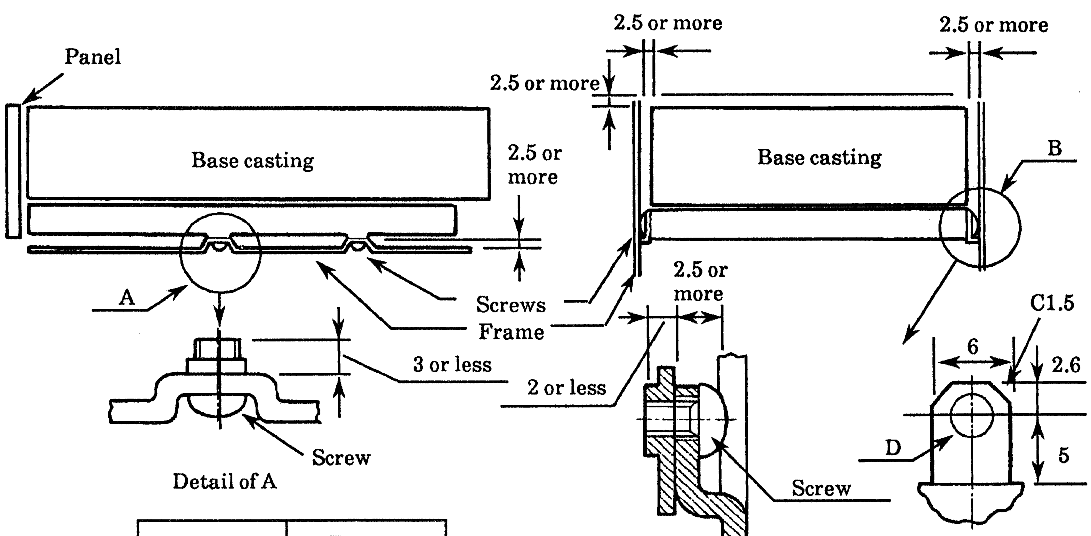
There are three possible installation positions. Note that the mounting angle must be true within 5° from the horizontal.

(2) Frame structure

When the drive is mounted with bottom threads, the embossed frame can be used as shown below (detail of A). However, when the drive is fixed with side threads, the frame should be designed according to detail B as shown below.

CAUTION

Screw length for mounting the drive differs according to the mounting method; it is important to use the current length of screw for either bottom or side threads.



Screw	D (mm)
M3	ø3.6

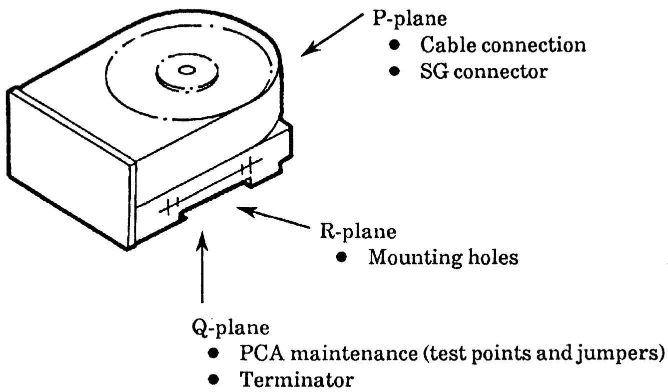
Detail of B

(3) Ambient temperature

The operating temperature range of the IDD is specified at a distance of 3 cm from the IDD.

Make sure to maintain the base temperature range of DE from 5°C to 58°C.

(4) Service area



3.3 Cables and Connectors

3.3.1 Drive connectors location

As shown in Figure 3.3, cable connectors are located at the rear of the IDD.

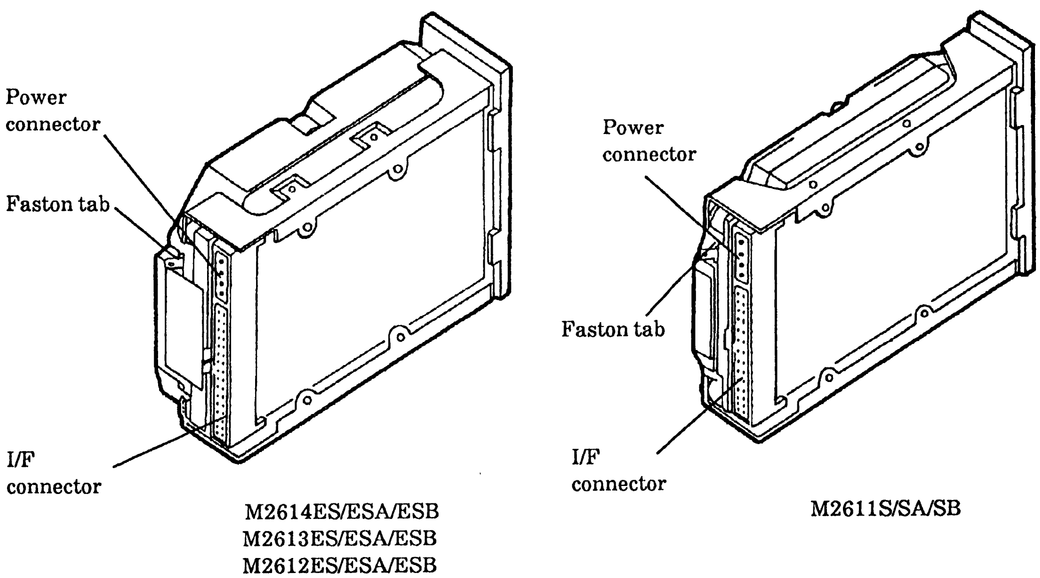


Figure 3.3 Drive connectors location

3.3.2 Recommended parts for connection

Table 3.1 lists the recommended cables and connectors specification.

Table 3.1 Recommended parts for connection

	Name	Model	Manufacturer	Remarks
Host interface (SCSI)	Cable connector (IDD, closed-end)	FCN-707B050-AU/B	Fujitsu	Bump type
	Cable connector (IDD, through-end)	FCN-707B050-AU/O	Fujitsu	Bump type
	Cable	455-248-50	SPECTRA-STRIP	
Drive power supply	Cable connector	1-480424-0	AMP	
	Contact	170148-2		
	Cable	AWG-18~24	—	
SG	Cable fasten receptacle	62187-1	AMP	
	Fasten tab for the IDD	61761-2	AMP	
	Cable	AWG20		

3.3.3 Connection of components

Figure 3.4 shows the cable connection between the IDD and host system. The maximum length of the SCSI interface cable must be less than 6 m. The terminator is only installed on the controller PCA when the IDD is connected to the beginning or ending position of SCSI cable. Figure 3.5 shows the SCSI terminator power jumper settings, and Figure 3.6 shows the power connector pin assignments.

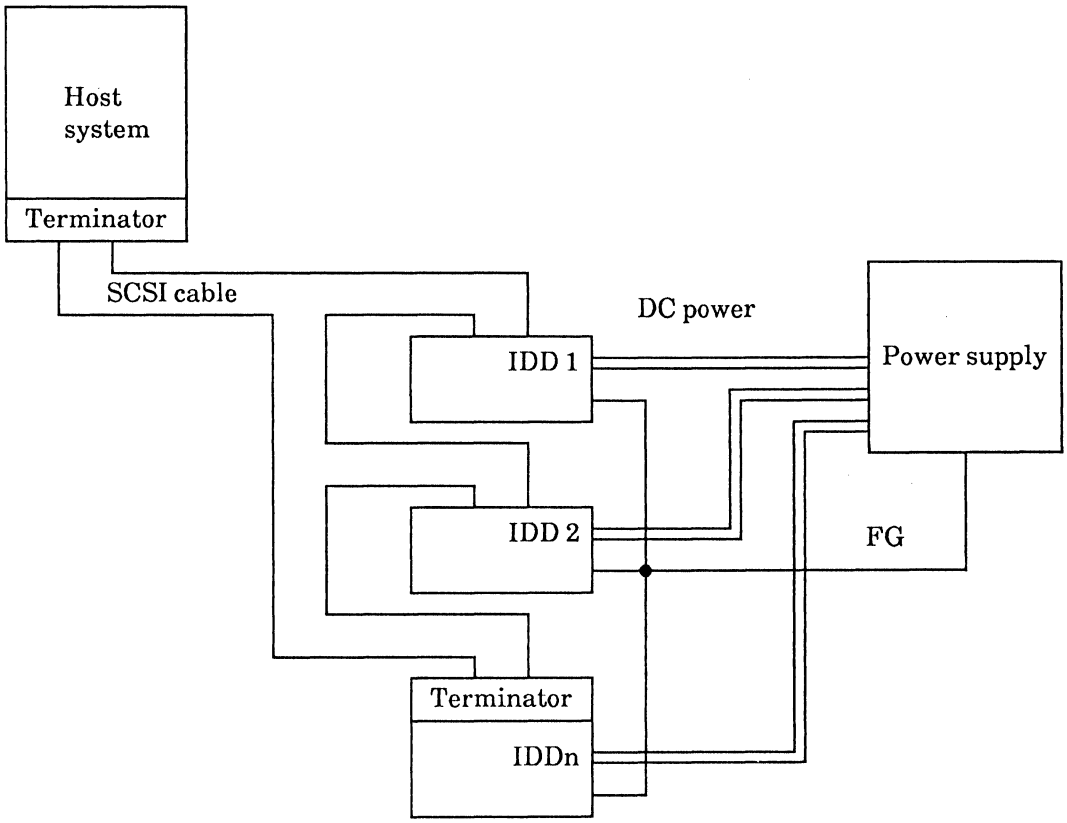
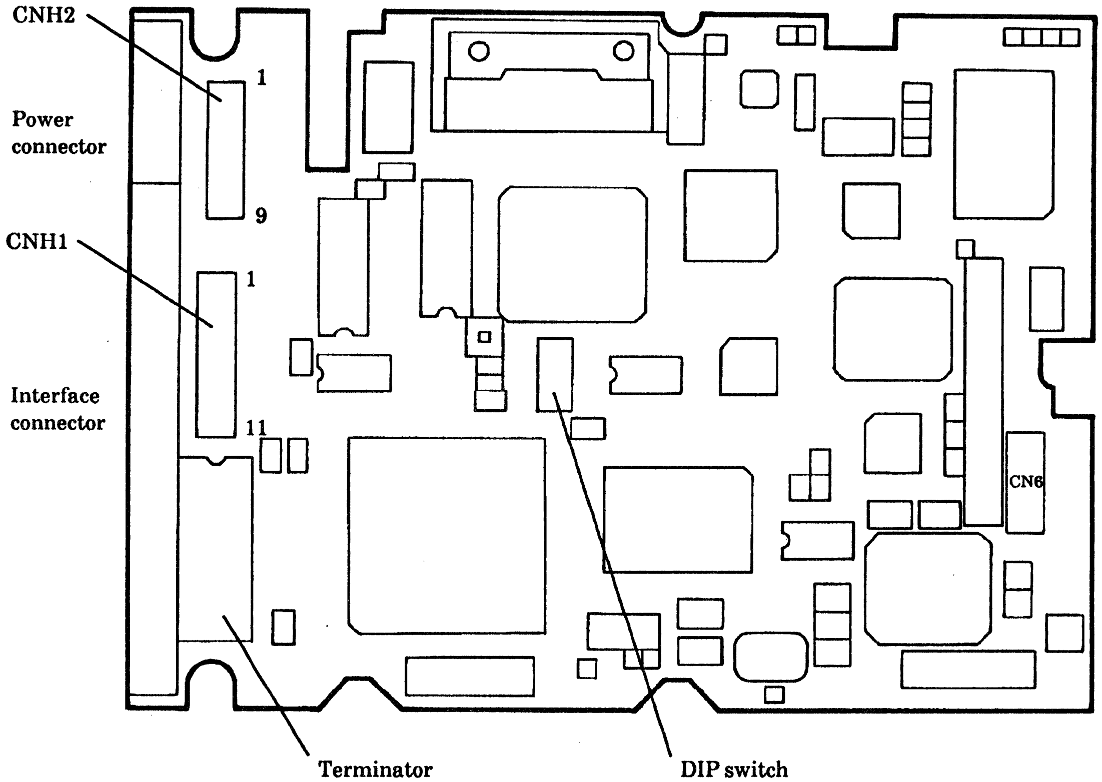


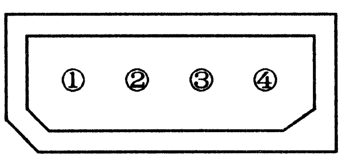
Figure 3.4 Cable connection



Note:

Terminator is already installed in IDD at shipment. Remove the terminator if the IDD is not installed at beginning or ending position of SCSI cable.

Figure 3.5 SCSI terminator/DIP switch/setting circuit location



(View from cable side of connector)

①	+12 VDC
②	+12V RETURN
③	+5V RETURN
④	+5VDC

Figure 3.6 Power connector pin assignments

3.4 DC Grounding

For DC ground, a fasten tab is provided as the SG connector (refer to Figure 3.3).

3.5 Setting Plugs

The drive has two short circuits (CNH1, CNH2) and one DIP switch. Using these setting circuit, the user can make various setting. For the short circuit and DIP switch location, see Figure 3.5.

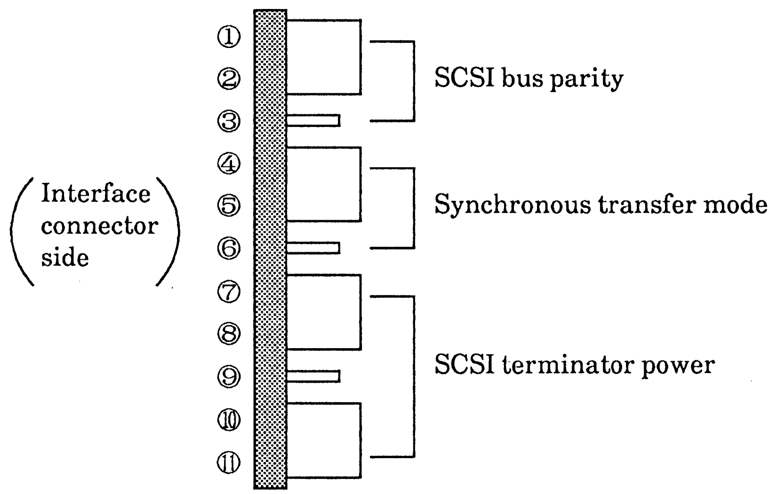


Figure 3.7 CNH1 default setting

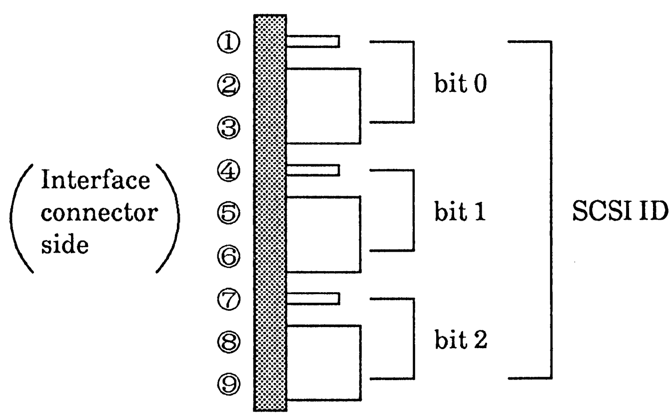


Figure 3.8 CNH2 default setting

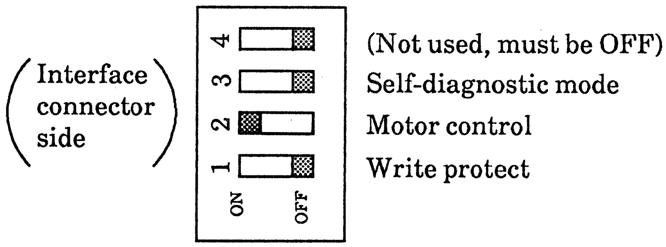


Figure 3.9 DIP switch default setting

3.5.1 Short circuit setting

(1) SCSI bus parity

CNH1	
1–2	SCSI bus parity is enabled. (default)
2–3	SCSI bus parity is disabled.

(2) Synchronous transfer mode

CNH1	
4–5	Synchronous transfer is enabled. (default)
5–6	Synchronous transfer is disabled.

(3) SCSI terminator power

CNH1		
7–8	10–11	① SCSI bus terminator power source is used. (default) ② IDD terminator power source is used. (Note)
8–9	10–11	IDD terminator power source is used.
7–8	9–10	SCSI bus terminator power source is used.

Note:

According to the following condition, power source for terminator is decided.

①: Bus terminator power voltage > IDD terminator power voltage
②: Bus terminator power voltage < IDD terminator power voltage

(IDD terminator power voltage = IDD power voltage (5 V) – 0.3 V ≒ 4.7 V)

(4) SCSI ID

CNH2			SCSI ID
2–3	5–6	8–9	0
1–2	5–6	8–9	1
2–3	4–5	8–9	2
1–2	4–5	8–9	3
2–3	5–6	7–8	4
1–2	5–6	7–8	5
2–3	4–5	7–8	6
1–2	4–5	7–8	7

3.5.2 DIP switch setting

(1) Write protect

Key 1	
ON	Write protect
OFF	Non write protect

(2) Motor control

Key 2	
ON	Self-starting
OFF	Waiting MOTOR START command

(3) Self-diagnostic mode

Key 3	
ON	Normal mode
OFF	Test mode

3.6 Reformatting

If the block size must be changed, the IDD must be reformatted according to the following procedures.

① Connect the IDD to be reformatted to the system.

② If it is necessary to change the sector size (data block length), issue a MODE SELECT command that specifies the new data block length as shown in Figure 3.10, prior to step ③.

Byte	Parameter
0	X'15'
1	0 0 0 1 0 0 0 0
2	X'00'
3	X'00'
4	X'0C'
5	X'00'

Byte	Parameter
0	X'00'
1	X'00'
2	X'00'
3	X'08'
4	X'00'
5	X'00'
6	X'00'
7	X'00'
8	X'00'
9	Block length (MSB)
10	Block length
11	Block length (LSB)

Bytes 9–11:
X'000100' for 256 bytes/sector
X'000200' for 512 bytes/sector
X'000400' for 1024 bytes/sector

Figure 3.10 MODE SELECT command for reformatting

③ Issue a FORMAT UNIT command. The disk medium is reformatted with the specified block length, and the alternate block assignment for the medium defects is performed according the primary defect list.

3.7 External LED Connection

The user can connect the external LED to the drive if necessary. The external LED is connected to CN6 on the PCA.

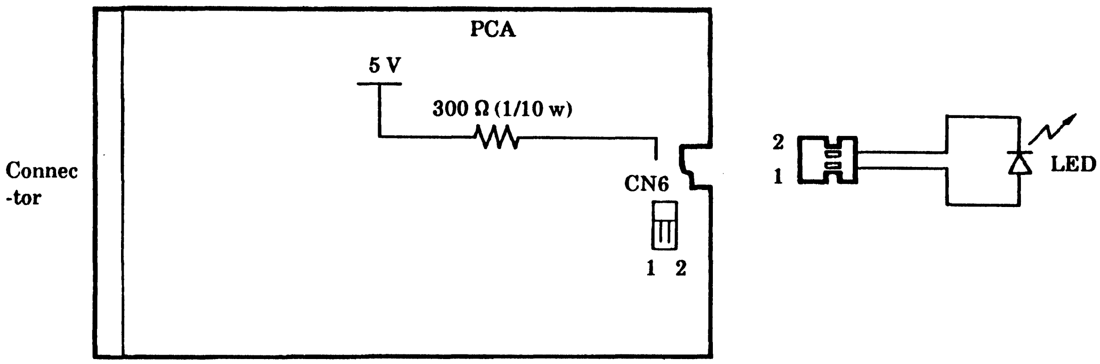


Figure 3.11 External LED connection

Table 3.2 Housing and contact for external LED

Connector name	Part name	Part number	Manufacturer	Remarks
External LED	Housing	608283302815000	ELCO	
	Contact	608283052330808	ELCO	for wire AWG 24–30
		608283252330808		for wire AWG 32

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CHAPTER 4 HOST INTERFACE

4.1 Terminology

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.
IDD:	Intelligent Disk Drive: An abbreviation of M2614ES/ESA/ESB, M2613ES/ESA/ESB, M2612ES/ESA/ESB, M2611S/SA/SB Intelligent Disk Drive.
Initiator (INIT):	SCSI device that has initiated an input/output operation on the SCSI device. This can be abbreviated as INIT in this manual.
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.

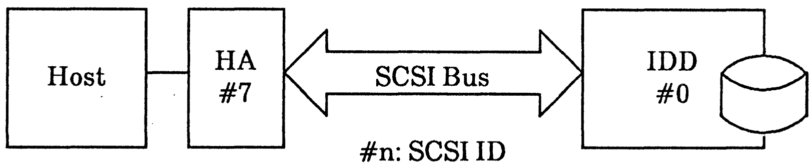
Status: One byte of information that is transferred from a target to an initiator on termination of each command to indicate the command termination status.

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

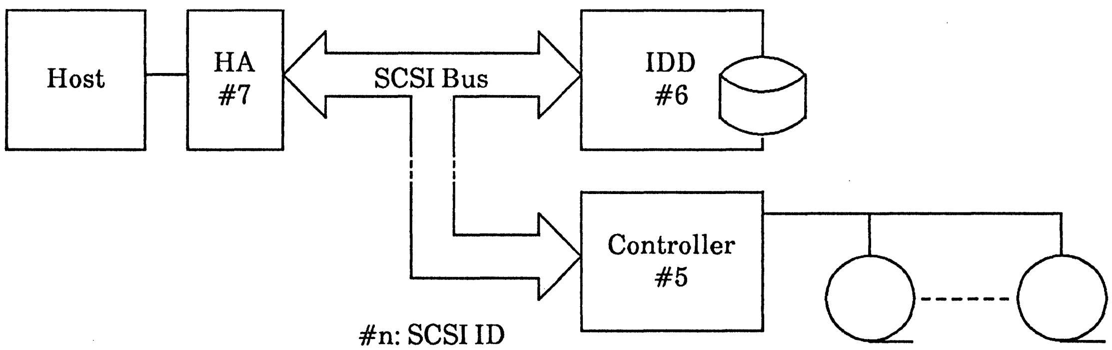
4.2 System Configuration

Up to eight SCSI devices can be connected to the SCSI bus. Figure 4.1 shows sample system configurations.

(1) Single INIT, Single TARG



(2) Single INIT, Multi TARG



(3) Multi INIT, Multi TARG

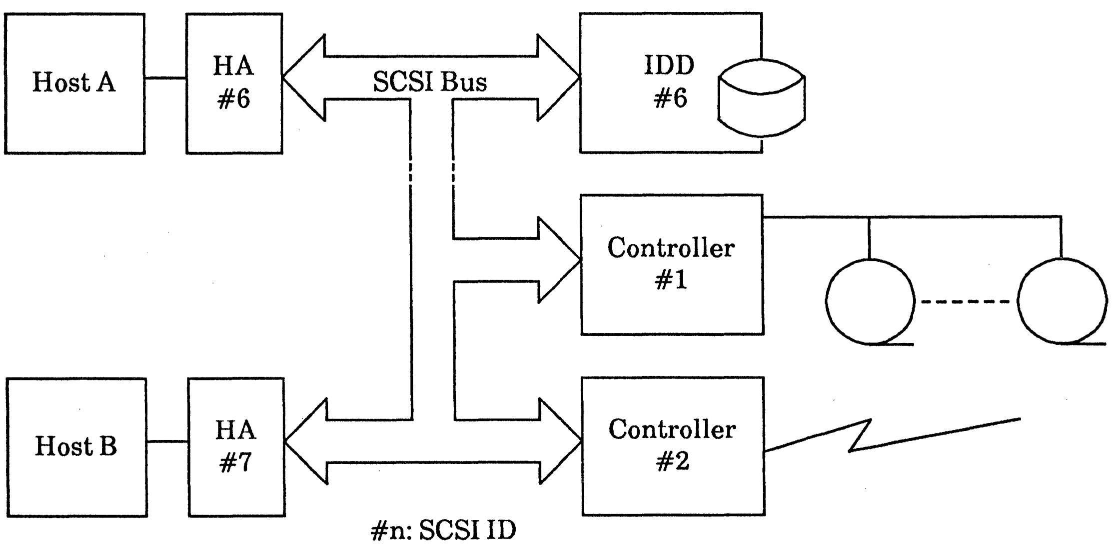


Figure 4.1 Example of SCSI configuration

4.3 Interface Signals

Figure 4.2 shows interface signal lines and Figure 4.3 shows the connector pin assignments.

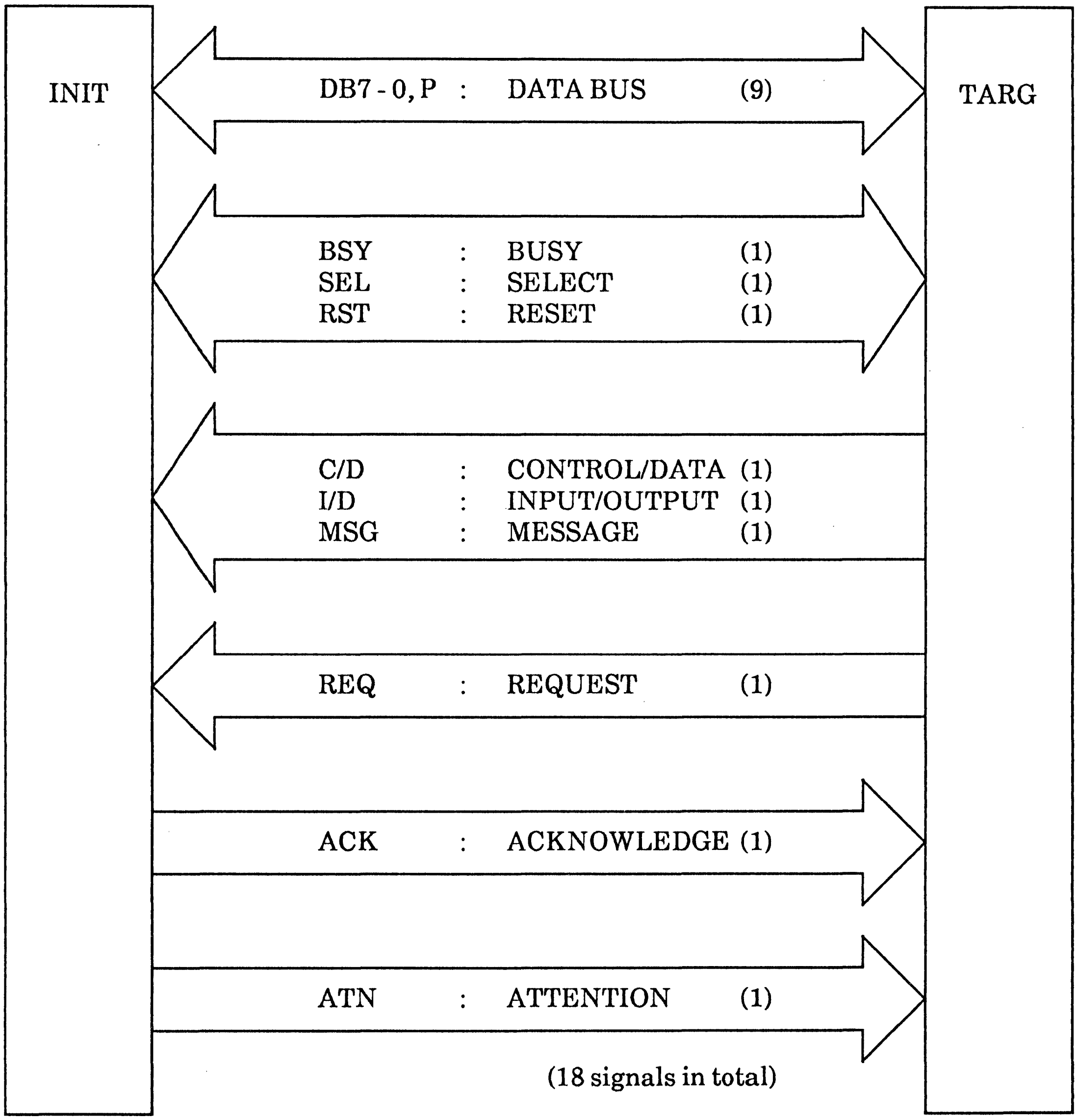


Figure 4.2 Interface signals

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

G: Ground

*: Power supply for terminator (+5 VDC)

Figure 4.3 Host interface connector signal assignments

(1) DB7 - 0, P

The bidirectional data bus consists of eight data bits and odd parity bit.

[MSB(2^7) : DB7, LSB (2^0) : DB)]

The data bus is used to transfer command, data, status, or message in the INFORMATION TRANSFER phase. SCSI IDs are sent to the data bus in the ARBITRATION phase for determining the priority of bus arbitration. In the SELECTION or RESELECTION phase, SCSI IDs of the INIT and the TARG are indicated on the data bus.

The value of data bit (n) is '1' when DB(n) signal is True, and '0' when it is False.

The use of parity bit is a system option. The IDD handles the parity as shown below:

- The IDD implements the bus parity check feature, which can be enabled or disabled by setting a jumper on the IDD PCA.
- Parity values are always guaranteed when valid data is transferred to the bus from the IDD.

(2) BSY

This signal indicates that the bus is being used. In the ARBITRATION phase, it indicates arbitration request.

(3) SEL

This signal is used by an INIT to select a TARG or by a TARG to reselect an INIT.

(4) RST

This signal indicates the RESET condition which is used to clear all SCSI devices.

(5) C/D, I/O, and MSG

These signals are always driven by a TARG to distinguish between the different INFORMATION TRANSFER phases as shown below.

C/D	I/O	MSG	DB7-0, P	Direction	Phase
0	0	0	Data	INIT → TARG	DATA OUT
0	1	0	Data	INIT ← TARG	DATA IN
1	0	0	Command	INIT → TARG	COMMAND
1	1	0	Status	INIT ← TARG	STATUS
0	0	1	—		not used
0	1	1	—		not used
1	0	1	Message	INIT → TARG	MESSAGE OUT
1	1	1	Message	INIT ← TARG	MESSAGE IN

The I/O signal is also used to distinguish between the SELECTION phase and RESELECTION phase.

(6) REQ

This signal is driven by a TARG to indicate a transfer request in the INFORMATION TRANSFER phase.

(7) ACK

This signal is driven by an INIT to indicate a response to the REQ signal in the INFORMATION TRANSFER phase.

(8) ATN

This signal is driven by an INIT to indicate the ATTENTION condition which informs a TARG that the INIT has a message to be transferred to the TARG.

(9) TERMPWR:Power supply for terminator (+5 VDC)

TERMPWR pins of the interface connector are used to supply the power to the terminator. Figure 4.4 shows the terminator circuit configuration in the IDD.

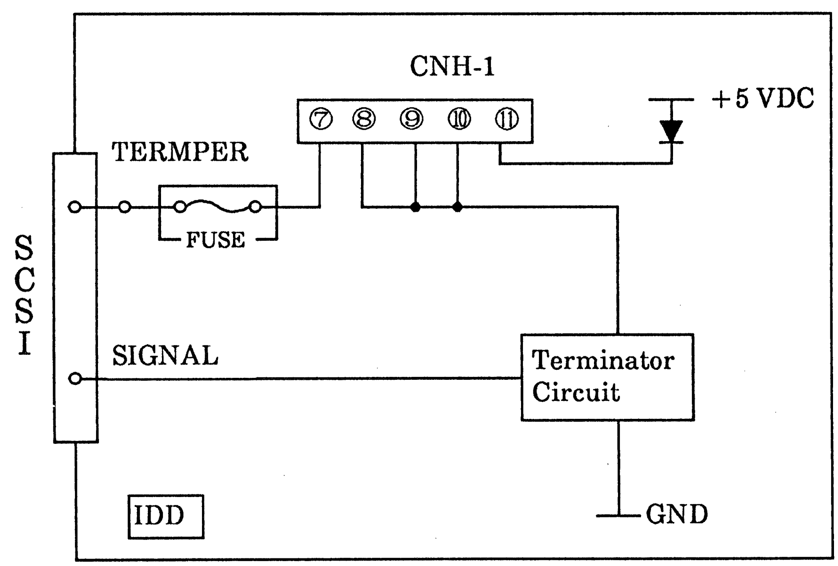


Figure 4.4 SCSI terminator circuit in IDD

4.4 Bus Phases

4.4.1 BUS FREE phase

All SCSI devices do not use the bus in the BUS FREE phase. SCSI devices shall detect BUS FREE phase after SEL and BSY signals are both false for at least 400 ns (Bus Settle Delay).

SCSI devices which have detected the BUS FREE phase shall release all bus signals within the 800 ns Bus Clear Delay after BSY and SEL become false for a Bus Settle Delay. The maximum time allowed for releasing the bus after both SEL and BSY become false is 1.2 μs.

4.4.2 ARBITRATION phase

The ARBITRATION phase allows one SCSI device to gain control of the SCSI bus so that an INIT starts the SELECTION phase or a TARG starts the RESELECTION phase.

The ARBITRATION phase is the option for the system. This must be installed to the system that uses several INITs, or that uses the RESELECTION phase.

The procedure to obtain control of the SCSI bus is as follows:

① The SCSI device shall wait for BUS FREE phase.

② The SCSI device shall wait at least 800 ns (Bus Free Delay) after the BUS FREE phase detection. Then the SCSI device that arbitrates the bus asserts the data bus bit corresponding to its own SCSI ID and BSY signal within 1.8 μs (Bus Set Delay) since the BUS FREE phase was last observed.

③ After waiting at least 2.2 μs (Arbitration Delay) since the SCSI device asserted BSY signal, the SCSI device shall examine the value on the data bus to determine the priority of the bus arbitration. The highest-priority is assigned to DB7 (ID = 7) and the lowest-priority is assigned to DB0 (ID = 0).

When the SCSI device detects any ID bit which is assigned higher priority than its own SCSI ID, the SCSI device shall release its signals then may return to step ①. The SCSI device has lost the arbitration.

The SCSI device which detects no higher SCSI ID bit on the data bus can obtain the bus control, then it shall assert SEL signal. The SCSI device has won the arbitration.

Any other SCSI device that is participating in the ARBITRATION phase shall release its signals (BSY and its SCSI ID) within 800 ns (Bus Clear Delay) after SEL signal becomes true, then may return to step ①. The SCSI device has lost the arbitration.

④ The SCSI device which wins arbitration shall wait at least 1.2 μs (Bus Clear Delay + Bus Settle Delay) after asserting SEL signal before changing any signal state.

4.4.3 SELECTION phase

The INIT selects a TARG in the SELECTION phase. In systems with the ARBITRATION phase not implemented, the INIT starts the SELECTION phase in the following sequence:

① The INIT shall wait for at least 800 ns (Bus Clear Delay) after BUS FREE phase detection. Then the INIT asserts SCSI IDs of the desired TARG and INIT itself on the data bus (*1).

② After waiting at least 90 ns (Deskew Delay ×2), the INIT asserts SEL signal.

In systems with the ARBITRATION phase implemented, the INIT starts the SELECTION phase in the following sequence:

③ The INIT shall wait for at least 1.2 μs (Bus Clear Delay + Bus Settle Delay) after turning SEL signal on. Then the INIT asserts SCSI IDs of the desired TARG and INIT itself on the data bus (*1).

④ The INIT releases BSY signal after waiting at least 90 ns (Deskew delay × 2).

⑤ The INIT shall then wait at least 400 ns (Bus Settle Delay) before looking for the response (BSY signal) from the TARG.

If an SCSI device (TARG to be selected) detects its SCSI ID bit on the data bus when the SEL signal is true and both BSY and I/O signals are false for at least 400 ns (Bus Settle Delay), the selected SCSI device shall assert BSY signal within 200 μs (Selection Abort Time) of its most recent detection of being selected in response to the INIT. The selected TARG may sample all bits on the data bus to identify the INIT's SCSI ID.

At least 90 ns (Deskew Delay × 2) after the BSY signal (asserted by the TARG) detection, the INIT shall release SEL signal.

If the INIT cannot detect the response from the TARG when the Selection Timeout Delay (or longer) has passed after starting the SELECTION phase, the timeout procedure shall be performed through one of the following schemes (*2):

① The INIT asserts the RST signal.

② The INIT maintains SEL signal true and releases the data bus (SCSI IDs). Subsequently, the INIT waits for the response from the TARG for at least 200 μs (Selection About Time) + 90 ns (Deskew Delay × 2). If no response is detected, the INIT releases the SEL signal.

*1: If a single INIT operates without the RESELECTION phase, it is allowed to assert only the TARG's SCSI ID.

*2: The recommended Selection Timeout Delay is 250 ms.

4.4.4 RESELECTION phase

A TARG which has disconnected an INIT can reconnect the INIT during the RESELECTION phase. A TARG performs the RESELECTION phase in the following sequence after obtaining control of the SCSI bus through the ARBITRATION phase:

① TARG asserts the I/O signal and the SCSI IDs of the TARG itself and INIT to the data bus when at least 1.2 μs (Bus Clear Delay + Bus Settle Delay) have passed after asserting the SEL signal.

② The TARG releases the BSY signal after waiting at least 90 ns (Deskew Delay × 2).

③ The TARG shall then wait at least 400 ns (Bus Settle Delay) before looking for the response (BSY signal) from the INIT.

If both SEL and I/O signals are true and the BSY signal is false for at least 400 ns, the SCSI device (INIT to be reselected) which detected its SCSI ID bit on the data bus shall respond by asserting the BSY signal within 200 μs (Selection Abort Time) of its most recent detection of being reselected. The reselected INIT shall examine all the bits on the data bus to identify the TARG's SCSI ID which requests reselection.

When the TARG detects a response (BSY signal) from the INIT, the TARG asserts BSY signal and waits at least 90 ns (Deskew Delay × 2), then the TARG releases SEL signal. The INIT shall release the BSY signal after making sure that the SEL signal becomes false.

If the TARG cannot detect a response from INIT when the Selection Timeout Delay (or longer) has passed after starting the RESELECTION phase, the timeout procedure shall be performed as follows (*1):

- The TARG maintains the SEL and I/O signals true and releases the data bus (SCSI IDs). Subsequently, the TARG waits for the response from INIT for at least 200 μs (Selection Abort Time) + 90 ns (Deskew Delay × 2). If no response is detected, the TARG releases the SEL and I/O signals.

*1: The IDD waits for at least 250 ms before starting the timeout procedure.

4.4.5 INFORMATION TRANSFER phase

Data, command, status, or message is transferred via the data bus in the INFORMATION TRANSFER phase. The INFORMATION TRANSFER phase type is specified by the combinations of C/D, I/O, and MSG signals.

Information transfer is controlled by one or more REQ and ACK signals.

Each REQ corresponds to one ACK (REQ/ACK handshake). One byte of information is transferred through one REQ/ACK handshake. Two REQ/ACK handshake modes are available; Asynchronous mode and Synchronous mode.

(1) INFORMATION TRANSFER phase type

The TARG must establish the C/D, I/O, and MSG signals for at least 400 ns (Bus Settle Delay) before the leading edge of the REQ signal which requests transfer of the first byte, and must retain the state of these control signals to the trailing edge of the ACK signal, which corresponds to the last byte.

(2) Asynchronous mode

Information is transferred by the interlocked REQ and ACK signals. Operation in this mode is available for DATA, COMMAND, STATUS, and MESSAGE phases.

Figure 4.5 shows timing requirements for interlocked REQ/ACK handshake at the IDD SCSI connector.

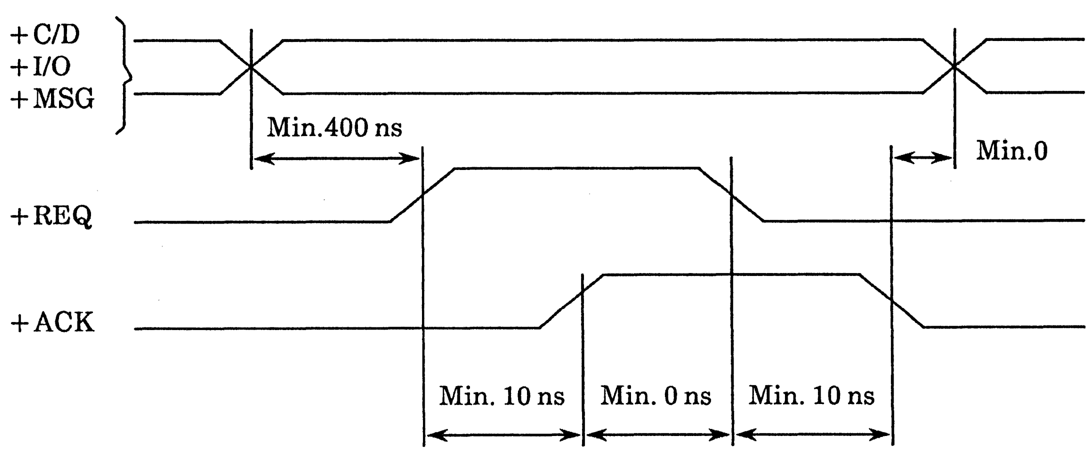
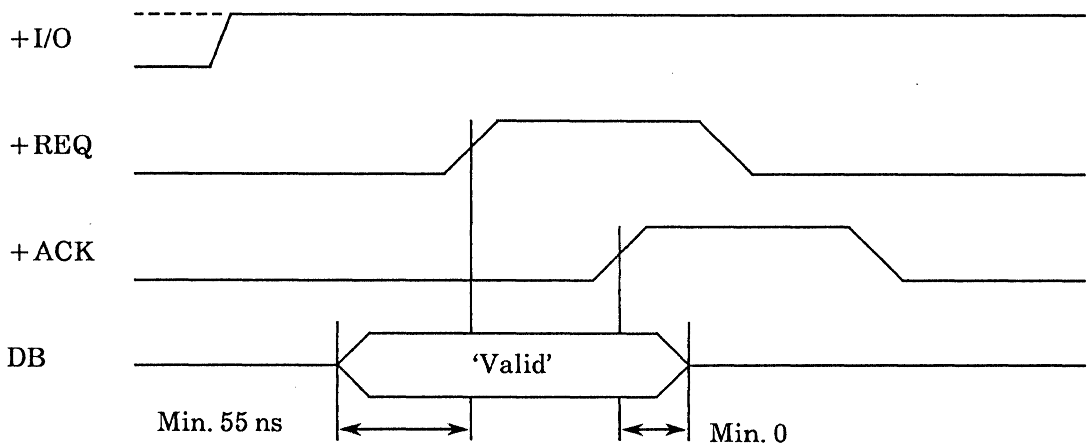


Figure 4.5 Transfer in asynchronous mode (REQ, ACK)

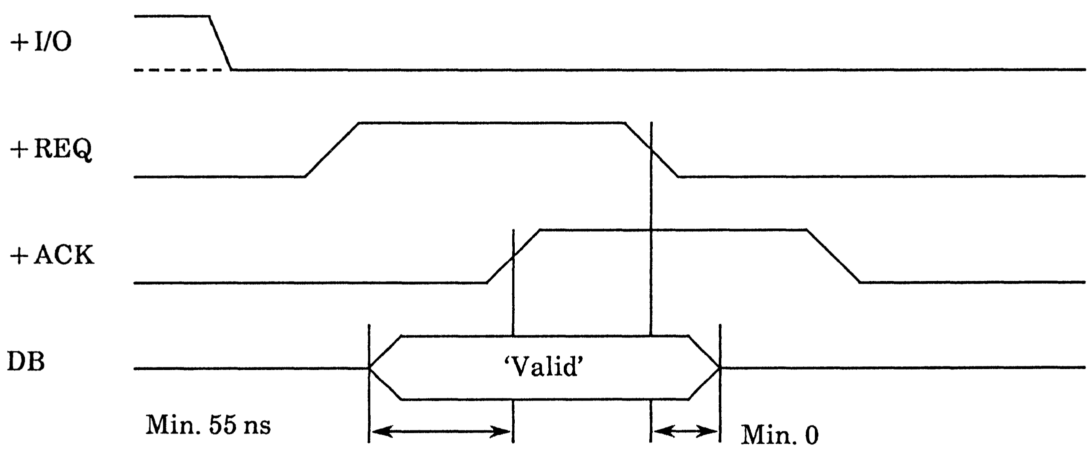
When the I/O signal is true, the TARG must retain the value on the data bus at the TARG's interface connector during the period shown in Figure 4.6.



(Deskew Delay + Cable Skew Delay)

Figure 4.6 Transfer in asynchronous mode (TARG → INIT)

When the I/O signal is false, the INIT must retain the value on the data bus at the INIT's interface connector during the period shown in Figure 4.7.



(Deskew Delay + Cable Skew Delay)

Figure 4.7 Transfer in asynchronous mode (INIT → TARG)

(3) Synchronous mode

Information is transferred through offset interlock of REQ/ACK handshake. Operation in this mode is only available for the DATA phase.

Prior to using this mode, synchronous mode parameters shall be agreed by the INIT and the TARG. Parameter definition is established by exchanging a SYNCHRONOUS DATA TRANSFER REQUEST message between the INIT and the TARG. The following parameters shall be defined:

- REQ/ACK Offset: Maximum number of REQ signals which can be sent by the TARG prior to receiving the ACK signal
- Transfer Period: Minimum interval of REQ and ACK pulses

The TARG can send as many REQ signals as defined by the "REQ/ACK offset" value prior to receiving the ACK signal. The INIT must respond with the ACK signal as an acknowledgement corresponding to the received REQ signal. To guarantee data transfer validity, the TARG must check that the number of REQ pulses is equal to that of ACK pulses.

Figure 4.8 shows timing requirements for REQ and ACK signals during the synchronous mode transfer.

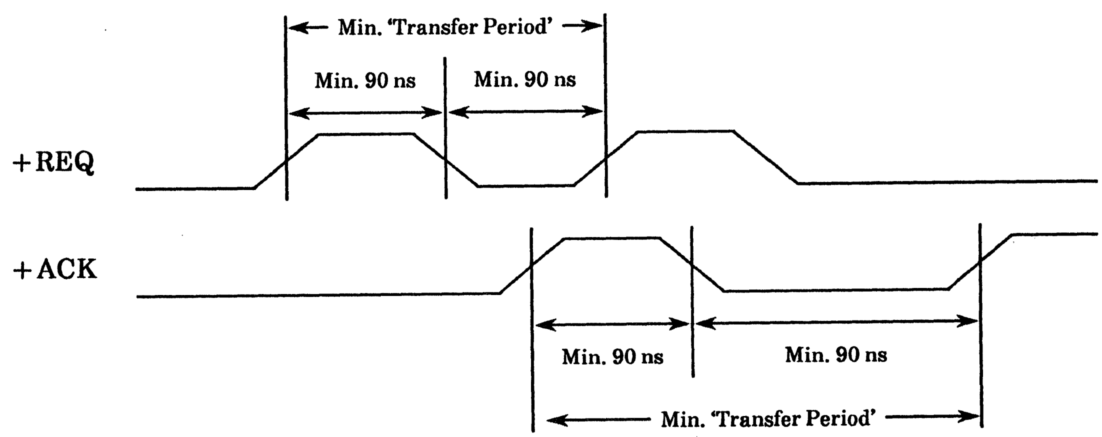


Figure 4.8 Transfer in synchronous mode (REQ, ACK)

If the I/O signal is true, the TARG must retain the value on the data bus at the TARG's interface connector during the period shown in Figure 4.9.

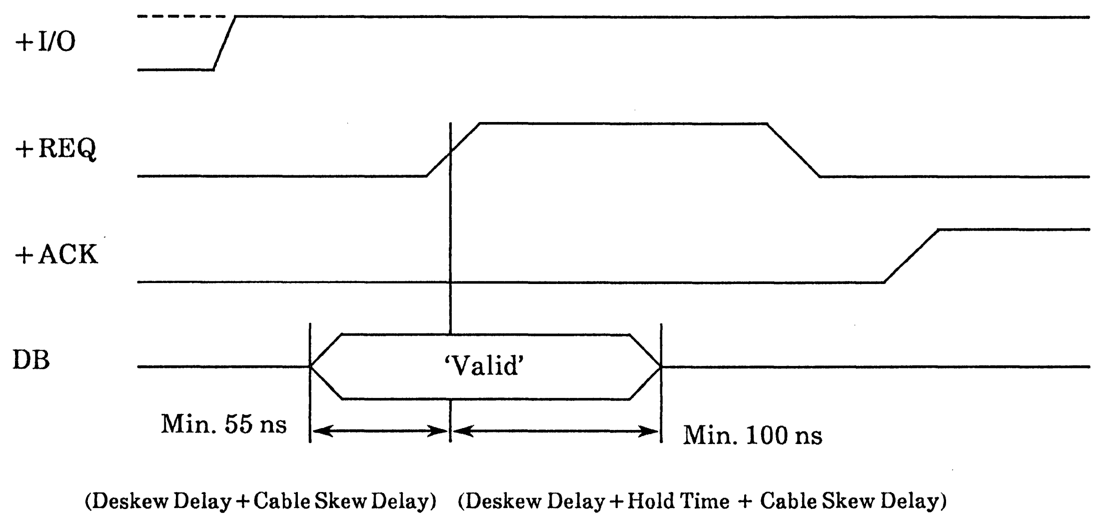


Figure 4.9 Transfer in synchronous mode (TARG → INIT)

If the I/O signal is false, the INIT must retain the value on the data bus at the INIT's interface connector during the period shown in Figure 4.10.

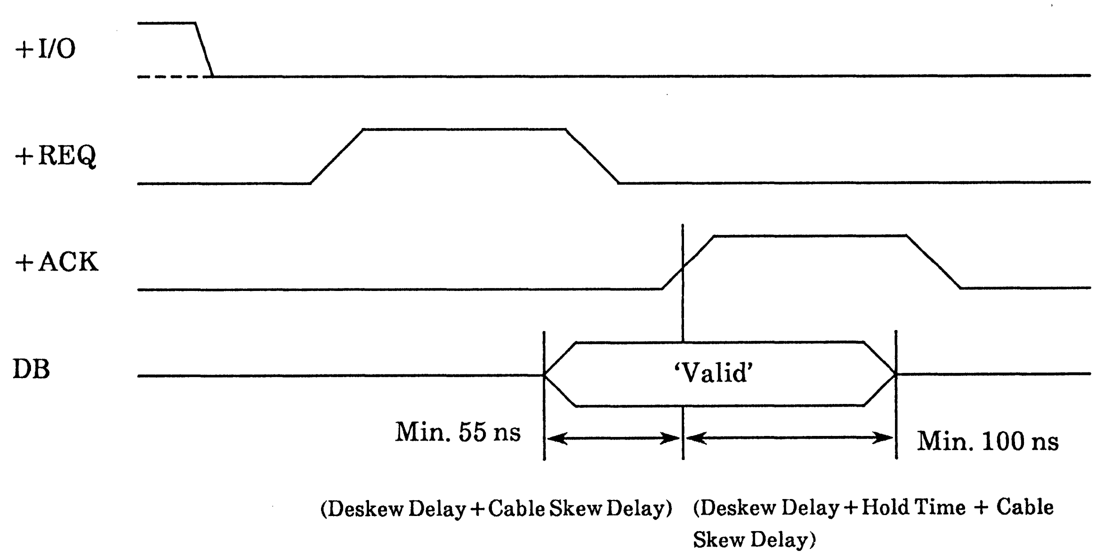


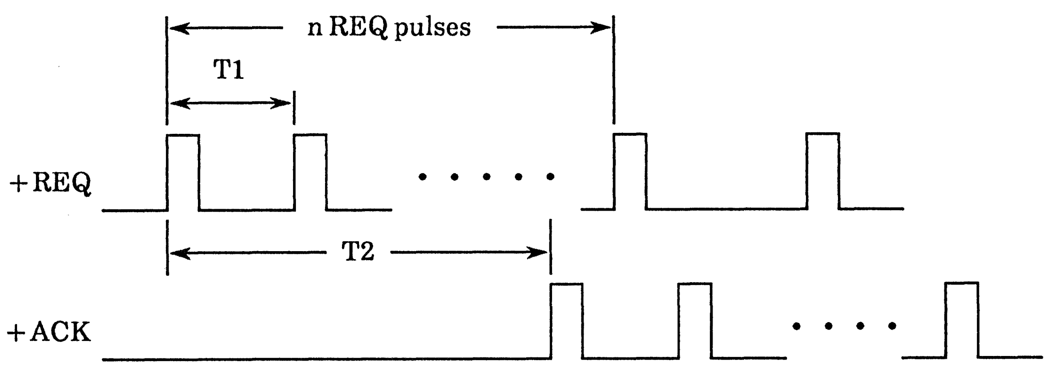
Figure 4.10 Transfer in synchronous mode (INIT → TARG)

Table 4.1 lists parameters used for data transfer in the synchronous mode which can be executed by the IDD. SYNCHRONOUS DATA TRANSFER REQUEST messages are exchanged to determine which parameter values are actually used. See Chapter 5 for a detailed description of message exchange.

Table 4.1 Parameters used for synchronous mode data transfer

Parameter	Value
REQ/ACK Offset	1 to 8
Transfer Period (Minimum ACK interval can be received by IDD)	Min 400 ns
Transfer Period (Minimum REQ interval sent from IDD)	400 ns, 600 ns, 800 ns, or 1,000 ns

Data transfer rate with the synchronous transfer mode depends on REQ/ACK Offset, Transfer Period, and response time of ACK pulse from the INIT. The following conditions shall be considered to estimate the average transfer rate can be achieved between the IDD and INIT:



n: REQ/ACK Offset value
T1: Transfer Period for REQ pulses; 400, 600, 800, or 1000 (ns)
T2: Average time between REQ pulse and the corresponding ACK pulse responded from the INIT, at the IDD's interface connector.

① If $(n \times T1) \geqq (T2 + 820)$,

Transfer rate on SCSI $\doteq$ 1000/T1 (MB/s)

② If $(n \times T1) < (T2 + 820)$,
Transfer rate on SCSI = $(n \times 1000)/(T2 + 820)$ (MB/s)

The value of 2 or more for REQ/ACK Offset may be required to achieve higher transfer rate than 1.5 MB/s with the asynchronous mode transfer.

Refer to Chapter 5 when synchronous mode transfer is inhibited by setting jumper (refer to Subsection 3.5.1).

(4) Time supervision

When the IDD is operating as a TARG, the IDD performs time supervision for approximately 30 seconds to wait for ACK signal in response to REQ signal. If timeout is detected, the IDD forces the SCSI bus to go into the BUS FREE phase. The command being executed at the time.

4.5 Bus Conditions

4.5.1 ATTENTION condition

The ATTENTION condition allows an INIT to inform a TARG that the INIT has message(s) to be sent to the TARG. By sending the ATN signal, the INIT can create the ATTENTION condition any time except during the ARBITRATION or BUS FREE phase.

The TARG may initiate the MESSAGE OUT phase at its convenience in response to the ATTENTION condition so that it may receive messages from the INIT.

The INIT turns the ATN signal off after receiving a REQ signal which corresponds to the last byte of the message to be sent before sending the ACK signal.

If a parity error is detected in the received message, the TARG will retry the MESSAGE OUT phase using the following sequence:

① The TARG asserts the REQ signal upon detecting that the ATN signal has gone false; the bus phase is not changed.

② The INIT will resend all of the previous message bytes which have been transferred during this MESSAGE OUT phase. The ATN signal will be asserted before sending the first ACK signal if two or more message bytes are to be sent.

If all message bytes are normally received by the TARG, the TARG changes the bus phase to any INFORMATION TRANSFER phase other than the MESSAGE OUT phase and transfers at least one byte except that the TARG goes to the BUS FREE phase after receiving the message.

4.5.2 RESET condition

All SCSI devices are reset immediately and the SCSI bus goes to the BUS FREE phase through the RESET condition. Any SCSI device may create the RESET condition at any time by asserting the RST signal. However, the IDD does not create this condition.

The RST signal must be asserted for at least 25 μs (Reset Hold Time).

All SCSI devices must release all bus signals other than RST signal within 800 ns (Bus Clear Delay) after the RST signal becomes true.

The following operations which are being executed or preserved are affected by the RESET condition in the IDD ('Hard' Reset):

① All uncompleted commands are cleared.

② The reserve status (if any) is released.

③ The sense data pending state is cleared and all preserved sense data is lost.

④ Synchronous data transfer parameters which have been established between the IDD and SCSI device(s) are reset so that the data transfer mode for all SCSI devices is initialized in the asynchronous mode.

⑤ Pending statuses are cleared and UNIT ATTENTION condition is created if the IDD is in the ready state.

⑥ MODE SELECT parameters which have been established are cleared, then the IDD sets the default values for all parameters.

4.6 Bus Phase Sequences

Figure 4.11 shows the allowable bus phase sequence applied to systems without the ARBITRATION phase and systems with the ARBITRATION phase. Figure 4.12 provides an example of the bus phase sequence during a single command execution.

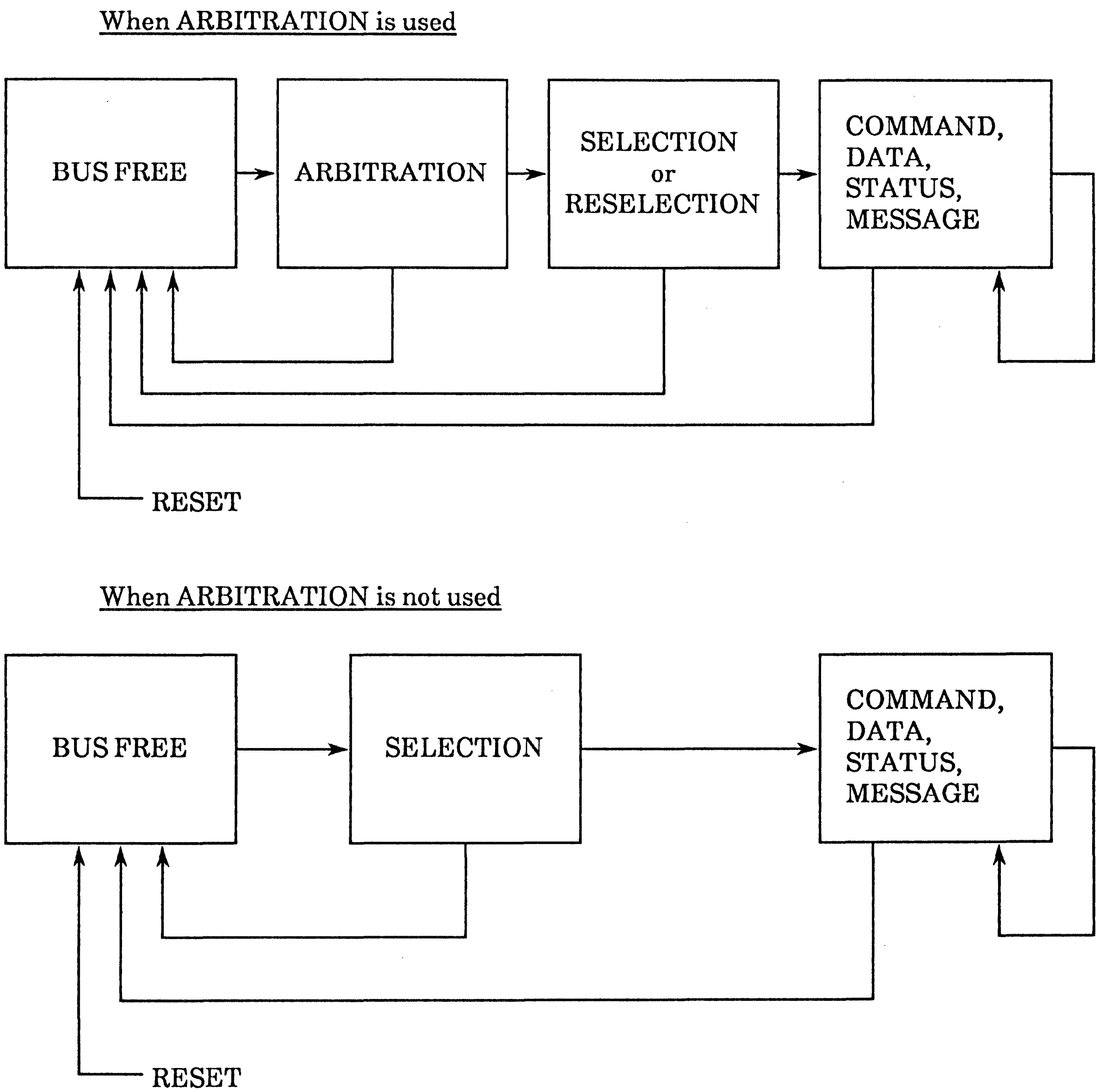


Figure 4.11 Bus phase sequences

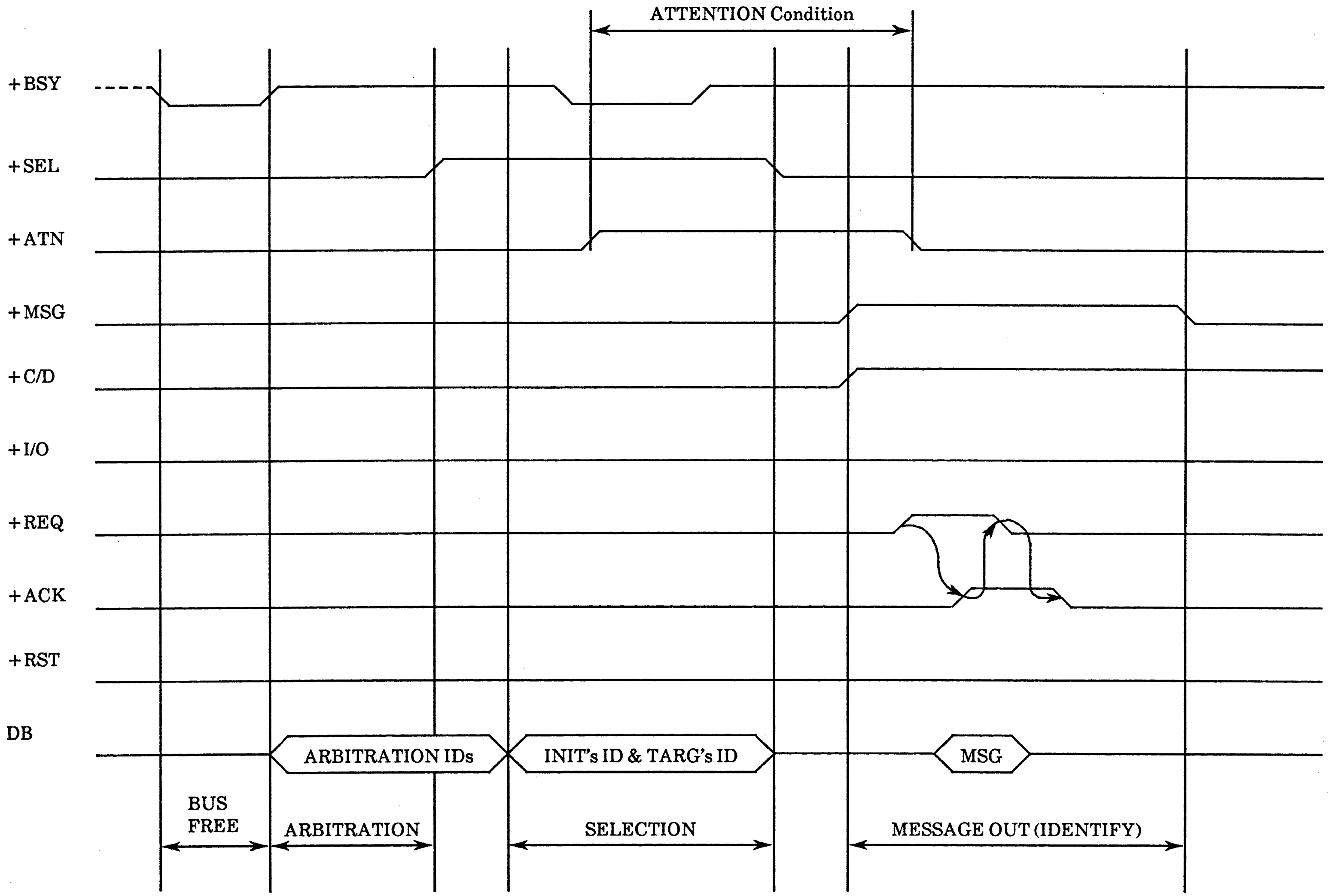


Figure 4.12 BUS phase sequence example (1/5)

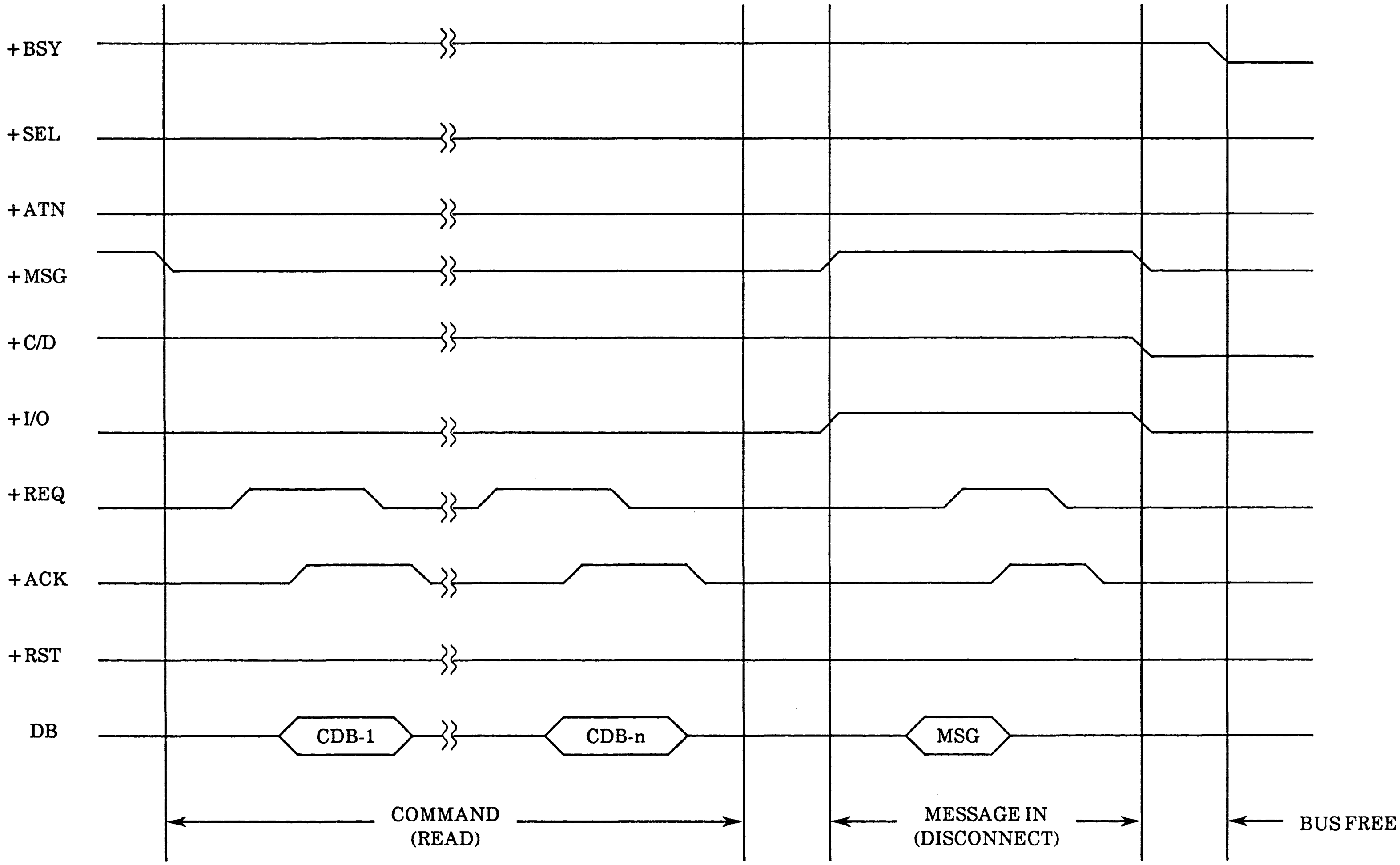


Figure 4.12 BUS phase sequence example (2/5)

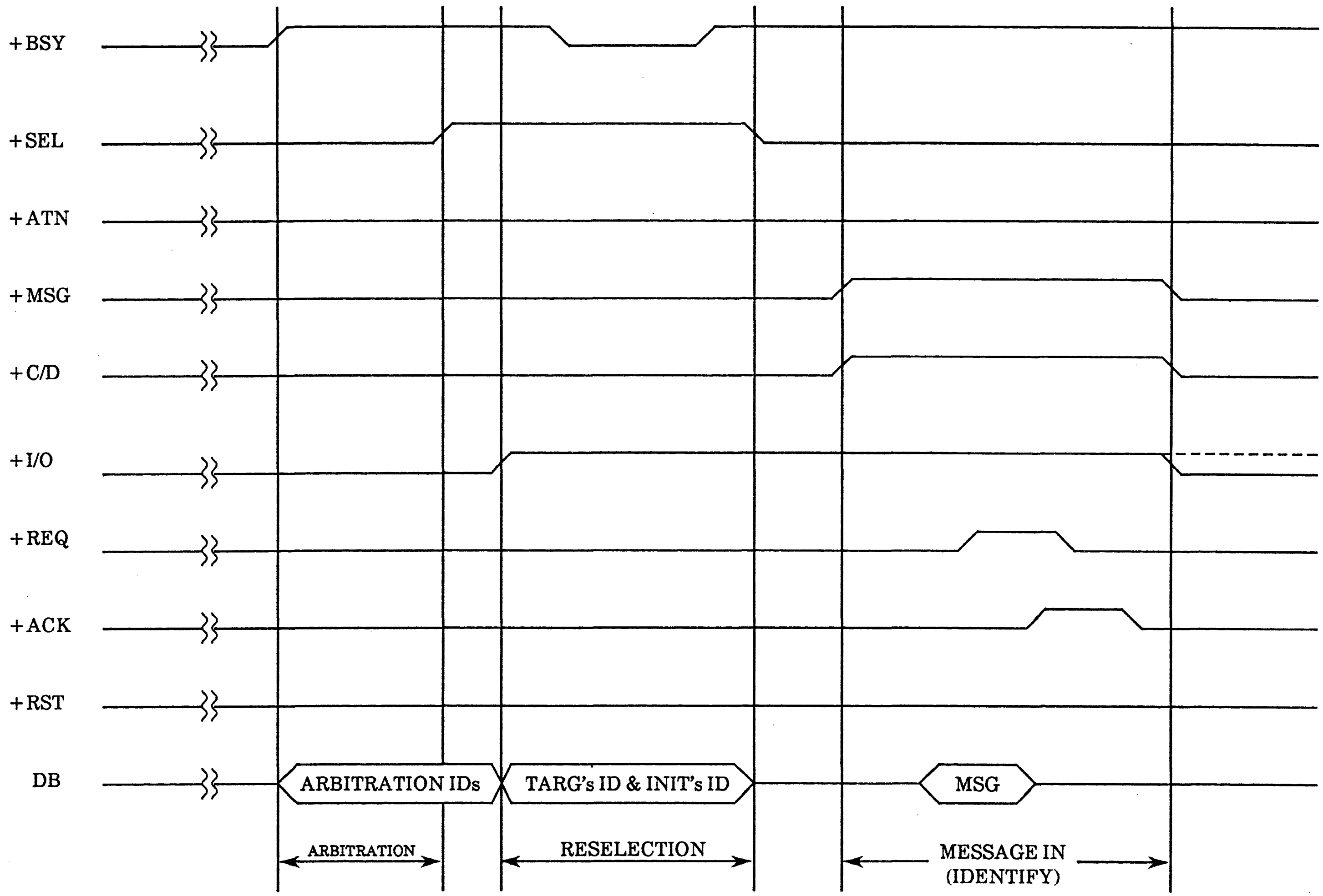


Figure 4.12 BUS phase sequence example (3/5)

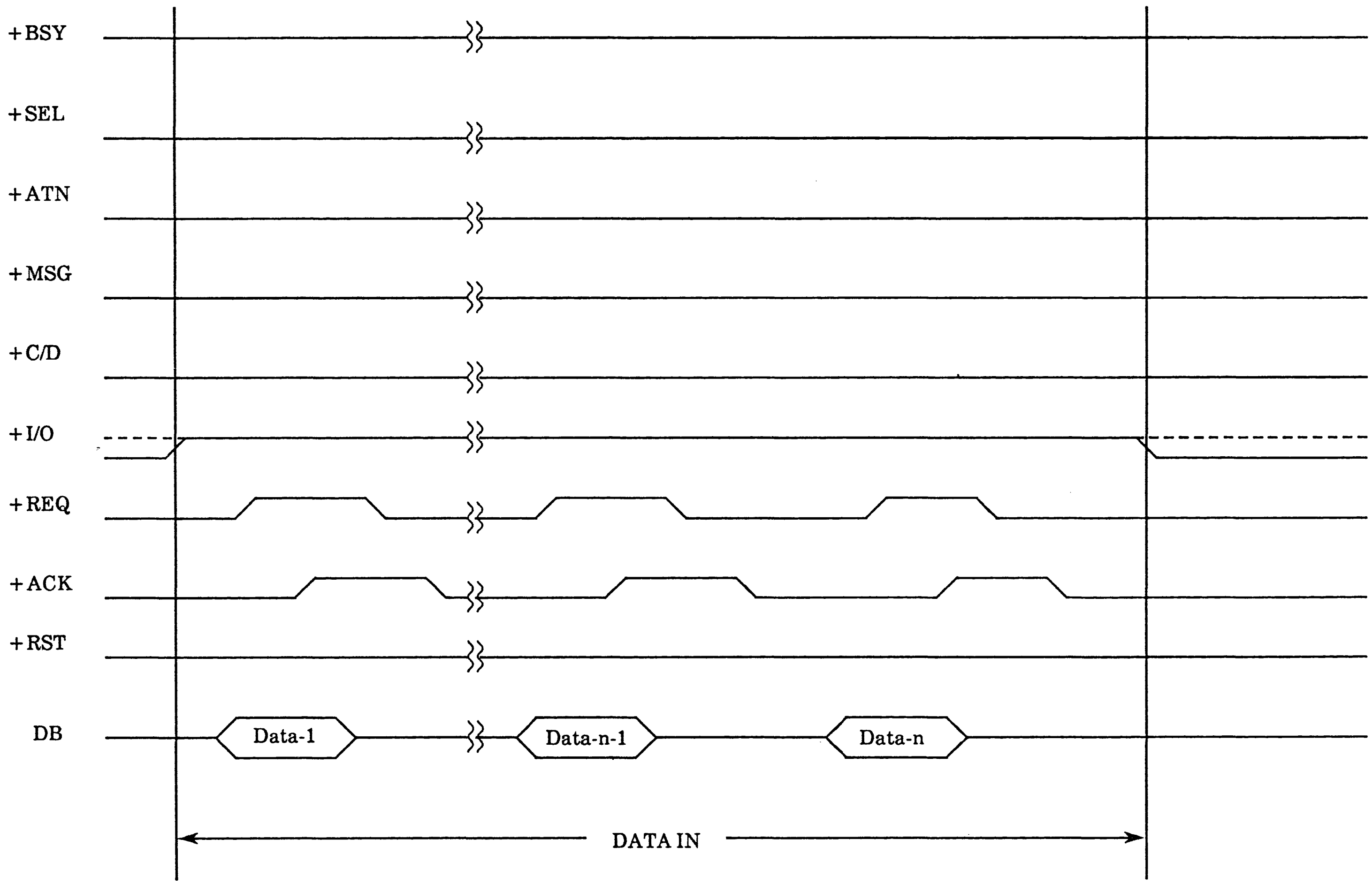


Figure 4.12 BUS phase sequence example (4/5)

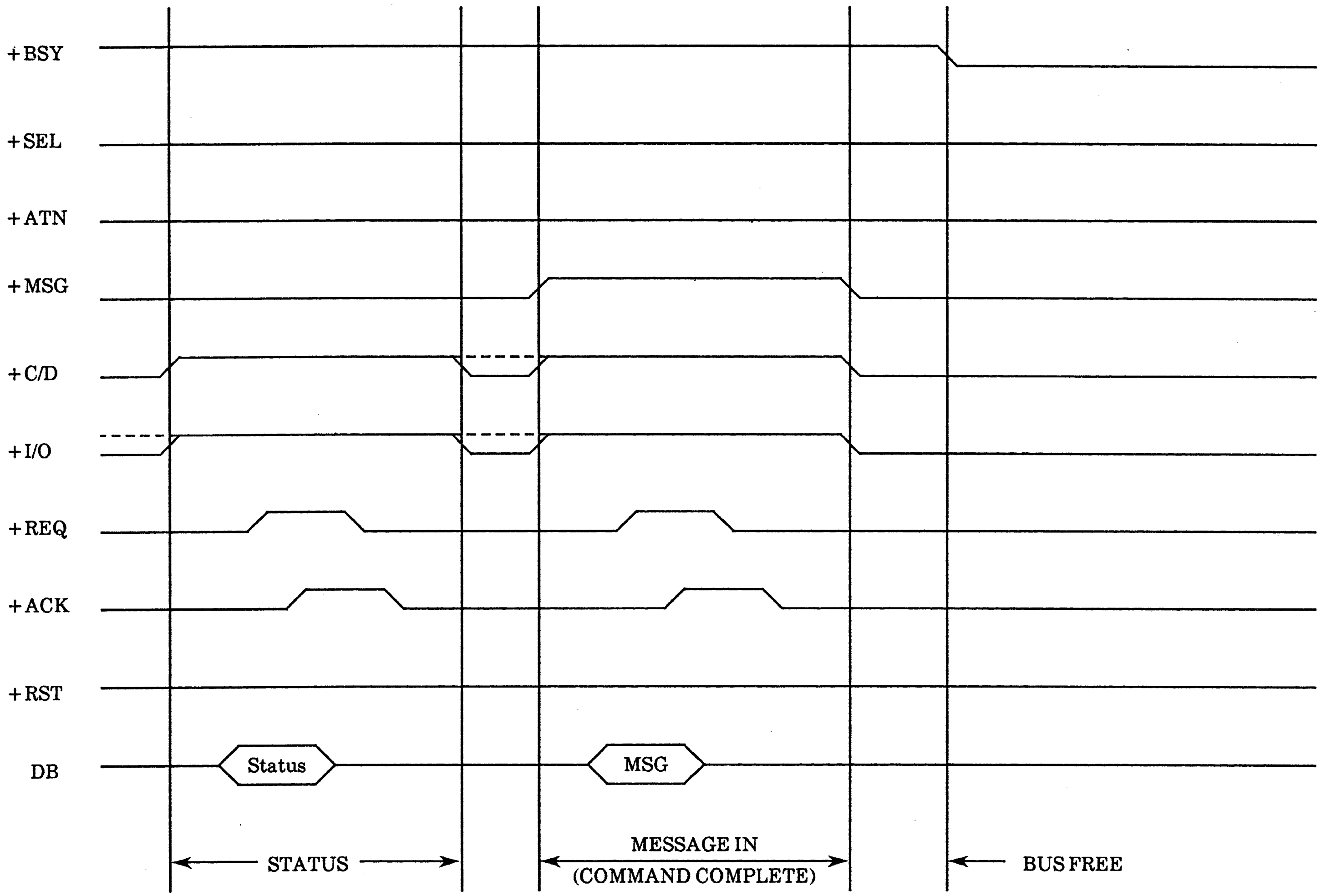


Figure 4.12 BUS phase sequence example (5/5)

4.7 Electrical Requirements

4.7.1 Electrical characteristics

Table 4.2 lists signal sources for each interface phase. Table 4.3 shows the signal values and electrical levels.

Table 4.2 Bus phases and signal sources

Bus Phase \ Signal	BSY	SEL	C/D, I/O MSG, REQ	ACK, ATN	DB7~0, P	RST
BUS FREE	N	N	N	N	N	A
ARBITRATION	A	W	N	N	ID	A
SELECTION	I & T	I	N	I	I	A
RESELECTION	I & T	T	T	I	T	A
COMMAND	T	N	T	I	I	A
DATA IN	T	N	T	I	T	A
DATA OUT	T	N	T	I	I	A
STATUS	T	N	T	I	T	A
MESSAGE IN	T	N	T	I	T	A
MESSAGE OUT	T	N	T	I	I	A

N: Not driven by any SCSI device. The terminator pulls the signal to the false state.

A: Any SCSI device can drive the signal. Two or more SCSI devices may drive the signal at the same time.

W: Only the SCSI device which wins arbitration can drive the signal.

ID: Each SCSI device which is arbitrating the bus drives a unique data bit (SCSI ID).

I: Only the SCSI device which operates as an INIT can drive the signal.

T: Only the SCSI device which operates as a TARG can drive the signal.

I & T: INIT, TARG or both can drive this signal according to the interface sequence.

Table 4.3 Signal values and electrical levels

Signal value	Electrical level
TRUE, asserted, on, or '1'	Low (0.0 to 0.8 VDC)
FALSE, negated, released, off, or '0'	High (2.0 to 5.25 VDC)

4.7.2 Driver and receiver circuits

(1) Driver circuit for signals other than REQ and ACK

The MB463 (Fujitsu) or open collector NAND gate equivalent to SN7438 (TI) is recommended.

(2) Receiver circuit for signals other than REQ and ACK

A schmitt trigger receiver circuit equivalent to SN74LS240 (TI) is recommended.

(3) Driver circuit for REQ and ACK signals

For the REQ and ACK signals, a glitch on the interface line must not occur. MB412 (Fujitsu) or a driver circuit equivalent to Am26LS31 is recommended for use with the receiver circuit described later.

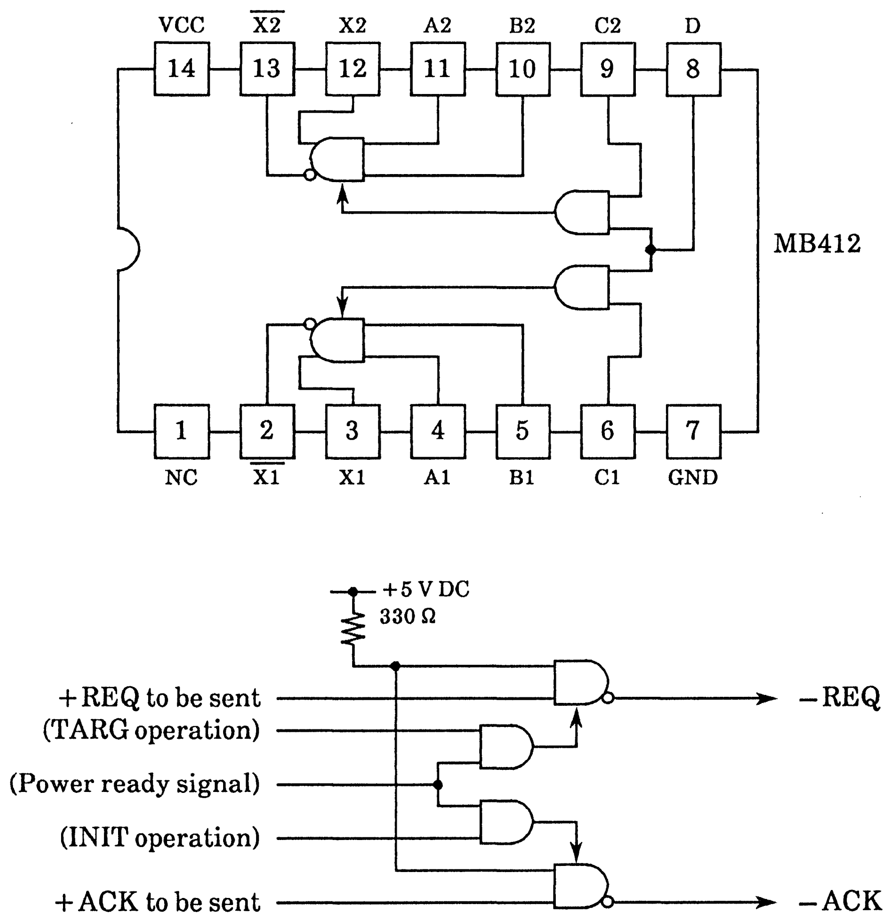
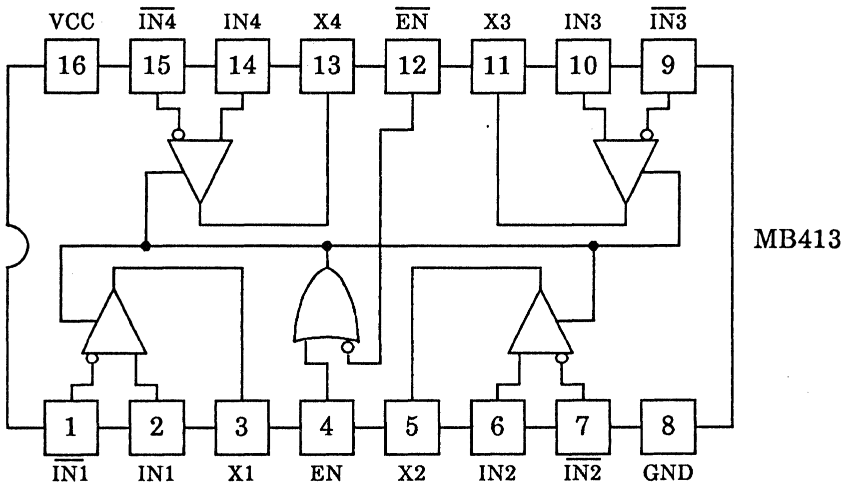


Figure 4.13 Driver circuit for REQ and ACK (recommended)

(4) Receiver circuit for REQ and ACK signals

MB413 (Fujitsu) or a receiver circuit equivalent to Am26LS32 is recommended for use with the driver circuit described above.



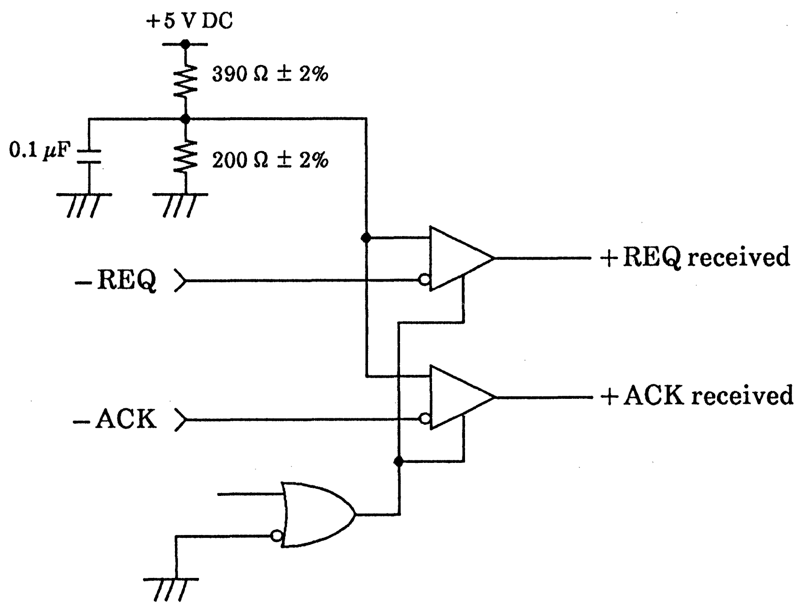


Figure 4.14 Receiver circuit for REQ and ACK (recommended)

4.7.3 Termination circuit

The termination circuits shown in Figure 4.15 are installed in SCSI devices which are connected at both ends of the interface cable.

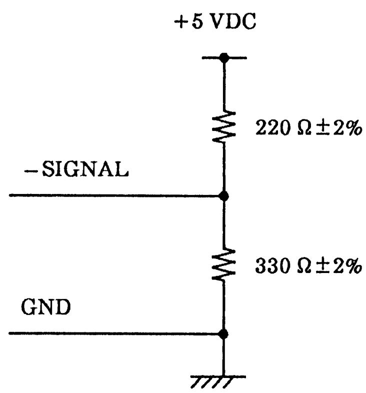


Figure 4.15 SCSI termination circuit

4.8 Physical Requirements

4.8.1 Connector requirements

The nonshielded SCSI connector installed on the IDD is a 50-conductor connector which consists of two rows of 25 male pins with adjacent pins 2.54 mm (0.1 in) apart.

The nonshielded cable connector used should be a 50-conductor connector consisting of two rows of 25 female contacts with adjacent contacts 2.54 mm (0.1 in) apart.

4.8.2 Cable requirements

A characteristic impedance of 100 Ω ± 10% is recommended for the unshielded twisted-pair ribbon cable. Characteristic impedance greater than 90 Ω is preferred for the shielded cable. A minimum conductor size of 28 AWG shall be employed. It is recommended that the shielded cable be used for connection outside the system cabinet.

To minimize discontinuities and signal reflections, cables of different impedance should not be used on the same bus. The maximum cable length is 7 m. A cable length of 1 m or more is recommended between SCSI devices.

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CHAPTER 5 MESSAGES

5.1 Message System

The message system allows communication between SCSI devices. Messages are transferred via the SCSI data bus in the MESSAGE OUT and MESSAGE IN phases.

5.1.1 Message type

Byte 1 of each message contains the message code. Message code X'01' indicates the beginning of a multiple-byte extended message. Messages with other message codes are single-byte messages. Figure 5.1 shows the extended message format. Tables 5.1 and 5.2 list the message which are implemented in the IDD.

Byte	Content	
Byte-00	X'01'	
01	nn: Message Length	
02	Extended Message Code	nn bytes
03 ~ nn+1	(Arguments)	nn bytes

Figure 5.1 Extended message format

Table 5.1 Single byte messages

Code	Message	Transfer direction
00	COMMAND COMPLETE	TARG → INIT
02	SAVE DATA POINTER	TARG → INIT
03	RESTORE POINTERS	TARG → INIT
04	DISCONNECT	TARG → INIT
05	INITIATOR DETECTED ERROR	TARG ← INIT
06	ABORT	TARG ← INIT
07	MESSAGE REJECT	TARG ↔ INIT
08	NO OPERATION	TARG ← INIT
09	MESSAGE PARITY ERROR	TARG ← INIT
0A	LINKED COMMAND COMPLETE	TARG → INIT
0B	LINKED COMMAND COMPLETE WITH FLAG	TARG → INIT
0C	BUS DEVICE RESET	TARG ← INIT
80 | FF	IDENTIFY	TARG ↔ INIT

Table 5.2 Extended messages

Extended message code	Message	Length in bytes	Transfer direction
01	SYNCHRONOUS DATA TRANSFER REQUEST	5	TARG ↔ INIT

5.1.2 Pointers

The following pointers are required to manage command execution on the SCSI:

- Command pointer
- Data pointer
- Status pointer

The pointers reside in the SCSI device which operates as an INIT. There are two sets of pointers, active and saved.

The active pointers are used to control a command which is currently being executed on the SCSI. Each time a byte of command, data, or status is transferred in the INFORMATION TRANSFER phase, the corresponding active pointer is incremented.

The saved pointers are required to provide the following capability:

- Concurrent operation on two or more TARGs or multiple peripheral devices under SCSI control

- Retry on SCSI for command execution error recovery

If the INIT allows disconnection, the INIT must provide two or more sets of saved pointers. The INIT must set the active and saved pointers to the same value at the beginning of each command.

The TARG can control saving and restoring pointers using the message system.

5.2 Message Explanation

Symbols:

(I → T): Message is sent from an INIT to a TARG.
(T → I): Message is sent from a TARG to an INIT.
(I ↔ T): Message is sent from an INIT to a TARG or from a TARG to an INIT.

(1) COMMAND COMPLETE message : X'00' (T → I)

This message indicates that the execution of a single command or a series of linked commands has terminated and valid status has been sent to the INIT. The TARG shall go into the BUS FREE phase after this message is sent successfully.

(2) SAVE DATA POINTER message : X'02' (T → I)

This message directs the INIT to save the active data pointer. In response to this message, the INIT stores the value of the active data pointer into the saved data pointer for the currently attached LUN.

(3) RESTORE POINTERS message : X'03' (T → I)

This message directs the INIT to restore the most recently saved pointers to the active pointers (command pointer, data pointer, and status pointer). The INIT retrieves the saved pointers for the currently attached LUN and makes them active.

(4) DISCONNECT message : X'04' (T → I)

This message informs the INIT that the current operation is temporarily disconnected from the SCSI. After sending this message successfully, the TARG goes into the BUS FREE phase. The TARG continues command processing within the TARG and reselects the INIT to complete the command execution when the reconnection is needed. The INIT does not save the active pointers through this message.

(5) INITIATOR DETECTED ERROR message: X'05' (I → T)

This message informs the TARG that the INIT has detected an error that does not preclude the TARG from retrying the operation. The validity of active pointer values is not assured. If the TARG retries the operation after receiving this message, the TARG should restore the pointers by sending a RESTORE POINTERS message or by disconnection followed by reconnection.

(6) ABORT message : X'06' (I → T)

This message directs the TARG to perform the following:

- If an LUN has been identified, the TARG clears the I/O operation issued by the INIT and pending status for the INIT associated with the specified device (LUN). Then, the TARG enters the BUS FREE phase.

Only one I/O operation associated with the INIT is cleared. This message does not affect I/O operations and pending statuses for other INITs. If a LUN has not been identified prior to this message, the TARG enters the BUS FREE phase without any other operation.

(7) MESSAGE REJECT message : X'07' (I ↔ T)

This message indicates that the message which is received immediately before is inappropriate or has not been implemented.

To identify the rejected message, the MESSAGE REJECT message shall be transferred in the following sequence:

- If INIT sends this message, assert the ATN signal before negating the ACK signal for the last byte of received message.
- If TARG sends this message, change to the MESSAGE IN phase immediately after the ACK signal is negated during the MESSAGE OUT phase.

(8) NO OPERATION message : X'08' (I → T)

This message does not result in any operation. The INIT sends this message in response to the message request from the TARG when the INIT does not currently have any other valid message to send.

(9) MESSAGE PARITY ERROR message : X'09' (I → T)

This message indicates that the message received by the INIT contains the byte in which a parity error was detected. To identify the message in which an error was detected, the INIT shall assert the ATN signal before negating the last ACK signal which corresponds to the message containing the parity error.

(10) LINKED COMMAND COMPLETE message : X'0A' (T → I)

This message indicates that the execution of a command which specifies a link bit one (flag bit = '0') has been completed and that valid status information has been sent to the INIT. After receiving this message, the INIT updates the pointers to the initial value for the next linked command.

(11) LINKED COMMAND COMPLETE WITH FLAG message : X'0B' (T → I)

This message indicates that the execution of a command which specifies a link bit one (flag bit = '1') has been completed and that valid status information has been sent to the INIT. After receiving this message, the INIT updates the pointers to the initial value for the next linked command.

(12) BUS DEVICE RESET message : X'0C' (I → T)

This message directs the TARG to clear all I/O operations and all pending statuses. The TARG which receives this message clears not only I/O operations issued by the connected INIT, but also I/O operations issued by any INITs, then the TARG goes to the BUS FREE phase.

In the IDD, the reset function due to receiving this message is the same as the reset operation caused by a RESET condition. See Subsection 4.5.2 for details.

(13) IDENTIFY message : X'80' to X'FF' (I ↔ T)

This message specifies the logical unit number (LUN) under the TARG to establish the path connection.

- Bit 6: D

  This bit can only be specified by the INIT. When this bit is set to 1, it indicates that the INIT has the ability to accommodate disconnection/reconnection function.

- Bits 5 to 3: These bits shall be set to zeros.

- Bits 2 to 0: LUN

  The logical unit number is specified in these bits. In the IDD, the LUN shall be set to zero (0).

Normally, the IDENTIFY message is sent from the INIT as the first message after the SELECTION phase to identify the LUN of the unit to be accessed.

Also, the TARG sends this message after the RESELECTION phase to notify the INIT of the LUN to be reconnected. After this message is received by the INIT, the data command, and status pointers for the specified LUN are restored to the active state.

(14) SYNCHRONOUS DATA TRANSFER REQUEST message (I ↔ T)

BYTE	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	1
1	0	0	0	0	0	0	1	1
2	0	0	0	0	0	0	0	1
3	mm: Transfer Period (4 × mm (ns))							
4	xx: REQ/ACK Offset							

The following parameters used for data transfer in synchronous mode are defined between the SCSI devices by exchanging this message:

- Transfer Period: Minimum time between leading edges of successive REQ pulses and of successive ACK pulses

- REQ/ACK Offset: Maximum offset value between the REQ and ACK pulses.

  TARG can send up to xx REQ pulses before its corresponding ACK pulses are received, where: xx = X'00' → Asynchronous transfer mode
  xx = X'FF' → Offset value is unlimited.

To transfer data in the synchronous mode, the SCSI devices shall define parameters used for the synchronous mode transfer after power on, 'Hard' Reset condition, or BUS DEVICE RESET message. The message exchange described below is performed to establish the transfer mode.

If the INIT recognizes that a SYNCHRONOUS DATA TRANSFER REQUEST message must be sent, it creates an ATTENTION condition and requests that the TARG to receive the message. The INIT specifies the REQ/ACK Offset value which does not cause its buffer overflow and the Transfer Period value which is required for data handing within the INIT.

If the message is received by the TARG, the TARG interprets the values requested by the INIT and returns a SYNCHRONOUS DATA TRANSFER REQUEST or a MESSAGE REJECT message. The SYNCHRONOUS DATA TRANSFER REQUEST message can be returned with REQ/ACK Offset and Transfer Period values, which can be handled by the TARG itself and are not exceed the value requested by the INIT.

Table 5.3 indicates how the IDD responds to the message from an INIT and which transfer mode is to be determined when the IDD operates as a TARG.

If the TARG recognizes the negotiation for the synchronous transfer, it sends a SYNCHRONOUS DATA TRANSFER REQUEST message to the INIT. The TARG can specify the REQ/ACK Offset value which does not cause its buffer overflow and the Transfer Period value which meets the data handling requirements of the TARG.

The INIT shall interpret the values requested by the TARG and shall return a SYNCHRONOUS DATA TRANSFER REQUEST or a MESSAGE REJECT message. The SYNCHRONOUS DATA TRANSFER REQUEST message can be returned with REQ/ACK Offset and Transfer Period values which can be handled by the INIT itself and are not exceed the value requested by the TARG.

Table 5.4 summarizes the message exchange ways initiated by the IDD and transfer mode to be determined when the IDD operates as a TARG. If the INIT does not respond the message listed in Table 5.4, the IDD assumes that the synchronous mode transfer has not been established and transfers data in the asynchronous mode.

The data transfer mode established by above-mentioned message exchange must remain in effect on both SCSI devices until one of the following occurs:

- Transfer mode between identical SCSI devices is modified.
- A BUS DEVICE RESET message is received.
- 'Hard' Reset condition

The default data transfer mode is asynchronous. After power on, a BUS DEVICE RESET message or a 'Hard' Reset condition, the transfer mode remains in asynchronous mode unless message exchange resulting from SYNCHRONOUS DATA TRANSFER REQUEST message is performed.

If the IDD preserves the default asynchronous transfer mode for any INIT, the IDD tries to establish the synchronous transfer mode by using the message exchange way shown in Table 5.4 when the IDD is selected first from each INIT.

Note:

> Data transfer rate on a SCSI with the synchronous mode transfer depends on REQ/ACK Offset, Transfer Period, and response time of ACK pulse from the INIT. To estimate the transfer rate, refer to Subsection 4.4.5.

Table 5.3 Message exchange for synchronous transfer initiated by INIT (IDD = TARG)

Value requested by INIT	Response from IDD (TARG)	Transfer mode to be defined
REQ/ACK Offset ≧ 9	REQ/ACK Offset = 8	Synchronous mode (Offset = 8)
1 ≦ REQ/ACK Offset ≦ 8	REQ/ACK Offset = (Value requested by INIT)	Synchronous mode (Offset = value requested by INIT)
REQ/ACK Offset = 0	REQ/ACK Offset = 0	Asynchronous mode
Transfer Period ≦ X'64' (400 ns)	Transfer Period = X'64' (400 ns)	Synchronous mode with 2.5 MB/s max. (REQ cycle ≧ 400 ns, ACK cycle ≧ 404 ns)
X'65' (404 ns) ≦ Transfer Period ≦ X'85' (532 ns)	Transfer Period = (Value requested by INIT)	Synchronous mode with 1.875 MB/s max. (REQ cycle ≧ 600 ns, ACK cycle ≧ 404 ns)
X'86' (536 ns) ≦ Transfer Period ≦ X'A6' (664 ns)	Transfer Period = (Value requested by INIT)	Synchronous mode with 1.5 MB/s max. (REQ cycle ≧ 1000 ns, ACK cycle ≧ 804 ns)
Transfer Period ≧ X'A7' (668 ns)	REQ/ACK Offset = 0	Asynchronous mode

Table 5.4 Message exchange for synchronous transfer initiated by IDD (IDD = TARG)

<table>
<tr><th>Value requested by IDD (TARG)</th><th>Response from INIT</th><th>Transfer mode to be defined</th></tr>
<tr><td rowspan="6">REQ/ACK Offset = 8
Transfer Period = X'64' (400 ns)</td><td>MESSAGE REJECT message (*)</td><td>Asynchronous mode</td></tr>
<tr><td>REQ/ACK Offset = 0 (*)</td><td>Asynchronous mode</td></tr>
<tr><td>1≦REQ/ACK Offset≦8</td><td>Synchronous mode (Offset = INIT response value)</td></tr>
<tr><td>Transfer Period = X'64' (400 ns)</td><td>Synchronous mode with 2.5 MB/s max.
(REQ cycle≧400 ns,
ACK cycle≧400 ns)</td></tr>
<tr><td>X'65' (404 ns)
≦Transfer Period
≦X'85' (532 ns)</td><td>Synchronous mode with 1.875 MB/s max.
(REQ cycle≧600 ns,
ACK cycle≧404 ns)</td></tr>
<tr><td>X'86' (536 ns)
≦Transfer Period
≦X'A6' (664 ns)</td><td>Synchronous mode with 1.5 MB/s max.
(REQ cycle≧1000 ns,
ACK cycle≧804 ns)</td></tr>
</table>

*: The REQ signal cycle sent by IDD is 400 ns, 533 ns or 677 ns. SEND MESSAGE REJECT message or SYNCHRONOUS DATA TRANSFER REQUEST message with REQ/ACK Offset = 0 as response if an INIT requires X'C9' (1,004 ns) or more for the Transfer Period.

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CHAPTER 6 DATA FORMAT AND ADDRESSING

6.1 Cylinder Addressing

The storage area on the media in the drives is divided into a user area, CE cylinder area, and SA cylinder area as shown in Figure 6.1.

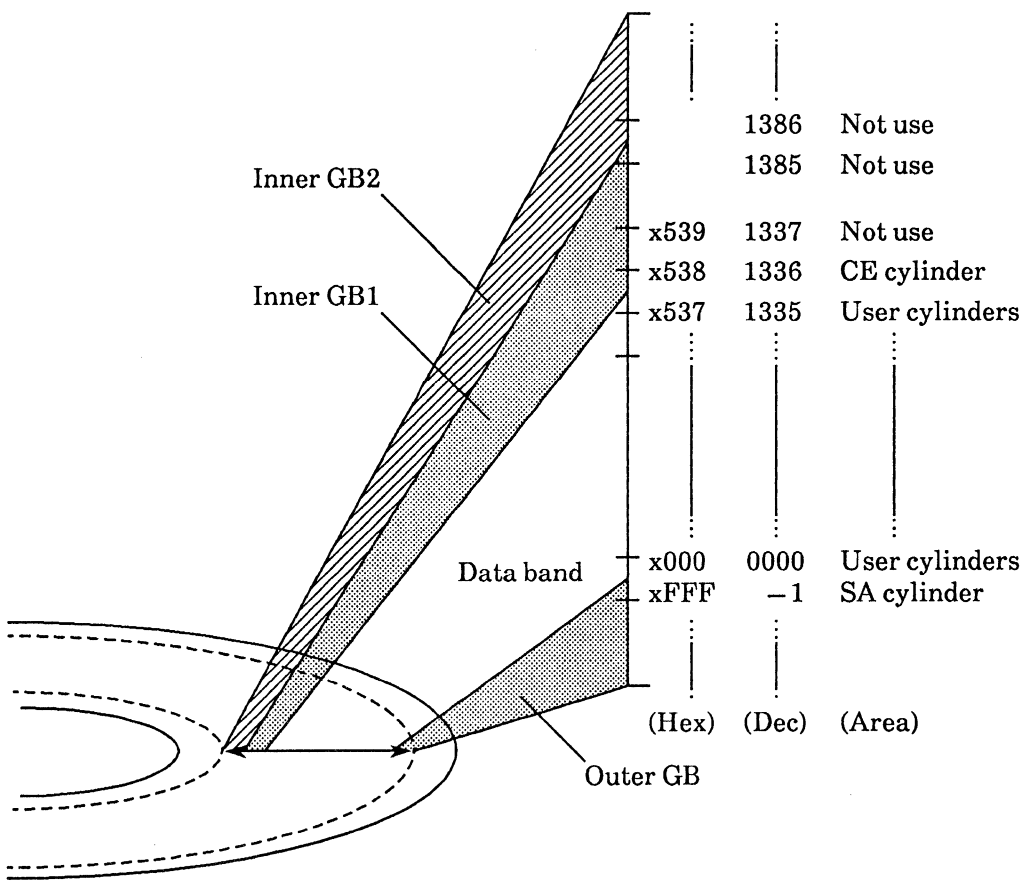


Figure 6.1 Cylinder configuration

6.1.1 User area

This area is used to store user data.

6.1.2 CE cylinder area

This area is dedicated to diagnosis. Its format is the same as that of the user area. The user can access this area with a group 1 command. See Chapter 7 for further details.

6.1.3 SA cylinder area

This area is used only for the IDD. In it is stored the following five types of information. The length of the sector in the track is fixed at 516 bytes per sector. This area cannot be accessed.

① Map (primary list) of defects detected at the factory

② Defect data (grown list) added by a user command

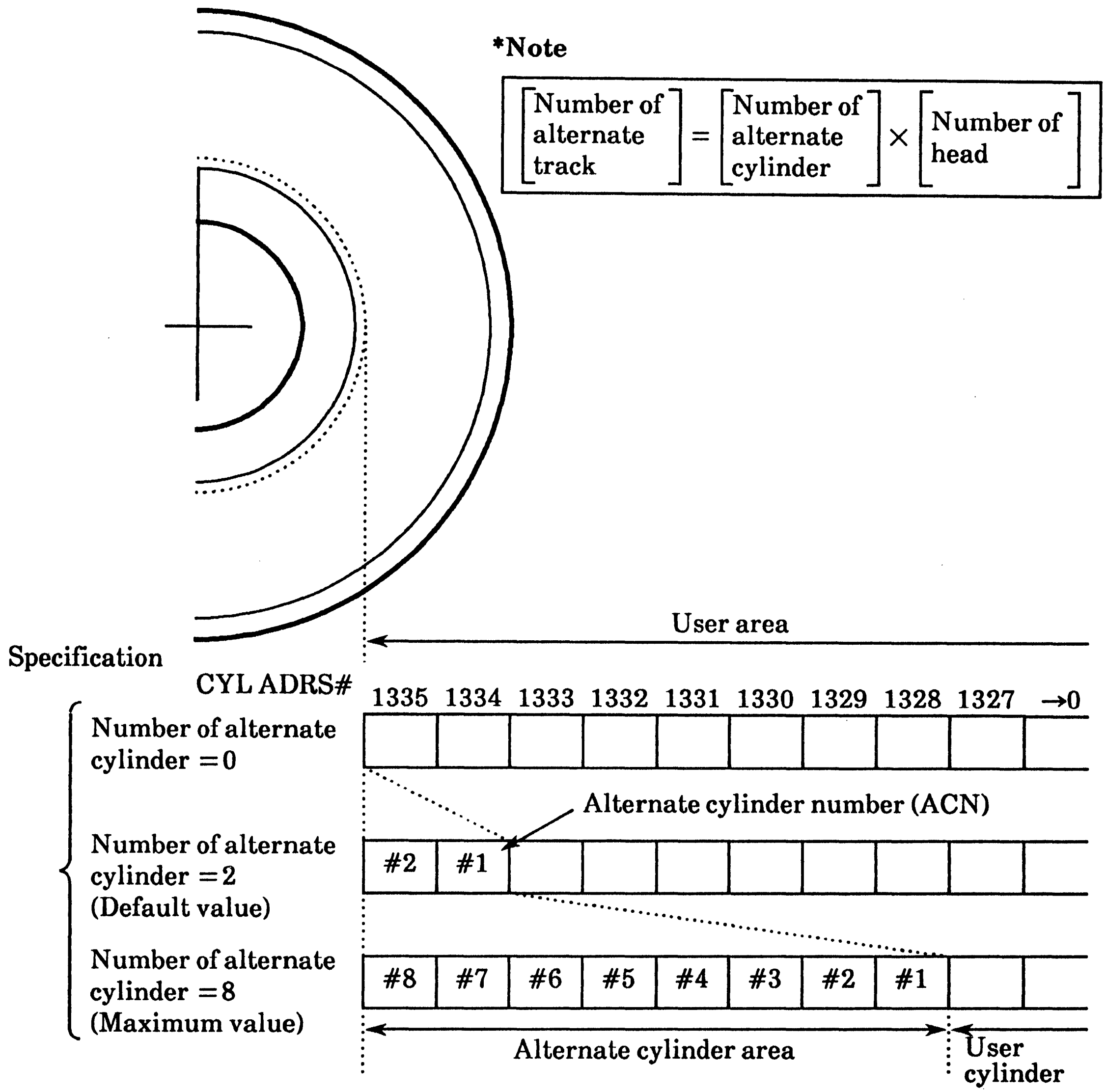
③ System/drive information

④ Defect management table used during bad sector replacement

⑤ Factory information

6.1.4 Alternate cylinder

The IDD uses several cylinders in the user cylinder as the alternate cylinder. The number of alternative cylinders can be specified in the program with a MODE SELECT command. From 0 up to 8 cylinders can be specified (by number of tracks). The default number of alternate cylinder is 2. The IDD has the alternate sector in each cylinder (except SA cylinder). When the formatting is performed with decreasing the number of alternate sectors, it is recommended to specify the number of alternate cylinders more than usual.



6.2 Specification of Number of Alternate Cylinder/Cylinder Configuration

6.2.1 Sector

The format of the user area on the IDD disk is the same as that of the CE area. The number of hard sectors for each cylinder is 68 for M2611, 136 for M2612, 204 for M2613, and 272 for M2614. Positions and the number of these sectors do not change if the logical block length is changed as the result of reformatting. The last several sectors are used as spare sectors. (The default number of spare sectors is 5 for the M2614, 4 for the M2613, 3 for the M2612, and 2 for the M2611.) The number of spare sectors can be specified in the program with a MODE SELECT command. It is variable between 0 and 34. Spare sectors are also allocated in alternate cylinders. The last several cylinders of the user area are allocated as the alternate cylinders (the default number of alternate cylinders is 2), and the number of these alternate cylinders can be specified with a MODE SELECT command within the range from 0 to 8. All sectors in these alternate cylinders are used as spare sectors.

Figure 6.2 shows an example of the configuration of cylinders in user and CE areas.

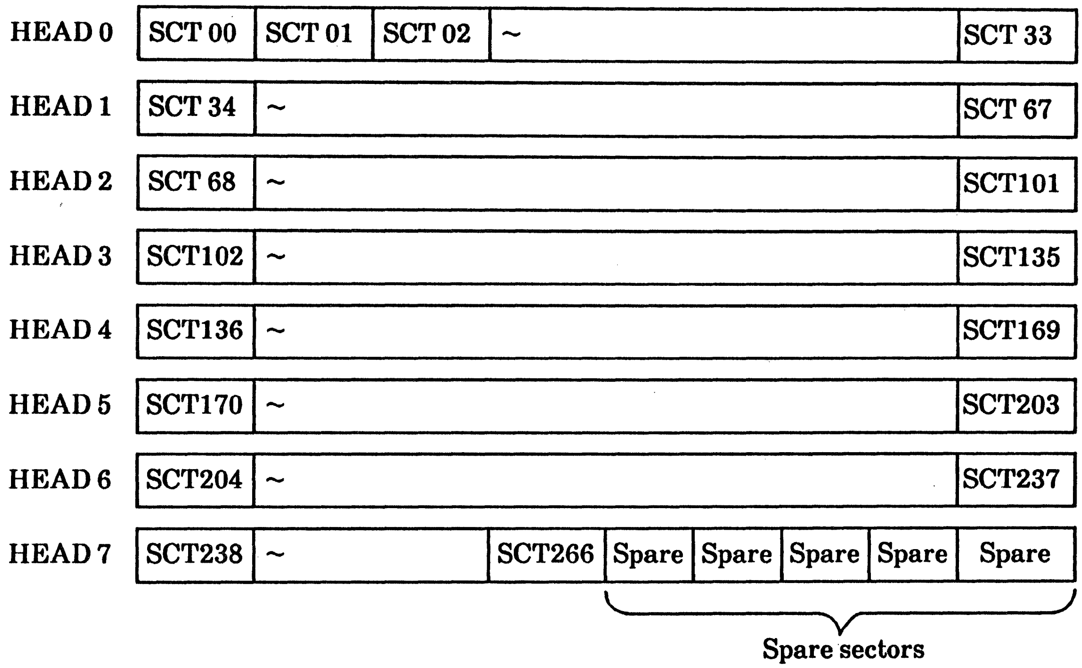


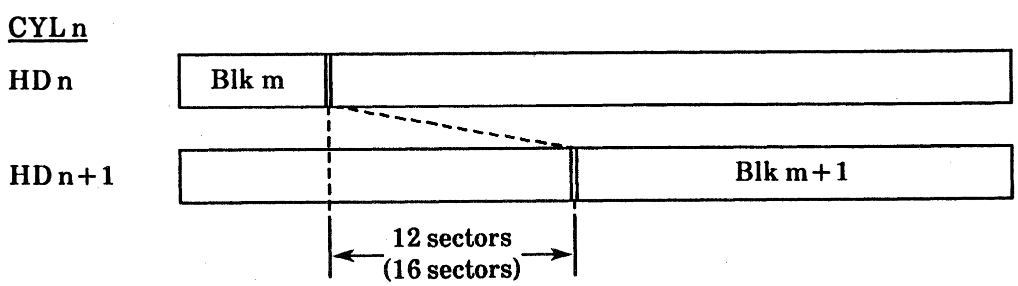
Figure 6.2 Example of cylinder format (M2614ES: 5 spare sectors)

6.2.2 Track skew/cylinder skew

The IDD provides a skew between a cylinder and track so that continuous blocks can be read/written effectively. Each skew value is determined to achieve the maximum performance of the drive. Any attempt to modify it with a parameter is ignored.

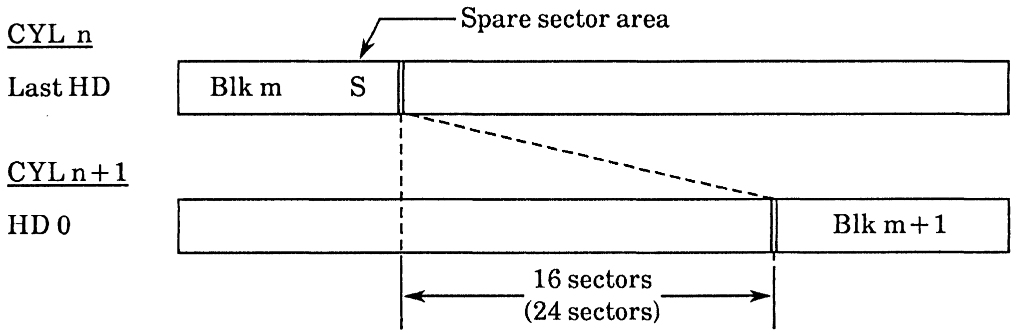
(1) Track skew

Track skew is equivalent to 12 sectors (6 ms) for M2614/M2613/M2612 and 16 sectors (8 ms) for M2611. The first block of the next track is positioned 12 or 16 sectors after the maximum logical block address of the preceding track.



(2) Cylinder skew

Cylinder skew is equivalent to 16 sectors (8 ms) for M2614/M2613/M2612 and 24 sectors (12 ms) for M2611. The first block of the next cylinder is positioned 16 or 24 sectors after the last block (including the spare sector) of the preceding cylinder.



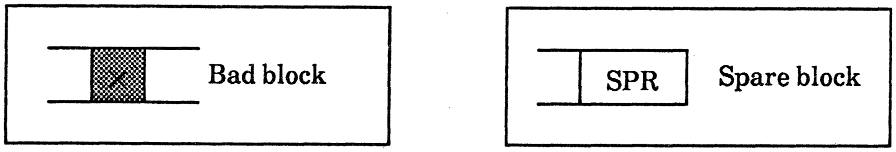
6.2.3 Bad/alternate sector processing

Bad/alternate sector processing by the FORMAT UNIT command is different from the REASSIGN BLOCKS command as described below.

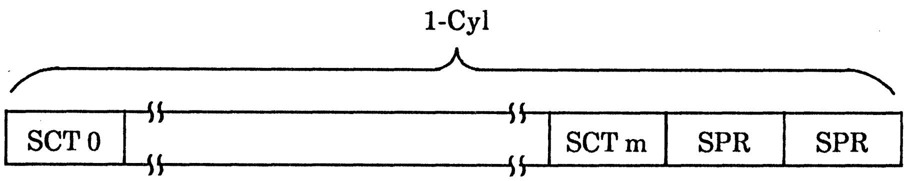
(1) FORMAT UNIT command

Bad/alternate sector processing is performed by skipping bad sectors (sector skip). When bad sectors are skipped, the sectors following the skipped sector are shifted one-sector length backward until the last spare sector is utilized. This processing is continued until all spare sectors are used. If all spare sectors have been used, spare sectors in alternate cylinders are used as supplements.

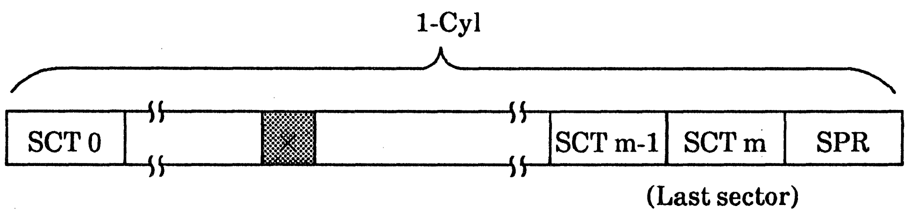
The following is an example of bad/alternate sector processing performed when there are two spare sectors.



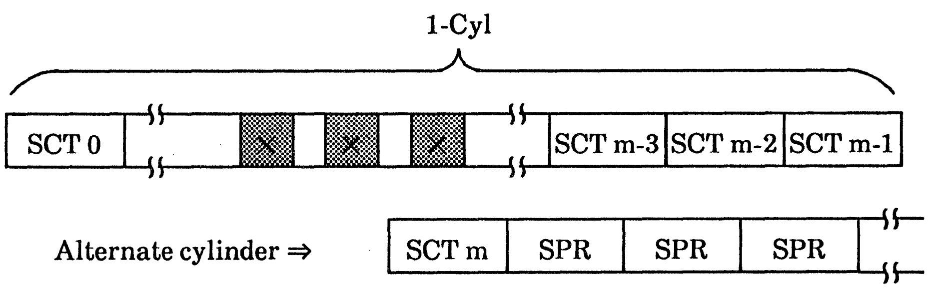
① Normal format (Example)



② One bad block (Example)



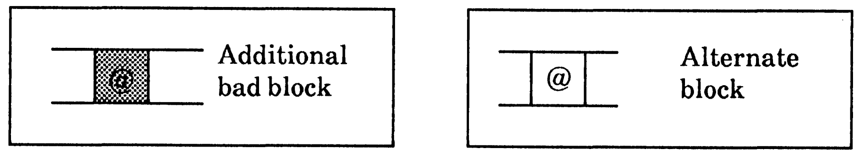
③ Three bad blocks (Example)



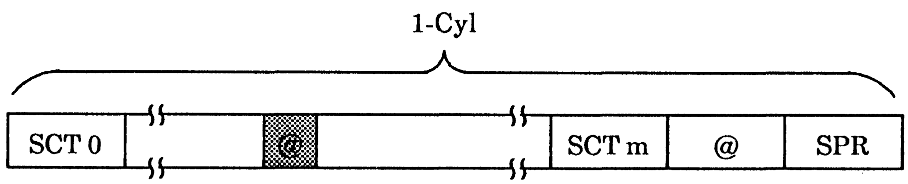
(2) REASSIGN BLOCKS command

For bad/alternate sector processing, spare sectors in the cylinder are given priority. If all spare sectors have been used, a defective block is replaced with a block in the alternate cylinder. During execution of a REASSIGN BLOCKS command, sectors are not skipped.

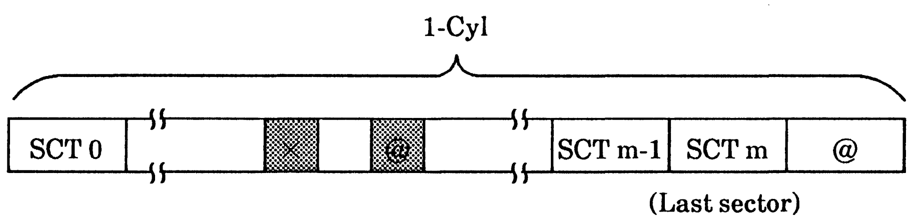
The following is an example of bad/alternate sector processing when there are two spare sectors in the cylinder.



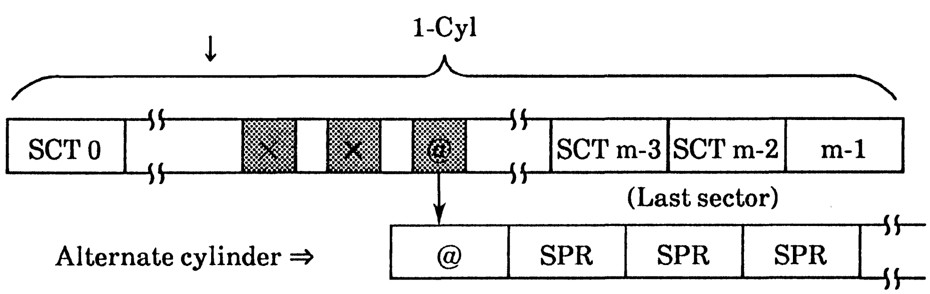
① Normal format (Example)



② When a sector is previously skipped (Example)



③ When there is no spare sector in cylinder (Example)



6.2.4 Sector format

The IDD has 34 sectors per track. These sectors are fixed on the disk surface, that is, physical positions and the number of these sectors do not change with the logical block length. However, physical positions and the number of blocks can be changed with the data block length and format parameters.

There are only two types of sector formats; 256-byte format and 512-byte format. When a 512-byte format is used, the data length can be changed by ±20 bytes. When a 256-byte format is used, the data length cannot be changed. The IDD can support a logical block length of 1024 ±40 bytes; although, the 512-byte format is used within the IDD.

Illustration A shows the 256-byte sector format. This format is used only when the 256-byte format is set for the system. In the 256-byte sector format, each sector has one common ID block and two data blocks. The first data block matches the even block address and the later data block matches the odd address. Since alternate sector processing is performed in physical sector units, these two blocks processed simultaneously. When either of these blocks are specified in the parameter of a REASSIGN BLOCKS command, alternation is performed as usual for the specified block, but both alternation and copy to the destination are performed for the unspecified block.

Illustration B shows the 512-byte sector format. This format is used when 512 ±20 bytes or 1024 ±40 bytes are set for the system. The IDD supports a format whose data length is changed within ±20 bytes.

A. 256 bytes × 2/sector format (68 blocks/track)

(bytes)

0	2	12	20	33	297	313	577	602–631
	Gap 1	ID	Gap 2a	Data 1	Gap 2b	Data 2	Gap 3	Servo zone

Gap 1

Write Splice (1 byte) + Sync (9 bytes) = 10 bytes

ID

(bytes)

12	13		14	16	18
SB X'19'	Flag	ACN	Cylinder address	Sector address	CRC (2 bytes)

ACN:
- X0 .... Ordinary cylinder
- X1 to X8 .... Alternate cylinder number

Flag:
- Bit 7 .... Defective Block Flag
- Bit 6 .... Alternated Block
- Bit 5 .... Spare Block
- Bit 4 .... Assigned Block

Gap 2a

Pad (3 bytes) + Write Splice (1 byte) + Sync (9 bytes) = 13 bytes

Gap 2b

Pad (3 bytes) + Write Splice (1 byte) + Sync (12 bytes) = 16 bytes

Data 1, 2

(bytes)

33 / 313	34 / 314	290 / 570
SB X'19'	Data 1 or 2 (256 bytes)	ECC 1 or 2 (7 bytes)

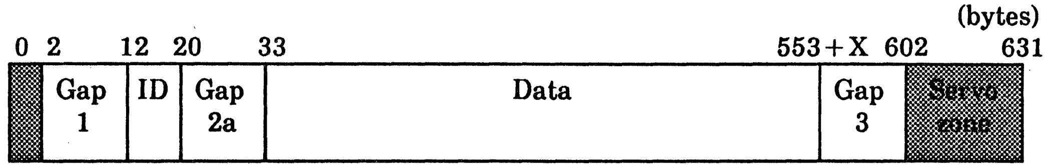
Gap 3

Pad (3 bytes) + Write Splice (1 byte) + Isg (21 bytes) = 25 bytes

Servo Zone

30 bytes (Read/Write Protect)

B. 512 bytes/sector format (34 blocks/track)



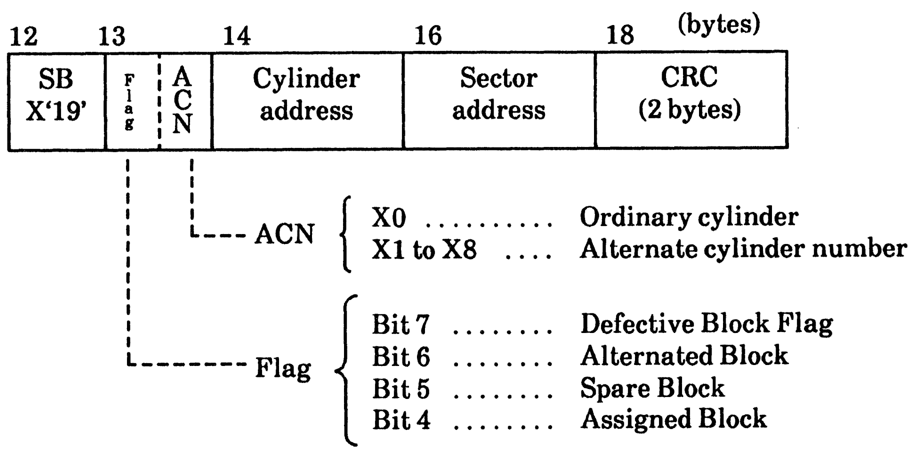
(−20 bytes ≦ X ≦ 20 bytes)

The value of X may be changed in 2 byte increments when the logical block length is 512 bytes. (When the logical block length is 1024 bytes, it can be changed in 1 byte increments.)

Gap 1

Write Splice (1 byte) + Sync (9 bytes) = 10 bytes

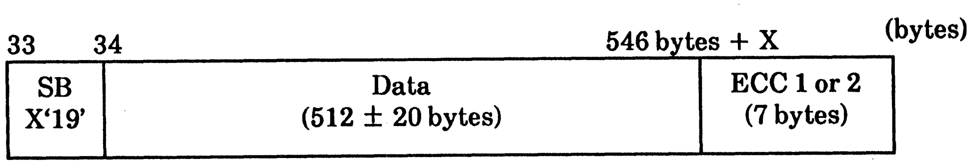
ID



Gap 2

Pad (3 bytes) + Write Splice (1 byte) + Sync (9 bytes) = 13 bytes

Data



Gap 3

Pad (2 bytes) + Write Splice (1 byte) + Isg (44 bytes − X) = 49 bytes − X

Servo Zone

30 bytes (Read/Write Protect)

6.3 Block Addressing

Data on the disk is accessed according to its logical block address which does not depend on the physical structure of the IDD. Data blocks addresses are specified with numbers that are consecutive within each volume (logical block addressing). Logical block addresses in the user area are independent of those in the CE area.

6.3.1 Block addressing in user area

The first data block in the user area is assigned address ‘00.00’. The succeeding blocks from 00 are assigned consecutive addresses. Since data blocks in spare and bad sectors are not assigned logical block addresses, it is impossible to access this data.

The maximum usable block address depends on the logical data block length and format parameters (alternate sector/zone (cylinder) and alternate track/ volume). Table 6.1 lists logical data block lengths and maximum block addresses under standard format parameters.

Table 6.1 Maximum block addresses in user area

		M2611	M2612	M2613	M2614
Alternate sector/zone		2	3	4	5
Alternate track/volume		4	8	12	16
Max block address ‘000000’ to	256 bytes	X‘2AFD7’	X‘56A1B’	X‘8245F’	X‘ADEA3’
	512±20 bytes	X‘157EB’	X‘2B50D’	X‘4122F’	X‘56F51’
	1024±40 bytes	X‘ABF5’	X‘15A86’	X‘20917’	X‘2B7A8’

6.3.2 Block addressing in CE area

The first data block in the CE cylinder is assigned address 80000000 and the succeeding blocks are assigned consecutive addresses. Since data blocks in spare and bad sectors are not assigned logical block addresses, it is impossible to access this data.

To access data in the CE area, a group 1 command must be used. A group 0 command cannot access data in this area.

The maximum usable block address depends on the logical data block length and format parameter (alternate sector/zone (cylinder) and alternate track/volume). Table 6.2 lists logical data block lengths and maximum block addresses under standard format parameters.

Table 6.2 Maximum block addresses in CE area

		M2611	M2612	M2613	M2614
Alternate sector/zone		2	3	4	5
Max block address '80000000' to	256 bytes	X'80000083'	X'80000109'	X'8000018F'	X'80000215'
	512±20 bytes	X'80000041'	X'80000084'	X'800000C7'	X'8000010A'
	1024±40 bytes	X'80000020'	X'80000041'	X'80000063'	X'80000084'

CHAPTER 7 COMMANDS

7.1 Outline

7.1.1 CDB format

The command descriptor block (CDB) which is transferred from an INIT in the COMMAND phase gives operational commands to a TARG.

The three high-order bits of byte 0 in the CDB constitute the "group code" field which specifies a command group number and the CDB length. The IDD uses the following command groups:

- Group 0: 6-byte long CDB (Basic commands)
- Group 1: 10-byte long CDB (Extended commands)
- Group 6: 10-byte long CDB (Diagnostic commands)

The five low-order bits of byte 0 are the "command code" field. Figures 7.1 to 7.3 show the basic formats of the respective group CDB's.

Note:

Group-6 commands are only for diagnostics in the factory, so basic format and CDB format of group-6 commands are not disclosed.

Byte \ Bit	7	6	5	4	3	2	1	0
00	0	0	0	Command code				
01	LUN			Logical block address (MSB)				
02	Logical block address							
03	Logical block address (LSB)							
04	Transferring block count							
05	Control byte							

Figure 7.1 Group-0 CDB basic format

Byte \ Bit	7	6	5	4	3	2	1	0
00	0	0	1	Command code				
01	LUN			0	0	0	0	0
02	Logical block address (MSB)							
03	Logical block address							
04	Logical block address							
05	Logical block address (LSB)							
06	0	0	0	0	0	0	0	0
07	Transfer block count (MSB)							
08	Transfer block count (LSB)							
09	Control byte							

Figure 7.2 Group-1 CDB basic format

(1) A "group code" field specifies a CDB format and its byte count.

(2) A "command code" field specifies the command to be executed.

(3) A "logical unit number (LUN)" field specifies the address of the IDD (shall be set to zero) when the IDENTIFY message is not implemented. The INIT can specify the device address (LUN) by way of an IDENTIFY message issued upon completion of the SELECTION phase. In this case, the IDD ignores the contents of the LUN field in the CDB.

(4) A "logical block address" field indicates the start address of the data block to be processed.

(5) A "transfer block count" field specifies the number of blocks to be transferred between the INIT and IDD. This field in the CDB may specify a transferring byte count or have no meaning, depending on the type of the command specified.

(6) Control byte:

Bit 7	6	5	4	3	2	1	0
0	0	0	0	0	0	Flag	Link

- Bit 0: Link — A command link is specified when this bit is '1'.
- Bit 1: Flag — This bit is only valid when the link bit is set to '1'. When the command terminates successfully, the LINKED COMMAND COMPLETE WITH FLAG message is sent to the INIT if this bit is '1', and the LINKED COMMAND COMPLETE message is sent if this bit is '0'.

7.1.2 Outline of command processing

(1) Single command

The following shows an example of processing a single command. This is the most basic SCSI operation. Although some commands may be accompanied by a disconnection/reconnection before the completion of the command execution this function is not described in the following example. See Subsection 7.1.3 for details about the disconnection/reconnection function.

① The INIT sets the command pointer, data pointer, and status pointer to the initial values for the command to be issued.

② The INIT obtains control of the SCSI bus through the ARBITRATION phase and then selects the TARG in the SELECTION phase.

③ If an ATTENTION condition occurs, the TARG executes the MESSAGE OUT phase and normally receives an IDENTIFY message which specifies the LUN to be accessed.

④ The TARG receives a CDB from the INIT in the COMMAND phase. The link bit of the control byte in the CDB is '0'.

⑤ The TARG interprets the command and executes the requested operation. If the command requires data transfer at the SCSI, the DATA IN or DATA OUT phase is executed.

⑥ The TARG sends the status byte indicating a result of command execution to the INIT in the STATUS phase upon termination of command execution.

⑦ The TARG sends a COMMAND COMPLETE message in the MESSAGE IN phase and then goes to the BUS FREE phase.

(2) Command link

The command link facility enables a TARG to execute two or more commands successively. Issue of the first command by the INIT and the execution of the first command are executed in the same manner as the above single command example, except for the following:

- The Link bit of the control byte of the CDB transferred as step ④ is '1'.
- The status byte reported at step ⑥ upon successful completion of the command indicates INTERMEDIATE status and the link facility is then executed.
- Either the LINKED COMMAND COMPLETE or LINKED COMMAND COMPLETE WITH FLAG message is sent at step ⑦ depending on the value of the Flag bit of the CDB.

The INIT updates the pointer to the initial values for the next command upon receipt of the LINKED COMMAND COMPLETE (WITH FLAG) message. The TARG executes the COMMAND phase after the MESSAGE IN phase to obtain the command to be executed next.

The command link continues until a command is issued with the Link bit of the CDB is '0' or a command terminates abnormally with a CHECK CONDITION status.

7.1.3 Disconnection/Reconnection

If a process which does not require any SCSI operation is to be performed during command execution in a TARG, the TARG can disconnect the SCSI bus, and then execute the command within the TARG. This facility enables the INIT to perform multiprocessing on the SCSI bus.

To disconnect the SCSI, the TARG sends a DISCONNECT message to the INIT and then enters the BUS FREE phase. In this case, the TARG may request the pointer operation before issuing the DISCONNECT message.

The TARG performs the command execution within itself and then reconnects the INIT when SCSI operation again becomes necessary. For the reconnection, the TARG obtains control of the SCSI bus through the ARBITRATION phase and reselects the INIT by executing the RESELECTION phase. Then, the TARG notifies the LUN reconnected by issuing the IDENTIFY message. The INIT restores the pointers for the specified LUN to restart command execution.

An IDD operating as a TARG executes the above disconnection/reconnection process when each of the following conditions are satisfied. Disconnection is permitted when;

- The system has an ARBITRATION phase and use of the ARBITRATION phase is enabled by the setting plug in the IDD.
- The SCSI ID of an INIT has been notified in the SELECTION phase.
- The INIT has permitted disconnection in the IDENTIFY message issued after the SELECTION phase.

Under normal circumstances, the IDD becomes ready to accept a new I/O request from SCSI after the disconnection.

7.2 Commands

Tables 7.1 and 7.2 list the commands implemented on the IDD. Symbols in these tables denote the following:

- Type

S:	Standard (Mandatory)	Commands defined in SCSI standard
E:	Extended	
O:	Optional	
FJ:	Fujitsu unique (vendor unique) command	

- CDB

a : Address of data block to be processed
b : Number of bytes to be transferred
c : control bits field
d : Address of data buffer to be processed
f : Control flags
i : Interleaving factor
l : Number of data blocks to be processed
m : Modifier field
u : LUN

- Data Transfer

–: No data is transferred on SCSI during command execution.
T → I : Data is transferred from TARG to INIT.
I → T : Data is transferred from INIT to TARG.
( ) : Data transfer may or may not occur depending on the CDB specification.

- Disconnection

–: SCSI disconnection does not occur during command execution.
× : SCSI disconnection occurs during command execution if the INIT permits the disconnection.

Table 7.1 Group 0 commands

Command	Type	CDB (HEX)						Data Transfer	Discon-nection	Remarks
		00	01	02	03	04	05			
TEST UNIT READY	O	00	u0	00	00	00	0f	–	–	
REZERO UNIT	O	01	u0	00	00	00	0f	–	×	
REQUEST SENSE	S	03	u0	00	00	bb	0f	T→I	–	
FORMAT UNIT	S	04	uc	00	ii	ii	0f	(I→T)	×	
REASSIGN BLOCKS	O	07	uc	00	00	00	0f	I→T	×	
READ	S	08	ua	aa	aa	ll	0f	T→I	×	
WRITE	S	0A	ua	aa	aa	ll	0f	I→T	×	
SEEK	O	0B	ua	aa	aa	00	0f	–	×	
NO OPERATION	FJ	0D	u0	00	00	00	0f	–	–	
INQUIRY	E	12	u0	00	00	bb	0f	T→I	–	
PRIORITY RESERVE	FJ	14	u0	00	00	00	0f	–	–	
MODE SELECT	O	15	uc	00	00	bb	0f	I→T	–	
RESERVE UNIT	O	16	uc	00	00	00	0f	–	–	
RELEASE UNIT	O	17	uc	00	00	00	0f	–	–	
MODE SENSE	O	1A	u0	mm	00	bb	0f	T→I	–	
START/STOP UNIT	O	1B	uc	00	00	00	0f	–	×	
RECEIVE DIAGNOSTIC RESULTS	O	1C	uc	00	bb	bb	0f	T→I	–	
SEND DIAGNOSTIC	O	1D	uc	00	00	00	0f	–	×	

Table 7.2 Group 0 commands

Command	Type	CDB (HEX)										Data Transfer	Discon-nection	Remarks
		00	01	02	03	04	05	06	07	08	09			
READ CAPACITY	E	25	uc	aa	aa	aa	aa	00	00	0c	0f	T→I	×	
READ EXTENDED	E	28	uc	aa	aa	aa	aa	00	ll	ll	0f	T→I	×	
WRITE EXTENDED	E	2A	uc	aa	aa	aa	aa	00	ll	ll	0f	I→T	×	
SEEK EXTENDED	O	2B	uc	aa	aa	aa	aa	00	00	00	0f	–	×	
WRITE AND VERIFY	O	2E	uc	aa	aa	aa	aa	00	ll	ll	0f	I→T	×	
VERIFY	O	2F	uc	aa	aa	aa	aa	00	ll	ll	0f	(I→T)	×	
SET LIMITS	O	33	uc	aa	aa	aa	aa	00	ll	ll	0f	–	–	
READ DEFECT DATA	O	37	u0	cc	00	00	00	00	bb	bb	0f	T→I	×	
WRITE BUFFER	O	3B	uc	00	dd	dd	dd	bb	bb	bb	0f	I→T	–	
READ BUFFER	O	3C	uc	00	dd	dd	dd	bb	bb	bb	0f	T→I	–	
READ LONG	O	3E	uc	aa	aa	aa	aa	00	bb	bb	0f	T→I	–	
WRITE LONG	O	3F	u0	aa	aa	aa	aa	00	bb	bb	0f	I→T	–	

7.2.1 Group 0 command

(1) TEST UNIT READY

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	0	0	0	0	0	X'00'
1	LUN			0	0	0	0	0	LUN
2	0	0	0	0	0	0	0	0	X'00'
3	0	0	0	0	0	0	0	0	X'00'
4	0	0	0	0	0	0	0	0	X'00'
5	0	0	0	0	0	0	Flag	Link	Control

This command is used to check the status of the disk drive.

When the drive is ready and the INIT issuing this command is able to use the drive, a GOOD status is reported to in response to the command.

Until the device information (DVINF) has been completely read, the following responses are given when TEST UNIT READY and REQUEST SENSE commands are sent:

		TEST UNIT READY	REQUEST/SENSE	
Drive	DVINF	Status	Sense key	Sense code
NOT RDY	—	CHECK	2: NOT READY	04: Drive Not Ready
READY	Before or during reading	BUSY	2: NOT READY	3E: LU has not Self-Configured yet
READY	Failed in reading	CHECK	4: H/W ERROR	4C: LU Failed Self-Configuration
READY	Read normally	GOOD	—	

(2) REZERO UNIT

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	0	0	0	0	1	X'01'
1	LUN			0	0	0	0	0	LUN
2	0	0	0	0	0	0	0	0	X'00'
3	0	0	0	0	0	0	0	0	X'00'
4	0	0	0	0	0	0	0	0	X'00'
5	0	0	0	0	0	0	Flag	Link	Control

This command moves the disk drive read/write head to the initial position. The data block with logical block address is zero resides within initial position (cylinder 0, track 0).

The command is used to initialize the disk drive positioning control system, as well as to clear a fault or seek error condition detected during drive status check.

Since processing equivalent to this command is performed during internal error recovery by the IDD, the INIT need not issue this command explicitly except when error recovery by the IDD is inhibited by parameters set in the MODE SELECT command.

(3) REQUEST SENSE

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	0	0	0	1	1	X'03'
1	LUN			0	0	0	0	0	LUN
2	0	0	0	0	0	0	0	0	X'00'
3	0	0	0	0	0	0	0	0	X'00'
4	Byte transfer count								
5	0	0	0	0	0	0	Flag	Link	Control

This command is used to transfer sense data to the INIT.

The IDD's sense data length is 48 bytes. The CDB's "byte transfer count" field indicates the number of sense data bytes that can be received by the INIT. The IDD transfers sense data to the INIT according to the length specified by the "byte transfer count" field, or the IDD's sense data count (48 bytes) whichever is shorter.

The IDD generates sense data in one of the following cases and stores the sense data for the INIT that issued the REQUEST SENSE command:

- The current command results in the CHECK CONDITION status.
- The current command is terminated abnormally when the IDD forces the SCSI bus into the BUS FREE phase because of an unrecoverable SCSI error.

  Note:

  If the LUN is not specified, then sense data will not be generated.

- The IDD terminates (clears) the command under execution is aborted because the INIT does not reply to the RESELECTION phase.
- The command under execution is terminated (cleared) abnormally due to a PRIORITY RESERVE command issued by another INIT.

The generated sense data is stored until it is transferred to the INIT which is to store this sense data, or the INIT issues a command other than the NO OPERATION command to the IDD. The stored sense data is cleared when either an ABORT message is received, a BUS DEVICE RESET message is received from any INIT, or a RESET condition is set.

If the REQUEST SENSE command is issued while the IDD is in the UNIT ATTENTION condition, the sense data indicating the UNIT ATTENTION condition is sent to the INIT, and the UNIT ATTENTION condition is cancelled.

When the "byte transfer count" field is set to zero, the command proceeds normally with sending four bytes (the stored sense data is cleared).

The REQUEST SENSE command reports the CHECK CONDITION status and is aborted only when one of the following conditions is detected. In this case, new sense data is created and the stored sense data is cleared.

- An error is detected in a field other than CDB's LUN field.
- Sense data cannot be transferred because of a hardware error in the IDD.
- A fatal error is detected in the SCSI bus.

In other cases, this command transfers sense data to the INIT if this data exists. If there is no stored sense data and an error occurs while executing this command, it transfers the sense data containing the details of the error to the INIT and results in the GOOD status.

See Chapter 8 for further details on the sense data.

(4) FORMAT UNIT

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	0	0	1	0	0	X'04'
1	LUN			Fmt Data	Cmp Lst	Defect list format			
2	0	0	0	0	0	0	0	0	X'00'
3	Interleaving factor (MSB)								
4	Interleaving factor (LSB)								
5	0	0	0	0	0	0	Flag	Link	Control

The FORMAT UNIT command is used to initialize (format) all areas (user and CE area) on the disk that can be accessed from the INIT. The IDD performs defect management by assigning alternate blocks for bad sectors on the disk units according to the parameters outlined in the format.

Format attributes must be established through the MODE SELECT command before data block length, user area cylinder size and the number of spare sectors for alternate blocks can be modified under this command.

For the defect management performed by this command, the following defect lists are defined to load or specify the positions of defects on the disk:

P-list: Primary defect list

This list contains defects (permanent defects) detected at the factory. The INIT can refer to the contents of this list only with a READ DEFECT DATA command; however, it cannot modify or add data to this list.

D-list: Data defect list

This list contains the locations of defects on the disk surface which are transferred from the INIT during the execution of this command. The IDD loads this defect information on the disk as a G-list.

G-list: Grown defect list

This list contains the positions of defects on the disk specified by the INIT. The INIT can reference the contents of this list via the READ DEFECT DATA command. The G-list contains the following defect location information:

- Defect information that the INIT transferred as a D-list using this command.

- Defect information that the INIT specified using a REASSIGN BLOCKS command.

Using the "FmtData (Format Data)" bit, "CmpLst (Complete List)" bit and "defect list format" field in CDB byte 1, the INIT can specify the method of defect processing performed by this command.

When the FmtData bit is set to 1, additional information (defect list) is transferred from the INIT during execution of this command. If this bit is set to 0, the additional information is not transferred.

When the CmpLst bit is set to 1, the existing G-list is replaced with the defect list (D-list), which is transferred from the INIT during execution of this command. If this bit is set to 0, the contents of the D-list are added to the existing G-list.

The "defect list format" field specifies the format the defect list is to be transferred from the INIT. When the FmtData bit is set at 1, the D-list is transferred.

Defect list format			D-list format
0	0	0	: Block address format
1	0	0	: Bytes format index format
1	0	1	: Physical sector address format

The CDB's "interleaving factor" field specifies the arrangement of logical data blocks in a physical sector on the disk. The IDD arranges logical blocks continuously irrespective of the value specified in the "interleaving factor" field.

The INIT transfers additional information in the following format when the CDB's FmtData bit is set to 1.

Header

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	X'00'							
1	FOV	DPRY	DCRT	STPF	–	DSP	–	
	0	0	0	0	0	0	0	0
	1	1/0	x	x	0	x	0	0
2	Defect list length (MSB)							
3	Defect list length (LSB)							

Defect list

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	Defect descriptor 0							
1								
≈								
x								
≈								
xx	Defect descriptor n							
xx+1								
≈								
xx+x								

a. Header

The first four bytes of the additional information sent from the INIT are assigned to a header. The INIT can specify the defect processing method to be used via the control flag in the header.

- FOV (Format Option Valid)

  0: The INIT does not specify the following functions specified by control flag bits 6 to 1 of byte 1. That is, the IDD performs formatting according to the default values of control flags. The INIT must set bits 6 to 1 of byte 1 to all 0s whenever it sets this bit (bit 7 of byte 1) to 1.

  1: The INIT explicitly specifies the following functions set by the control flag bits 6 to 1 of byte 1. The IDD performs formatting according to the control flag values.

- DPRY (Disable Primary) (Default value = 0)

  0: A P-list is used for formatting.

  1: A P-list is not used for defect processing.

- DCRT (Disable Certification)

  This bit specifies verification upon formatting. If this bit is set, this bit is ignored and IDD does not perform verification.

- STPF (Stop Format)

  This bit specifies whether the current format is to be used continuously when a necessary defect list cannot be read. The IDD ignores this bit. That is, this command results in a CHECK CONDITION status (medium error) when the recessary defect list cannot be read.

- DSP (Disable Saving Parameters)

  This bit indicates whether the MODE SELECT parameter related to the disk data format is to be saved on the disk at the end of this command. The IDD ignores this bit. That is, the MODE SELECT parameter related to the disk data format is saved on the disk at the end of this command.

- Defect list length

  This field sets the total byte count of the defect list transferred from the INIT by this command. The byte length of the defect descriptor that constitutes a defect list depends on its format. This field must set a multiple of 4 when the defect descriptor is written in a block address format. It must set a multiple of 8 when the defect descriptor is written in a bytes from index or physical sector address format. When this field is 0, no defect list is transferred.

b. Defect list

A defect list (D-list) lists locations of the defects on the disk specified by the INIT. It consists of one or more defect descriptors. Each defect descriptor must be written in the format specified by the CDB's "defect list format" field.

The structure of the defect descriptor that may be included in the defect list (D-list) is as follows.

- Defect descriptor written in block address format

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	Defective block address (MSB)							
1	Defective block address							
2	Defective block address							
3	Defective block address (LSB)							

The defect descriptor written in the above format specifies the logical address of the defective data block in four bytes. To specify multiple defect descriptors, list them in ascending order of block addresses.

If a D-list written in the block address format is specified, an alternate block is assigned assuming that the block (= physical block address) to which a logical data block is assigned when there is no defect on the disk is specified.

The IDD cannot execute this command by adding the defect list (D-list) written in the block address format to the existing G-list.

Inside the IDD, a block address format defect descriptor is recorded after conversion to the physical sector format. Accordingly, two physical sectors are processed simultaneously as defect descriptors if the logical block length is 1024 bytes.

- Defect descriptor written in bytes from index format

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	Cylinder number (MSB)							
1	Cylinder number							
2	Cylinder number (LSB)							
3	Head number							
4	Bytes from index to defect (MSB)							
5	Bytes from index to defect							
6	Bytes from index to defect							
7	Bytes from index to defect (LSB)							

The defect descriptor written in this format specifies the byte length from the index to the first byte containing a disk defect together with the cylinder number and head (track) number. Multiple defect descriptors must be specified in ascending order of defect positions assuming that the cylinder number is the more significant value and the bytes from index is the less significant value.

The IDD does not have a defect list written in this format because it stores the information about all defect positions in the physical sector address format. When bytes are read up to the defect position with a READ DEFECT DATA command, the original bytes-to-defect data loaded is not reported but only the representative position (first byte number) of the sector is converted and reported.

- Defect descriptor written in physical sector address format

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	Cylinder number (MSB)							
1	Cylinder number							
2	Cylinder number (LSB)							
3	Head number							
4	Physical sector number of defective block (MSB)							
5	Physical sector number of defective block							
6	Physical sector number of defective block							
7	Physical sector number of defective block (LSB)							

The defect descriptor written in this format specifies the physical sector number of the data block containing a disk defect together with the cylinder number and head (track) number.

Multiple defect descriptors must be specified in ascending order of defect positions assuming that the cylinder number is the more significant value and the bytes from index is the less significant value.

The method of disk defect processing performed during execution of this command is specified by the CDB and the header of the additional information transferred from the INIT. Combinations of control flag values and defect processing performed by the IDD are summarized below.

CDB byte 1					Header			Defect processing method
Fmt Data	Cmp Lst	Defect list format			FOV	DPRY	Defect list length	
0	0	0	0	0	[Additional information not transferred.]			① An alternate block is assigned to the defect contained in the P-list. ② The existing P-list is deleted.
1	0	d	d	d	0 1	0 0	Zero	① An alternate block is assigned to the defect contained in the P-list and the existing G-list. ② The existing G-list is deleted.
1	0	d	d	d	1	1	Zero	① An alternate block is assigned to the defect contained in the G-list. ② The P-list is saved but not used for defect processing. ③ The existing G-list is saved.
1	1	d	d	d	0	0	Zero	① An alternate block is assigned to the defect contained in the P-list. ② The existing G-list is deleted and not used for defect processing.
1	1	d	d	d	1	1	Zero	① Both P-list and existing G-list are not used for defect processing. (An alternate block is not assigned.) ② The P-list is saved but the existing G-list is deleted.
1	0	d	d	d	0 1	0 0	>0	① Alternate blocks are assigned to the defects contained in the P-list and existing G-list and the defect contained in the D-list transferred from the INIT. ② The D-list is added to the existing G-list.
1	0	d	d	d	1	1	>0	① Alternate blocks are assigned to the defects contained in the existing G-list and the defect contained in the D-list transferred from the INIT. ② The P-list is saved but not used for defect processing. ③ The D-list is added to the existing

CDB byte 1			Header			Defect processing method
Fmt Data	Cmp Lst	Defect list format	FOV	DPRY	Defect list length	
1	1	d d d	0 1	0 0	>0	① Alternate blocks are assigned to the defects contained in the P-list and the defect contained in the D-list transferred from the INIT. ② The existing G-list is deleted; it is not used for defect processing. ③ The D-list is loaded as a new G-list.
1	1	d d d	1	1	>0	① An alternate block is assigned to the defects contained in the D-list transferred from the INIT. ② The P-list is saved but not used for defect processing. ③ The existing G-list is deleted; it is not used for defect processing. ④ The D-list is loaded as a new G-list.

Note:

d, d, d : 0, 0, 0 = D-list described in block address format
1, 0, 0 = D-list described in bytes-from-index format
1, 0, 1 = D-list described in physical sector address format

(5) REASSIGN BLOCKS

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	0	0	1	1	1	X‘07’
1	LUN			0	0	0	0	0	LUN
2	0	0	0	0	0	0	0	0	X‘00’
3	0	0	0	0	0	0	0	0	X‘00’
4	0	0	0	0	0	0	0	0	X‘00’
5	0	0	0	0	0	0	Flag	Link	Control

This command is used to assign an alternate data block(s) to the defect(s) specified by the defect data list transferred from the INIT.

The INIT specifies logical addresses of one or more defective data blocks using a defect data list. The IDD finds the spare sector(s) for an unused alternate block(s) and assigns an alternate block(s) to the specified logical data block(s). When the alternate block(s) is assigned successfully, the information about the disk defect positions related to the data block specified by the defect descriptor list is recorded on the disk as a defect list (G-list).

If the defect data list specifies the data block to which an alternate block was assigned, the IDD assigns a spare sector for another usable alternate block.

If this command results in the CHECK CONDITION status for some reason, the command specific information field indicates the first logical data block address of the defect descriptor to which an alternate block was not assigned. If the descriptor to which an alternate block was not assigned cannot be determined or alternate blocks have been assigned to all the specified defect descriptors, the command specific information field is set to X‘FFFFFFFF’.

If an unrecoverable error is detected in a data block other than the block specified by the defect descriptor list during data block movement on disk for assigning an alternate block, the information byte field of the sense data indicates the logical address of this data block.

The INIT transfers the following defect data list using this command.

Header

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	X'00'							
1	X'00'							
2	Defect list length (MSB)							
3	Defect list length (LSB)							

Defect list descriptor

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	X'00'							
1								
2	Defective block logical address							
3								
≈	≈							
4n								
4n+1	Defective block logical address							
4n+2								
4n+4								

A defect data list consists of a 4-byte header and the succeeding one or more 4-byte defect descriptors.

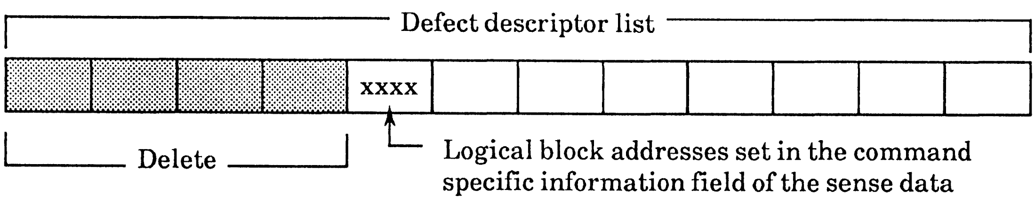
The "defect list length" field indicates the total bytes (4n + 4) of the defect descriptor list transferred after the header. It must be a multiple of 4. If zero is specified in this field, a defect descriptor list not transferred and this commands ends normally.

In the defect descriptor, the logical address of the defective data block is set in four bytes. To specify multiple defect descriptors, the INIT describes them in ascending order of logical data block addresses. If a logical block address is duplicated in the defect descriptor list, this command results in the CHECK CONDITION status and alternate block assignment is not performed. If zero is specified in this field, the defect data list is not transferred by this command.

Note on Command Use

If this command results in the CHECK CONDITION status, the sense code of the sense data is other than X'32' (No Defect Spare Location Available), and the logical block address of the command specific information field is valid, the INIT must issue this command in the following procedure.

① Delete the defect descriptors preceding the defect descriptors that specify the logical block addresses set in the command specific information field of the sense data, from the defect descriptor list.



② When the sense data reports a sense key "Medium Error" and a valid logical block address is set in the information field, this address is added to the new defect descriptor list created in step ① above.

③ Modify the list length indicated by the header, add the above new defect descriptor list, and issue a REASSIGN BLOCKS command again.

(6) READ

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	0	1	0	0	0	X'08'
1	LUN			Logical block address (MSB)					
2	Logical block address								
3	Logical block address (LSB)								
4	Transfer block count								
5	0	0	0	0	0	0	Flag	Link	Control

This command is used to read continuous logical blocks equivalent to the number of blocks specified in the "transfer block count" field, from the logical block address (on the disk) specified in the "logical block address" field, and transfers them to the INIT.

Up to 256 blocks can be specified for the "transfer block count" field. When the "transfer block count" field in CDB byte 4 is zero, transfer of 256 blocks is specified. If it is not zero, the specified value indicates the number of the blocks to be transferred.

(7) WRITE

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	0	1	0	1	0	X'0A'
1	LUN			Logical block address (MSB)					
2	Logical block address								
3	Logical block address (LSB)								
4	Transfer block count								
5	0	0	0	0	0	0	Flag	Link	Control

This command is used to write the data transferred from the INIT into the continuous logical blocks on the disk, from the logical block data block specified in the CDB's "logical block address" field.

Up to 256 blocks can be specified for the "transfer block count" field. When the "transfer block count" field in CDB byte 4 is zero, transfer of 256 blocks is specified. If it is not zero, the specified value indicates the number of the blocks to be transferred.

(8) SEEK

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	0	1	0	1	1	X'0B'
1	LUN			Logical block address (MSB)					
2	Logical block address								
3	Logical block address (LSB)								
4	0	0	0	0	0	0	0	0	X'00'
5	0	0	0	0	0	0	Flag	Link	Control

This command is used to seek the cylinder/track having the logical data block specified in CDB's "logical block address" field.

After reception of the CDB, the IDD performs disconnection if it is permitted. Then, the IDD performs reconnection at completion of seek operation and reports the status.

(9) NO OPERATION

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	0	1	1	0	1	X'0D'
1	LUN			0	0	0	0	0	LUN
2	0	0	0	0	0	0	0	0	X'00'
3	0	0	0	0	0	0	0	0	X'00'
4	0	0	0	0	0	0	0	0	X'00'
5	0	0	0	0	0	0	Flag	Link	Control

This command is used to check the disk drive. If this command is executed while sense data is being saved, the sense data is not cleared.

(10) INQUIRY

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	1	0	0	1	0	X'12'
1	LUN			0	0	0	0	0	LUN
2	0	0	0	0	0	0	0	0	
3	0	0	0	0	0	0	0	0	
4	Transfer byte length.								
5	0	0	0	0	0	0	Flag	Link	Control

This command is used to transfer the inquiry data (indicating the IDD characteristics) to the INIT.

If the UNIT ATTENTION condition is set, this command is executed normally and the condition is not cleared. This command is also executed normally if the disk drive is not ready or an illegal LUN is specified.

This command reports the CHECK CONDITION status and ends abnormally only if one of the following conditions is detected:

- A CDB field other than the LUN field is illegal.
- INQUIRY data cannot be transferred because of an IDD hardware error.
- The recovered error report mode is specified after recovery of an error.

The "transfer byte length" field indicates the number of INQUIRY data items that the INIT can receive. The IDD transfers data equivalent to the length specified in the "transfer byte length" field or the length (36 bytes) of INQUIRY data of the IDD, whichever is shorter. When zero is set in the "transfer byte length" field, this command ends normally without transferring any data.

The inquiry data format and contents of the IDD are as follows.

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	Qualifier			Device type code				
				(0, 0, 0, 0, 0) or (1, 1, 1, 1, 1)				
1	RMB	Device type qualifier						
	0	0	0	0	0	0	0	0
2	ISO version		ECMA versin			ANSI version		
	0	0	0	0	0	0	0	1
3	AENC	0	0	0	Response data format			
	0				0	0	0	1
4	Additional data length							
	X'1F'							
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	Rel Adr	WBus 32	WBus 16	Sync	Linked	Cache	Cmd Que	ASense
	0	0	0	1	1	0	0	0
8	X'46'	(F)	Vendor ID (ASCII)					
9	X'55'	(U)						
10	X'4A'	(J)						
11	X'49'	(I)						
12	X'54'	(T)						
13	X'53'	(S)						
14	X'55'	(U)						
15	X'20'	( )						

	BIT							
	7	6	5	4	3	2	1	0
BYTE 16	X'4D' (M)				X'4E' (N)		Product ID (ASCII)	
17	X'32' (2)				X'4F' (O)			
18	X'36' (6)				X'54' (T)			
19	X'32' (1)				X'36' ( )			
20	X'3x' (□)				X'44' (D)			
21	X'53' (S)				X'45' (E)			
22	X'20' ( )				X'54' (T)			
23	X'20' ( )				X'45' (E)			
24	X'20' ( )				X'52' (R)			
25	X'20' ( )				X'4D' (M)			
26	X'20' ( )				X'49' (I)			
27	X'20' ( )				X'4E' (N)			
28	X'20' ( )				X'45' (E)			
29	X'20' ( )				X'44' (D)			
30	X'20' ( )				X'20' ( )			
31	X'20' ( )				X'20' ( )			
32	X'xx' (xx)						Product revision (ASCII)	
33	X'xx' (xx) (Firmware revision)							
34	X'xx' (xx)							
35	X'xx' (xx)							

① Qualifier field

(0, 0, 0): The specified logical unit is an input/output unit of the type specified in the "device type" field.

(0, 1, 1): The specified logical unit is not supported. When this code is reported, the "device type code" field specifies X'1F'.

If LUN is set to 0, the IDD sets '(0, 0, 0, 0, 0)' (direct access device) in the "device type code" field; otherwise, it sets '(1, 1, 1, 1, 1)' (undefined device).

② RMB bit

When this bit is set to 1, the recording medium is removable. Since the IDD is a fixed disk drive, this bit is always set to 0.

③ Device type qualifier

This field is always set to 0.

④ SCSI Standard version

Byte 2 indicates the code indicating the version of the SCSI Standard that applies to the IDD. The IDD sets (0, 0, 1) as the ANSI Standard application level.

⑤ Response data format

This field sets the code that indicates the format of INQUIRY data. The IDD always sets (0, 0, 0, 1) in this field.

⑥ Additional data length

This field indicates the number of bytes following byte 5 of inquiry data. This value indicates the length of the inquiry data of the IDD irrespective of the value specified in the "transfer byte length" field, that is, it is always set to '1F' (overall data length = 36 bytes).

⑦ Functions provided

This field indicates the functions provided for the IDD. Each function corresponds to a bit in this field. If a bit is set to 1, the corresponding function is provided. If it is set to 0, the corresponding function is not provided.

[Byte 3]

- AENC: Asynchronous Event Notification Capability

[Byte 7]

- RelAdr: Relative Addressing
- WBus32: 32-bit Wide Data Transfer
- WBus16: 16-bit Wide Data Transfer
- Sync: Synchronous Data Transfer
- Linked: Linked Command
- Cache: Caching
- CmdQue: Command Queuing
- ASense: Autosense Transfer

⑧ Vendor ID

⑨ Product ID

This field indicates a product model name with an ASCII code. When the undefined LUN is specified, the IDD sets "Not Determined" in this field with an ASCII code.

⑩ Product revision

This field indicates the IDD's firmware revision with an ASCII code.

(11) PRIORITY RESERVE

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	1	0	1	0	0	X'14'
1	LUN			0	0	0	0	0	LUN
2	0	0	0	0	0	0	0	0	X'00'
3	0	0	0	0	0	0	0	0	X'00'
4	0	0	0	0	0	0	0	0	X'00'
5	0	0	0	0	0	0	Flag	Link	Control

This command is used to reserve the whole part of the IDD forcibly if it is reserved for another SCSI device or being used by another SCSI device. This command is executed normally if the disk drive is not ready.

The INIT that issues this command must have notified its own SCSI ID in the SELECTION phase. If the SCSI ID of the INIT cannot be identified, this command is not executed, but is terminated in the CHECK CONDITION status (ILLEGAL REQUEST).

This command is used to recover hardware errors in the multiinitiator environment. For example, if a certain INIT enters an unrecoverable error state while reserving an IDD, another INIT can get the right to access the IDD with this command.

When this command is executed, the IDD is reserved by the INIT that issued this command. The operation of the reserved IDD and the reservation cancellation condition are the same as those of the RESERVE UNIT command.

If an IDD retains an UNIT ATTENTION condition for the INIT that issued this command, this command is executed normally and the condition is cleared.

(12) MODE SELECT

		BIT							Remarks
		7	6	5	4	3	2	1	0	
BYTE	0	0	0	0	1	0	1	0	1	X'15'
	1	LUN			PF	0	0	0	SP	
	2	0	0	0	0	0	0	0	0	X'00'
	3	0	0	0	0	0	0	0	0	X'00'
	4	Parameter list length								
	5	0	0	0	0	0	0	Flag	Link	Control

This command is used to set or change various parameters related to disk drive physical attributes, data format, SCSI bus disconnection/reconnection timing, and error recovery. Using a MODE SENSE command, the INIT can obtain information about the types of parameters provided for the IDD, current parameter values, and changeable parameter ranges.

The data (MODE SELECT parameter) transferred from INIT to IDD consists of a header, block descriptor, and one or more page descriptors specifying various parameters. Page descriptors are classified according to parameter attribute. The IDD supports the following page descriptors.

Page code	Page descriptor name
1	: Read/write error recovery parameter
2	: Disconnect/reconnect parameter
3	: Format parameter
4	: Drive parameter
7	: Verify error recovery parameter
8	: Read caching parameter

When the PF (Page Format) bit of CDB byte 1 is 1, the MODE SELECT parameter sent from the INIT by this command are to be written in page descriptors. Usually, a MODE SELECT command must be issued with this bit set to 1. If this bit is 0, the IDD receives only a header and block descriptor from the INIT.

The SP (Save Pages) bit specifies whether the parameters specified by this command are to be saved on the disk. The IDD can save all parameters specified in page descriptors in page units. When the SP bit is set to 1, all pages except page 3 (format parameter) and page 4 (drive parameter) are saved on the disk immediately. If the SP bit is 0, these page parameters are not saved on the disk. Parameters in page 3 (format parameter) and page 4 (drive parameter) are saved on the disk during execution of a FORMAT UNIT command irrespective of the SP bit value set at issue of this command.

The CDB's "parameter list length" field specifies the overall length (in bytes) of MODE SELECT parameters sent from the INIT by this command. When 0 is set in the "parameter list length" field, this command ends normally without transferring data. The format and length of each MODE SELECT parameter is defined, so it must be specified (transferred) according to this length. If the overall parameter length specified in the "parameter list length" field does not match the overall length of MODE SELECT parameter definitions, this command results in the CHECK CONDITION status (ILLEGAL REQUEST) and all the parameters transferred are ignored.

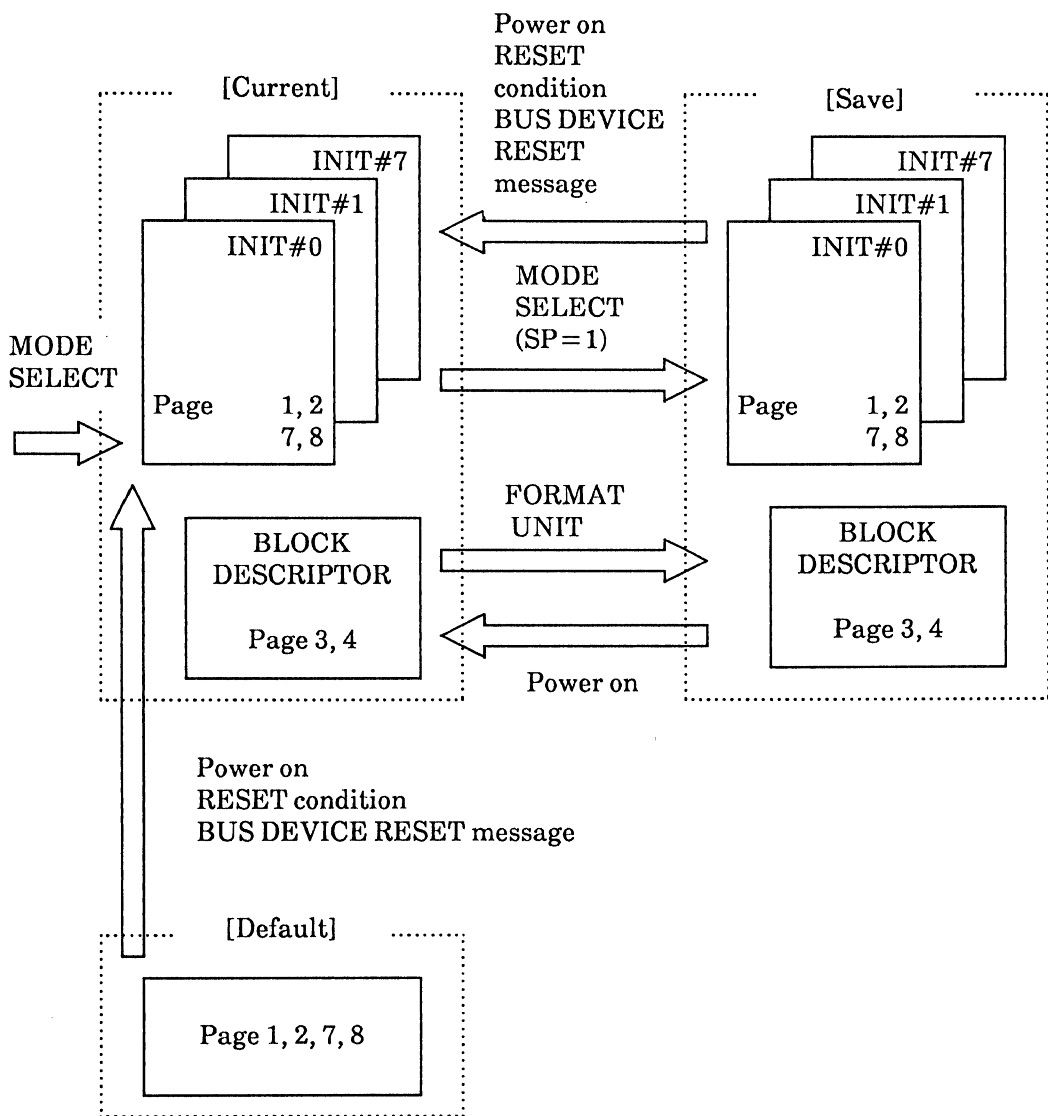
Each MODE SELECT parameter has three values; current, save, and default. A current value is the parameter that actually controls the IDD operation; the parameter specified by this command changes the current value. A save value is the parameter that is specified by this command and stored on the disk. A default value is the parameter that the IDD uses as a current value from the moment power is switched on the moment the save value has been read or when there is neither save parameter nor issued MODE SELECT command.

The IDD has a pair of current values and save values for the parameter (block descriptor, page 3, or page 4) related to the disk data format. For parameters in other pages (1, 2, 7, and 8), the IDD has independent current and save values corresponding to INIT IDs and a pair of default values that is common to all INITs. Therefore, different values may be specified in the parameters not related to the disk data format for different INITs.

When this command changes the parameters (block descriptor, page 3, or page 4) related to the disk data format, an UNIT ATTENTION condition is imposed upon all INITs except the INIT that issued this command.

At the moment the IDD is turned on, a RESET condition is produced, or the IDD receives a BUS DEVICE RESET message, the current value of the MODE SELECT parameter is initialized to the save parameter value if there is one. If there is no save parameter value, the current value is initialized to the default value.

The relationships between the current, save, and default parameters are shown below.


[Current]
INIT#7
INIT#1
INIT#0
Page 1, 2
7, 8
BLOCK
DESCRIPTOR
Page 3, 4
MODE
SELECT
Power on
RESET
condition
BUS DEVICE
RESET
message
MODE
SELECT
(SP = 1)
FORMAT
UNIT
Power on
[Save]
INIT#7
INIT#1
INIT#0
Page 1, 2
7, 8
BLOCK
DESCRIPTOR
Page 3, 4
Power on
RESET condition
BUS DEVICE RESET message
[Default]
Page 1, 2, 7, 8

The data configuration of the parameter list transferred from an INIT to an IDD by this command is shown below. The parameter list consists of a 4-byte header, a 8-byte block descriptor, and one or more page descriptors. When there is no block descriptor, the parameter list consists of a 4-byte header and one or more page descriptors.

Header

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	X'00'							
1	X'00' (Media type)							
2	X'00'							
3	X'00' or X'08' (Block descriptor length)							

Block descriptor

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	X'00'							
1	Data block count (MSB)							
2	Data block count							
3	Data block count (LSB)							
4	X'00'							
5	Data block length (MSB)							
6	Data block length							
7	Data block length (LSB)							

Page descriptor

		BIT							
		7	6	5	4	3	2	1	0
Page header	BYTE 0	0	0	Page code					
	1	Page length							
	2	Parameter field							
	≈								
	n								

a. Header

- Medium type

  X'00' (default type) must be specified in this field.

- Block descriptor length

  This field indicates the length (bytes) of the block descriptor that follows the header (not including the length of the page descriptor). Only one block descriptor can be specified for one IDD. Either X'00' or X'08' must be specified in this field. When X'00' is specified, the parameter list transferred from the INIT does not contain a block descriptor, that is, a header is followed by a page descriptor.

b. Block descriptor

An 8-byte block descriptor indicates logical attributes of the medium data format.

- Data block length

  This field indicates the total number of logical data blocks (block length is specified in the "data block length" field) allocated in the user area on the disk. When zero is specified, the user area consists of only logical data blocks having the length specified in the "data block length" field. Since the IDD composes the user area with logical blocks having the same format, this field must be set to zero or the value (indicated in the block descriptor reported by a MODE SENSE command) that is the same as the total number determined according to the value specified in the data block length, format parameter (page code = 3), and drive parameter (page code = 4).

If a value other than 0 is specified in this field and it does not match the data block count, the IDD ignores the value specified in this field. In this case, the MODE SELECT command results in the CHECK CONDITION status (recovered error). Using a MODE SENSE command, the INIT can find the number of data blocks actually used.

- Data block length

  This field specifies the byte length of the logical data block on the disk.

  The INIT can specify a nonzero value, X'100' (256), X'1EC' (492) to X'214', or X'984' (984) to X'428' (1064), in this field. If any other value is specified, the IDD performs parameter rounding. If an odd value is specified, 1 is added to it (round-up). If rounding or round-up is performed, the MODE SELECT command results in the CHECK CONDITION status (recovered error).

If zero is specified in this field, the same value as that current value is specified in this parameter.

c. Page descriptor

A page descriptor consists of a 2-byte header and a succeeding parameter field. Page descriptors are classified according to parameter attribute. The INIT may specify each page descriptor with a MODE SELECT command or it may specify multiple page descriptors in an arbitrary order.

- Page code

  This field specifies a code (page number) indicating a page descriptor type.

- Page length

  This field indicates the length (bytes) of the parameter field in bytes 2 through. The INIT must specify the same value as the page length specified in the "page descriptor" field that the IDD reported with a MODE SELECT command. If the specified page length is illegal, the MODE SELECT command results in the CHECK CONDITION status (ILLEGAL REQUEST) and all the parameters specified by the command are ignored.

  Parameters that the INIT can transfer with a MODE SELECT command and their lengths are as follows.

Parameter	Byte length
Header	4
Block descriptor	8 or 0
Page descriptor	
Page 1: Read/write error recovery parameter	12
Page 2: Disconnect/reconnect parameter	12
Page 3: Format parameter	24
Page 4: Drive parameter	20
Page 7: Verify error recovery parameter	12
Page 8: Read caching parameter	12

Configuration and functions of page descriptors are described below.

[Meanings of columns]

In the following table indicating the page descriptor configuration, the "default" column indicates the default of the parameter and the "changeable" column indicates whether the parameter may be changed (1: changeable). The INIT can find these attributes with a MODE SENSE command.

d. Read/write error recovery parameter (page code = 1)

		BIT								
		7	6	5	4	3	2	1	0	
BYTE	0	0	0	0	0	0	0	0	1	
	1	X'0A' or '06' (Page length)								
	2	0	0	TB	0	EER	PER	DTE	DCR	
	Default	0	0	1	0	1	0	0	0	
	Change-able	0	0	1	0	1	1	1	1	
	3	Retry count for read recovery								
	Default	0	0	0	1	0	0	0	0	(=16 trials)
	Change-able	1	1	1	1	1	1	1	1	
	4	Correctable bit length								
	Default	0	0	0	0	1	0	1	1	(=11 bits)
	Change-able	0	0	0	0	0	0	0	0	
	5	X'00' (Reserved)								
	6	X'00' (Reserved)								
	7	X'00' (Reserved)								
	8	Retry count for read recovery								
	Default	0	0	0	1	0	0	0	0	(=16 trials)
	Change-able	1	1	1	1	1	1	1	1	
	9	X'00' (Reserved)								
	10	X'00' (Reserved)								
	11	X'00' (Reserved)								

Both X'0A' and X'06' may be specified only for the error recovery parameter page length. However, if X'06' is specified for transfer, parameters in bytes 8 and after cannot be changed.

- TB (Transfer block)

  1 : The data block that is not recovered within the recovery limits specified should be transferred to the INIT before a CHECK CONDITION status is returned.

  0 : The data block that is not recovered within the recovery limits specified should not be transferred to the INIT.

- ERR (Enable Early Recovery)

  1 : When a recoverable data check is detected, it is not retried (read again) the number of times specified in the "retry count for read recovery" field; the data is corrected according to the ECC.

  0 : If a recoverable data check is detected, it is retried (read again) the number of times specified in the "retry count for read recovery" field, then the data is corrected according to the ECC.

- PER (Post Error)

  1: If an error that was recovered normally by the IDD is detected, the CHECK CONDITION status is reported after execution of the error. The sense key of the generated sense data indicates "Recovered Error" (contents of the error).

  0 : If any error that was recovered normally by the IDD is detected, the command results in the GOOD status and the contents of the error are not reported.

- DTE (Disable Transfer on Error)

  1 : If a disk drive error that was recovered normally by the IDD is detected, the command is terminated immediately.

  0 : If a disk drive error that was recovered normally by the IDD is detected, the command is executed continuously.

- DCR (Disable Correction)

  1 : If a correctable data check is detected, data correction according to the ECC is inhibited.

  0 : If a correctable data check is detected, data is corrected according to the ECC.

- Retry count for read recovery

  This field indicates the retry count that is needed when a data check error is detected while reading data from the disk. The IDD reads the ID of each data block repeatedly up to the retry count specified in this field. It reads data repeatedly up to the count specified in this field except that data is corrected according to the ECC.

Before the retry specified in this field, the IDD performs retry twice internally. Therefore, the actual retry count is specified number plus two. Even if 0 is specified in this field, two retries are performed automatically. Read retry recovers the block data caused read error by changing the slice level signal (reference signal for detecting data from read pulse) and the position signal (on track positioning signal) according to the retry count as shown below.

Retry count	Read retry	Retry count	Read retry
1–2	Read	11–12	Offset (−1)+Read
3	Re-seek+Read*	13–14	Offset (+2)+Read
4	Read	15–16	Offset (−2)+Read
5–6	Slice (−1)+Read	17–18	Offset (+3)+Read
7–8	Slice (+1)+Read	19–20	Offset (−3)+Read
9–10	Offset (+1)+Read	21–	To be repeated from *

- Correctable bit length

  This field indicates maximum burst error length (bits) subject to data correction according to the ECC. The INIT cannot change this parameter. The INIT must specify 0 or a default in this field. If another value is specified, the IDD reports the CHECK CONDITION status (ILLEGAL REQUEST).

e. Retry count for write recovery

This field specifies the maximum retry count needed for disk write error recovery. Before the retry specified in this field, the IDD performs retry twice internally. Therefore, the actual retry count is specified number plus two. Even if 0 is specified in this field, two retries are performed automatically.

[Combination of Error Recovery Flags]

EER	PER	DTE	DCR	Error recovery procedure
0	0	0	0	① Data read operation is retried up to the count specified in the "retry count for read recovery" or "retry count for write recovery" field, and the data is corrected according to the ECC if possible. ② If the error has been recovered successfully, command processing continues. ③ The contents of the recovered error are not reported to the INIT. ④ If an unrecoverable error is detected, the command is aborted immediately. ⑤ The data in the block containing an unrecoverable error is transferred to the INIT according to the TB bit value (READ or READ EXTENDED).
0	0	0	1	① Data read operation is retried up to the count specified in the "retry count for read recovery" or "retry count for write recovery" field, but the data is not corrected according to the ECC. ② If the error is recovered successfully, command processing continues. ③ The contents of the recovered error are not reported to the INIT. ④ If an unrecoverable error is detected, the command is aborted immediately. ⑤ The data in the block containing an unrecoverable error is transferred to the INIT according to the TB bit value (READ or READ EXTENDED).
0	0	1	0	----- (Impossible to specify) ----- (Note)
0	0	1	1	----- (Impossible to specify) ----- (Note)
0	1	0	0	① Data read operation is retried up to the count specified in the "retry count for read recovery" or "retry count for write recovery" field, but the data is not corrected according to the ECC if possible. ② If the error is recovered successfully, command processing continues. ③ If an unrecoverable error is detected, the command is aborted immediately. ④ The data in the block containing an unrecoverable error is transferred to the INIT according to the TB bit value (READ or READ EXTENDED). ⑤ If all the detected errors have been recovered, the CHECK CONDITION status (Recovered Error) is reported when execution of all commands is completed. The sense data indicates the contents of the last recovered error and the address of the block where this error occurred.

EER	PER	DTE	DCR	Error recovery procedure
0	1	0	1	① Data read operation is retried up to the count specified in the "retry count for read recovery" or "retry count for write recovery" field, but the data is not corrected according to the ECC. ② If the error is recovered successfully, command processing continues. ③ If an unrecoverable error is detected, the command is aborted immediately. ④ The data in the block containing an unrecoverable error is transferred to the INIT according to the TB bit value (READ or READ EXTENDED). ⑤ If all the detected errors are recovered, the CHECK CONDITION status (Recovered Error) is reported when execution of all commands is completed. The sense data indicates the contents of the last recovered error and the address of the block where this error occurred.
0	1	1	0	① Data read operation is retried up to the count specified in the "retry count for read recovery" or "retry count for write recovery" field, and the data is corrected according to the ECC if possible. ② Whether the error has been recovered successfully or not, the command results in the CHECK CONDITION status at completion of the error recovery. The sense data indicates the address of the data block where the error occurred. ③ The data in the block containing an error (recoverable or unrecoverable) is transferred to the INIT according to the TB bit value (READ or READ EXTENDED).
0	1	1	1	① Data read operation is retried up to the count specified in the "retry count for read recovery" or "retry count for write recovery" field, and the data is corrected according to the ECC. ② Whether the error has been recovered successfully or not, the command results in the CHECK CONDITION status at completion of the error recovery. The sense data indicates the address of the data block where the error occurred. ③ The data in the block containing an error (recoverable or unrecoverable) is transferred to the INIT according to the TB bit value (READ or READ EXTENDED).

EER	PER	DTE	DCR	Error recovery procedure
1	0	0	0	① When correctable data check is detected, the data is corrected according to the ECC immediately. When uncorrectable data check is detected, data read operation is retried up to the count specified in the "retry count for read recovery" or "retry count for write recovery" field. If the data becomes correctable in the course of retry, it is corrected according to the ECC. (For the ID, only the read operation is retried.) ② If the error is recovered successfully, command processing continues. ③ The contents of the recovered error are not reported to the INIT. ④ If an unrecoverable error is detected, the command is aborted immediately. ⑤ The data in the block containing an unrecoverable error is transferred to the INIT according to the TB bit value (READ or READ EXTENDED).
1	0	0	1	----- (Impossible to specify) ----- (Note)
1	0	1	0	----- (Impossible to specify) ----- (Note)
1	0	1	1	----- (Impossible to specify) ----- (Note)
1	1	0	0	① When correctable data check is detected, the data is corrected according to the ECC immediately. When uncorrectable data check is detected, data read operation is retried up to the count specified in the "retry count for read recovery" or "retry count for write recovery" field. If the data becomes correctable in the course of retry, it is corrected according to the ECC. (For the ID, only the read operation is retried.) ② If the error is recovered successfully, command processing continues. ③ If an unrecoverable error is detected, the command is aborted immediately. ④ The data in the block containing an unrecoverable error is transferred to the INIT according to the TB bit value (READ or READ EXTENDED). ⑤ If all the detected errors are recovered, the CHECK CONDITION status (Recovered Error) is reported when execution of all commands is completed. The sense data indicates the contents of the last recovered error and the address of the block where this error occurred.
1	1	0	1	----- (Impossible to specify) ----- (Note)

EER	PER	DTE	DCR	Error recovery procedure
1	1	1	0	① If correctable data check is detected, the data is corrected according to the ECC immediately. If uncorrectable data check is detected, data read operation is retried up to the count specified in the "retry count for read recovery" or "retry count for write recovery" field. If the data becomes correctable in the course of retry, it is corrected according to the ECC. (For the ID, only the read is retried.) ② Whether the error has been recovered successfully or not, the command results in the CHECK CONDITION status at completion of the error recovery. The sense data indicates the address of the data block where the error occurred. ③ The data in the block containing an error (recoverable or unrecoverable) is transferred to the INIT according to the TB bit value (READor READ EXTENDED).
1	1	1	1	----- (Impossible to specify) ----- (Note)

Note:

If an unspecifiable combination of error recovery flags is specified, the MODE SELECT command results in the CHECK CONDITION status (ILLEGAL REQUEST/Invalid Field in Parameter List) and all the parameters specified are ignored.

f. Disconnect/reconnect parameters (page code = 2)

		BIT								
		7	6	5	4	3	2	1	0	
BYTE	0	0	0	0	0	0	0	1	0	
	1	X'0A' (Page length)								
	2	Buffer full ratio								
	Default	0	0	0	0	0	1	0	0	(=512 bytes)
	Change-able	1	1	1	1	1	1	1	1	
	3	Buffer empty ratio								
	Default	1	0	0	0	0	0	0	0	(=12 KB)
	Change-able	1	1	1	1	1	1	1	1	
	4	X'00' (Reserved)								
	5	X'00' (Reserved)								
	6	X'00' (Reserved)								
	7	X'00' (Reserved)								
	8	X'00' (Reserved)								
	9	X'00' (Reserved)								
	10	X'00' (Reserved)								
	11	X'00' (Reserved)								

- Buffer full ratio

  This parameter specifies the timing at which the IDD starts reconnection for transferring data to the INIT with a READ or READ EXTENDED command.

  This value (n) specified in this parameter indicates the ratio of the size of the data read before the IDD starts data transfer to the overall buffer size (256). The IDD's data buffer size is 24 KB. Therefore, if the parameter value (n) is 32, the data size is 3 KB.

  When the data with the specified size can be transferred from the data buffer to the INIT, the IDD performs reconnection for starting data transfer to the INIT. If the total transferring data size specified in the command is shorter than the data size specified in this parameter, the IDD performs reconnection for starting data transfer to the INIT when 1/2 of transferring data blocks whose count is specified in the command are ready to be transferred.

- Buffer empty ratio

  This parameter specifies the timing at which the IDD starts reconnection for requesting the INIT to transfer data with a WRITE, WRITE EXTENDED, or WRITE AND VERIFY command.

  The value (n) specified in this parameter indicates the size of the unused area of the IDD's data buffer compared to the overall buffer size (256). The size of the IDD's data buffer is 24 KB. Therefore, if the parameter value (n) is 32, the unused area of the data buffer is 3 KB.

  When writing data onto the disk, the IDD uses the data that was previously prefetched in the data buffer one by one. When the unused buffer area size reaches the value specified in this parameter, the IDD performs reconnection for request transfer of the succeeding data. If the remaining data block size does not reach the specified buffer empty ratio, reconnection is performed when the size of unused area in the buffer becomes equivalent to the total size of remaining blocks.

  If the transferring byte length specified in the command is 24 KB or less, all the data is prefetched at one time, that is, the value specified in this parameter is ignored.

Note:

> If the value specified in the "buffer full ratio" or "buffer empty ratio" parameter is not at the boundary of a multiple of data block length, the IDD starts reconnection assuming that the data block boundary nearest to the specified value is specified.
>
> However, the specified parameter value is retained and the MODE SENSE command reports this value. (Neither rounding nor round-up is performed on this parameter.)

- Basic operations

  Basic operations related to disconnect and reconnect parameters are as follows.

  - Read operation

    The data read from disk is temporarily stored in the data buffer, then transferred to the SCSI bus. In this case, the IDD performs read operation in the following procedure.

    ① Upon reception of a command, the IDD disconnects the SCSI bus then performs positioning to the target block.

    ② When positioning to the target block is completed, the IDD starts reading data from the disk into the data buffer.

    ③ The IDD performs reconnection when data is read into the data buffer up to the size specified in the "buffer full ratio" parameter, thus starting data transfer to the INIT.

    ④ If the buffer becomes empty before all blocks whose count was specified in the command have been transferred because the INIT's data transfer capacity is high, the IDD issues SAVE DATA POINTER and DISCONNECT messages to save the data pointer currently being used for data transfer and perform disconnection.

    After this, reconnection and disconnection are repeated until all data blocks whose count was specified in the command have been transferred.

    ⑤ When the number of blocks specified in the command is too large and the INIT's transfer capacity is low, the unused area in the data buffer may be used up before reading all blocks (data overrun). After one rotation, the IDD performs positioning to the block in which overrun occurred and retries read operation.

    ⑥ When all the specified data blocks have been transferred, the IDD reports the status and terminates the command.

  - Write operation

    The data transferred from the INIT is temporarily stored into the data buffer, then written onto the disk. The IDD performs write operation in the following procedure.

    ① Upon reception of a command, the IDD enters the DATA OUT phase, stores the data from the INIT into the buffer, and performs positioning to the target block. After the data is stored in the buffer, the IDD performs disconnection.

If the buffer becomes full because of too many data blocks, the IDD stops data transfer from the INIT immediately, issues SAVE DATA POINTER and DISCONNECT messages, saves the current data pointer, and performs disconnection.

General Specification for buffer full ratio and buffer empty ratio

Generally, if the INIT data transfer speed is slower than the average disk drive effective data transfer speed (0.8 MB/s), when a small value is specified in both the buffer full ratio and the buffer empty ratio, the performance will be improved.

When the INIT data transfer speed is faster than the average disk drive effective data transfer speed, a larger value can be specified to shorten the possession time of the SCSI bus and to decrease overhead. Setting too great a value causes an overrun or underrun. Also, setting too great a buffer full ratio may cause a data transfer completion delay, so most efficient value has to be set for the system.

② When positioning to the target block is completed, the IDD transfers data from the buffer to the disk.

If positioning to the target block is performed earlier than completion of data storage in step ①, writing data onto the disk and storing data into the buffer are performed in parallel.

③ If all blocks whose count was specified in the command have not been transferred after disconnection, reconnection is performed for transferring the succeeding data when the size of the unused area (where data may be stored) reaches the value specified in the "buffer empty ratio" parameter.

Whenever the buffer becomes full after this, disconnection and reconnection are repeated until all data blocks whose count was specified in the command have been transferred.

④ If the data transfer capacity of the INIT is low, the buffer may become empty before completion of data prefetching (i.e., no more data cannot be written (data underrun)). After one rotation, the IDD performs positioning to the target sector while prefetching data from the INIT again, the retries write operation.

⑤ When all the specified data blocks have been written, the IDD reports the status and terminates the command.

g. Format parameter (page code = 3)

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	0	0	1	1
1	X'16' (Page length)							
2–3	Number of tracks/zone							
Default	X'000x' (=Number of heads)							
Change-able	X'0000'							
4–5	Number of tracks/zone							
Default	X'000x' (=Number of heads ÷ 2+1)							
Change-able	X'FFFF'							
6–7	Number of alternate tracks/zone							
Default	X'0000'							
Change-able	X'0000'							
8–9	Number of alternate tracks/drive							
Default	X'000x' (2 cylinders)							
Change-able	X'FFFF'							
10–11	Number of sectors/track							
Default	X'00xx'							
Change-able	X'0000'							
12–13	Data byte length/physical sector							
Default	X'xxxx'							
Change-able	X'0000'							
14–15	Interleave factor							
Default	X'0001'							
Change-able	X'0000'							

		BIT							
		7	6	5	4	3	2	1	0
16–17		Track skew factor							
	Default	X'00xx'							
	Change-able	X'0000'							
18–19		Cylinder skew factor							
	Default	X'00xx'							
	Change-able	X'0000'							
20		SSEC	HSEC	RMB	SURF	0	0	0	0
	Default	0	1	0	0	0	0	0	0
	Change-able	0	0	0	0	0	0	0	0
21		X'00' (Reserved)							
22		X'00' (Reserved)							
23		X'00' (Reserved)							

- Number of tracks/zone

  This field specifies the unit (zone) of allocation of spare sectors for alternate blocks. For the IDD, this value is equal to the number of heads. For the INIT, this value must be 0 or X'0001'.

- Number of alternate sectors/zone

  This field specifies the number of spare sectors for alternate sectors with a number of sectors per zone. The INIT may change this parameter within the range from 0 to 34. If a value exceeding 34 is specified, the IDD performs the parameter rounding. (See Note)

- Number of alternate tracks/zone

  This field specifies the area for alternate tracks with a number tracks per zone. This parameter is not changeable. The INIT must specify 0 in this field.

- Number of alternate tracks/drive

  This field specified the area for alternate blocks or tracks with a number of tracks per drive. The INIT must specify a multiple of the number of disk drive heads; it may specify tracks for 0 to 8 cylinders. If the specified value is not a multiple of the number of heads, the IDD performs the parameter round-up so that the cylinder boundary condition is satisfied. If 9 or more cylinders are specified, the IDD performs the parameter rounding so that tracks for 8 cylinders are specified in this parameter. (See Note)

  When the spare sectors (in the cylinder having the defective data block) that were allocated by the "number of alternate sectors/zone" parameter are used up, the alternate blocks are allocated to the area reserved by this parameter.

  Note:

  The INIT must not specify 0 in both "number of alternate sectors/zone" and "number of alternate tracks/drive" parameters. If 0 is specified in both parameters, the IDD performs the parameter round-up and sets a default in these parameters.

- Number of sectors/track

  This field specifies the number of sectors per track. This parameter is not changeable. The IDD ignores the value specified in this field.

- Data byte length/physical sector

  This field specifies the data length per physical sector. This parameter is not changeable. The INIT must specify 0 or the physical sector data byte length (see Table 7.3) corresponding to the logical sector data block length in this field. If another value is specified, the MODE SELECT command results in the CHECK CONDITION status (recovered error).

Table 7.3 Data byte length of corresponding physical sector

	Specification range		
Data byte length/ logical block	256 bytes	512±20 bytes (in 2 bytes)	1024±40 bytes (in 2 bytes)
Data byte length/ physical sector	512 bytes	512±20 bytes (in 2 bytes)	512±20 bytes (in one bytes)

- Interval factor

  This parameter is effective only for the MODE SENSE command. It indicates the interleave factor (always X'0001' for the IDD) of the current disk data format. For the MODE SELECT command, the value specified in this field is ignored.

- Track skew factor

  This parameter specifies the number of physical sectors (track skew) between the data block assigned the highest logical block address on a certain track and the data block assigned the next logical block address on the next track in the same cylinder. This parameter is not changeable. The IDD ignores the value specified in this field and sets the track skew most suitable for the specified data block.

- Cylinder skew factor

  This parameter specifies the number of physical sectors (track skew) between the data block assigned the highest logical block address on a certain cylinder and the data block assigned the next logical block address in the next track on the same cylinder. This parameter is not changeable. The IDD ignores the value specified in this field and sets the cylinder skew most suitable for the specified data block.

- SSEC (Soft Sectoring)

  When this bit is 1, disk data is formatted by the soft sectoring method. This parameter is not changeable. The INIT must always set this bit to 0.

- HSEC (Hard Sectoring)

  When this bit is 1, disk data is formatted by the hard sectoring method. This parameter is not changeable. Since the IDD employs the hard sectoring method, the value set in this bit is ignored.

- RMB (Removable Medium)

  If this bit is 1, the medium in the drive is removable. If this bit is 0, the medium is fixed. This parameter is not changeable. The INIT must always set this bit to 0.

- SURF (Surface Addressing)

  If this bit is 1, logical data block addresses are sequentially assigned to all sectors on the same recording plane (same head) then they are assigned to all sectors on the next recording plane (next head). When this bit is 0, logical data block addresses are assigned to all sectors on the same cylinder (all heads) then they are assigned to all sectors on the next cylinder. This parameter is not changeable. The INIT must always set this bit to 0.

h. Drive parameter (page code = 4)

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	0	1	0	0
1	X'12' (Page length)							
2–4	Number of cylinders							
Default	X'0538' (=1336)							
Changeable	X'FFFF'							
5	Number of heads							
Default	X'000x'							
Changeable	X'FFFF'							
6–8	"Write precompensation" start cylinder							
Default	X'000000'							
Changeable	X'000000'							
9–11	"Reduced Write Current" start cylinder							
Default	X'000000'							
Changeable	X'000000'							
12–13	X'0000' (Reserved)							
14–16	X'000000' (Reserved)							
17–19	X'000000' (Reserved)							

- Number of cylinders

  This field specifies the total number of cylinders that constitute the user area on the disk. This value includes the number of cylinders for alternate blocks that was specified in the "number of alternate tracks/drive" parameter (format parameter whose page code is 3). This parameter can be changed. However, the INIT must specify either 0 or the maximum number of cylinders (= 1336) usable for the user area. Zero specified in this field is equivalent to the maximum number (= 1336) of cylinders usable for the user area.

- Number of heads

  This field specifies the number of read/write heads. This parameter can be changed. However, the INIT must specify either 0 or a value that is less than the maximum number of heads. Zero specified in this field is equivalent to the maximum number of heads.

i. Verify error recovery parameter (page code = 7)

	BIT								
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	0	0	1	1	1	
1	X'0A' (Page length)								
2	0	0	0	0	EER	PER	DTE	DCR	
Default	0	0	0	0	1	1/0	0	0	(Note)
Change-able	0	0	0	0	1	1	1	1	
3	Retry count for verification								
Default	0	0	0	1	0	0	0	0	(=16 trials)
Change-able	1	1	1	1	1	1	1	1	
4	Correctable bit length								
Default	0	0	0	0	1	0	1	1	(=11 bits)
Change-able	0	0	0	0	0	0	0	0	
5	X'00' (Reserved)								
6	X'00' (Reserved)								
7	X'00' (Reserved)								
8	X'00' (Reserved)								
9	X'00' (Reserved)								
10	X'00' (Reserved)								
11	X'00' (Reserved)								

Unless otherwise specified, the above error recovery parameters are the same as read/write error recovery parameters except that they apply to verification by a VERIFY or WRITE AND VERIFY command.

j. Read caching parameter (page code = 8)

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	0	0	0	0	1	0	0	0
1	X'0A' (Page length)							
2	(Reserved)						MS	RCD
Default	0	0	0	0	0	0	0	0
Change-able	0	0	0	0	0	0	0	1
3	X'00' (Reserved)							
4	X'00' (Reserved)							
5	X'00' (Reserved)							
6	X'00' (Reserved)							
7	X'00' (Reserved)							
8	X'00' (Reserved)							
9	X'00' (Reserved)							
10	X'00' (Reserved)							
11	X'00' (Reserved)							

- RCD (Read Cache Disable)

  0 : The read-ahead cache function is effective.

  1 : The read-ahead cache function is not effective.

- MS (Multi Selection)

  Whether the minimum/maximum prefetch parameter is set with a multiplier ("transfer block count" specified in the command) or a number of logical blocks is specified. The IDD can set only 0 in this bit, that is, the number of logical blocks is selected.

- Prefetch suppression (Bytes 4 and 5)

  Since the IDD does not support this parameter, prefetching is performed for all transferring data blocks.
- Minimum prefetching data blocks (Bytes 6 and 7)

  For the IDD, the value of this parameter is fixed to 0 and unchangeable.

- Maximum prefetching data blocks (Bytes 8 to 11)

  For the IDD, the value of this parameter is fixed to the number of blocks equivalent to 24 KB and unchangeable.

[Read-Ahead Cache Function]

The simple read-ahead cache function is effective for the INIT that reads sequential data with multiple commands.

When the INIT issues a data read command, the IDD reads the specified data from the disk, transfers it to the INIT, and prefetches the succeeding data into the buffer. If the next command requests transfer of the buffer data, the data is directly transferred from the buffer (not from the disk). Thus, the latency time is eliminated when sequential data is read with multiple commands. That is, the apparent access time is reduced.

If the requested data does not exist in the buffer (error), read operation is terminated immediately and the next requested data is read.

If the issued command is a write instruction for the same block as that in the buffer, all the preceding data blocks in this buffer are cleared. The data written into the buffer with a WRITE command is not subject to the read-ahead cache function.

If one of the following commands that uses a buffer is issued in the IDD, all data in the buffer is cleared.

<Commands that clear all data in buffer>

FORMAT UNIT, REASSIGN BLOCKS, READ DEFECT DATA, MODE SELECT, MODE SENSE, START/STOP UNIT (Stop Instruction), READ LOG, SEND DIAGNOSTIC, WRITE BUFFER, READ LONG, and WRITE LONG

All data in the buffer is also cleared in the following cases.

① When a RESET condition arises

② When a BUS DEVICE RESET message is received from the INIT.

After execution of a READ or READ EXTENDED command, the read-ahead cache function is repeatedly executed until one of the following conditions arises.

① When all data blocks are prefetched up to the track boundary immediately after data transfer to INIT

② When all data blocks are prefetched up to the cylinder boundary

③ When a new command is received from an INIT and its function is to clear whole data in the buffer

④ When a new command (READ or READ EXTENDED) is received from an INIT and the beginning of the first logical data block specified by this command cannot be hit properly

⑤ When a recoverable error occurs within the IDD during a prefetch operation

(13) RESERVE UNIT

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	1	0	1	1	0	X'16'
1	LUN			3rd Pty	3rd Pty Dev ID			0	
2	x	x	x	x	x	x	x	x	
3	x	x	x	x	x	x	x	x	
4	x	x	x	x	x	x	x	x	
5	0	0	0	0	0	0	Flag	Link	Control

This command controls exclusive access to a logical unit (IDD) under the multi-initiator environment together with a RELEASE UNIT command.

The IDD is reserved by the INIT that issued this command or another SCSI device specified in the CDB.

The INIT that issues this command must report its own SCSI ID during the SELECTION phase execution. If this ID cannot be identified, this command is not executed and it results in the CHECK CONDITION status (ILLEGAL REQUEST/Initiator's SCSI ID Not Identified). CDB bytes 2 to 4 are ignored if set.

a. Reservation function

This command reserves the entire IDD (logical unit) for a specific SCSI device. The reserved state set by this command is maintained until one of the following conditions arises.

- When the reservation condition is changed by the INIT that issued this command (superseding reservation)
- When the INIT that issued this command cancels the reservation with the RELEASE UNIT command
- When a PRIORITY RESERVE command is executed by an INIT
- When a BUS DEVICE RESET message is issued from an INIT
- When a 'Hard' Reset condition arises
- When the IDD power is turned on/off

When the IDD is reserved for an SCSI and an INIT that does not have the right to reserve this IDD issues this command, this command results in the RESERVATION CONFLICT status.

After reservation of the IDD, all commands issued from an INIT other than the SCSI device that reserved the IDD are rejected (INQUIRY, REQUEST SENSE, PRIORITY RESERVE, and RELEASE UNIT commands are excluded) and the RESERVATION CONFLICT status is reported. INQUIRY, REQUEST SENSE, and PRIORITY RESERVE commands are executed normally if the IDD is reserved by another SCSI device. The RELEASE UNIT command results in the GOOD status; however, the RELEASE command issued from an SCSI device that does not have the right to reserve the IDD is ignored.

b. Reservation right and third party reservation function

When the "3rd Pty" bit of CDB byte 1 is 0, the IDD is reserved by the INIT that issued this command; that is, this INIT has the right to reserve this IDD.

When the "3rd Pty" bit is 1, a third party reservation function is specified. The INIT that issued this command by specifying the third party reservation function can reserve the IDD for the SCSI device that specified the IDD in the "3rd Pty Dev ID" field in CDB byte 1. If the IDD is reserved for another SCSI device using a third party reservation function, the INIT that issued this command has the right to reserve this IDD. To release the reserved state, the INIT that issued this command must issue a RELEASE UNIT command. The condition of maintaining the reserved state set using the third party reservation function does not change if this function is not used.

c. Modification of reservation condition (Superseding reservation)

The INIT that has the right to reserve the IDD can change the reservation condition by issuing another RESERVE UNIT command (superseding reservation).

After completion of superseding reservation, the IDD releases the existing reserved state and sets a new reserved state for a new RESERVE UNIT command.

Using this function, the INIT can change the SCSI device (that will reserve a logical unit) without canceling the logical unit that was previously reserved by the third party reservation function.

(14) RELEASE UNIT

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	1	0	1	1	1	X'17'
1	LUN			3rd Pty	3rd Pty Dev ID			0	
2	x	x	x	x	x	x	x	x	
3	0	0	0	0	0	0	0	0	X'00'
4	0	0	0	0	0	0	0	0	X'00'
5	0	0	0	0	0	0	Flag	Link	Control

This command is used to release the IDD reserved for the INIT. This command may be executed when the disk drive is not ready.

This command results in the GOOD status if the IDD is not in the INIT-related reserved state or the reserved state subject to release specified by the CDB of this command or the IDD is reserved by another SCSI device. In this case, this command does not affect the IDD's reserved state.

This INIT that issues this command must notify its own SCSI ID during selection phase execution. If this ID cannot be identified, this command is not executed and it results in the CHECK CONDITION status (ILLEGAL REQUEST/Initiator's SCSI ID Not Identified). CDB byte 2 is ignored if set.

a. Release function

This command release any IDD (logical unit) reserved by the INIT that issued this command.

b. Object of release and third party release function

When the "3rd Pty" bit of CDB byte 1 is 0, this command releases the IDD that the INIT (which issued this command) reserved by issuing a RESERVE UNIT command (without the third party reservation function) if such an IDD exists.

When the "3rd Pty" bit is 1, the third party release function is specified. Thus, this command can release the reserved state that was set by the third party reservation function. When the third party release function is specified, this command releases the IDD that was reserved by the INIT which issued this command (using a RESERVE UNIT command with the third party reservation function) for the SCSI device whose SCSI ID was specified in the "3rd Pty Dev ID" field of CDB byte 1 of this command.

(15) MODE SENSE

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	1	1	0	1	0	X'1A'
1	LUN			PF	0	0	0	0	LUN
2	PC		Page code						
3	0	0	0	0	0	0	0	0	X'00'
4	Transfer byte length								
5	0	0	0	0	0	0	Flag	Link	Control

This command is used to report various parameter values and attributes related to disk drive physical attributes and data format, SCSI bus disconnection/connection timings, and error recovery procedure to an INIT.

As explained below, the data (MODE SENSE data) transferred from IDD to INIT by this command consists of a header, a block descriptor, and one or more page descriptors containing parameters.

When the "PF (Page Format)" bit of CDB byte 1 is 1, the MODE SENSE data to be transferred to the INIT by this command is written in the page descriptor format. The IDD ignores this bit; it always transfers the MODE SENSE data specified in the CDB's "page code" field to the INIT using the page descriptor format.

The "page code" field of CDB byte 2 specifies the page code of the page descriptor to be transferred by this command. The IDD supports the following page descriptors and page codes.

Page code	Page descriptor name
1	: Read/write error recovery parameter (12 bytes)
2	: Disconnect/reconnect parameter (12 bytes)
3	: Format parameter (24 bytes)
4	: Drive parameter (20 bytes)
7	: Verify recovery parameter (12 bytes)
8	: Caching parameter (12 bytes)
3F	: All page descriptors supported by IDD (92 bytes)

When X'00' is specified in the "page code" field, only the header and block descriptor are transferred to the INIT but page descriptors are not transferred.

The "PC (Page Control)" field of CDB byte 2 specifies the type of the parameters in page descriptors.

PC	Types of parameters to be transferred to INIT
00	Current value: The current value of each parameter is reported. The meaning of the current value is given below. 0 is set in the field and bit positions that are not supported. ● The current value is the value specified in the last executed MODE SELECT command. ● The current value is the same as the save value if a MODE SELECT command has not been executed after power-on, generation of RESET condition, or reception of a BUS DEVICE RESET message from an INIT. ● For a parameter other than page 3 and page 4 parameters, the current value is the same as the default value if the save value does not exist
01	Values that can be changed: The parameter field and parameter bit that the INIT can change with a MODE SELECT command are reported. 1 is set at changeable field and bit positions and 0 is set at unchangeable or unsupported field and bit positions.
10	Default value: The default value of each parameter is reported. Page 3 and page 4 parameters are the same as the save value.

PC	Types of parameters to be transferred to INIT
11	Save value: The save value of each parameter is reported. Save values are as follows. ● For a parameter other than page 3 and page 4 parameters, the save value is specified in the last executed MODE SELECT command whose SP bit is 1. If this command has not been executed (no save value), the save value is as the default value. ● For page 3 and page 4 parameters, the save value indicates the value saved on the disk by a FORMAT UNIT command.

The "transfer byte length" field of the CDB specifies total number of MODE SENSE data bytes that can be transferred to the INIT with this command. The IDD transfers whole the MODE SENSE data specified in the "page code" field or the MODE SENSE data whose length is specified in the "transfer byte length", whichever is shorter, to the INIT. If 0 is specified in the "transfer byte length" field, no data is transferred.

The data configuration of the parameter list (MODE SENSE data) that is transferred to the INIT with this command is shown below. A 4-byte header, 8-byte block descriptor, and one or more page descriptors specified in the CDB are sequentially transferred to constitute a parameter list. When X'00' is specified in the "page code" field of the CDB, page descriptors are not transferred.

<u>Header</u>

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	Sense data length							
1	X'00' (Medium type)							
2	WP	X'00'						
3	X'08' (Block descriptor length)							

Block descriptor

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	X'00'							
1	Number of data blocks (MSB)							
2	Number of data blocks							
3	Number of data blocks (LSB)							
4	X'00'							
5	Data block length (MSB)							
6	Data block length							
7	Data block length (LSB)							

Page descriptor

		BIT							
		7	6	5	4	3	2	1	0
Page header	BYTE 0	PS	0	Page code					
	1	Page length							
	2	Parameter field							
	≈								
	n								

a. Header

- Sense data length

  This field indicates the total number of bytes (except this byte) of the parameter list that can be transferred to the INIT with this command. The IDD-supported length of the parameter list whose type is specified in the CDB is set in this field irrespective of the value specified in the CDB's "transfer byte length" field. To check that the whole parameter list requested by this command has been transferred, the INIT must make sure that the value of this field plus 1 is less than the value of the CDB's "transfer byte length" field.

- Medium type

  X'00' (default type) is always set in this field.

- WP bit

  When this bit is 1, data must not be written onto the disk. When it is 0, data may be written onto the disk. Use the setting switch on the IDD, to inhibit or permit writing data onto the disk.

- Block descriptor length

  This field indicates the length (bytes) of the block descriptor following the header. This value does not include the length of the page descriptor. The IDD always sets X'08' in this field to indicate that the header is followed by a block descriptor.

b. Block descriptor

The 8-byte block descriptor indicates the logical attributes of the disk data format.

- Number of data blocks

  This field indicates the total number of logical data blocks (the data block length is indicated by the "data block length" field) that exist in the user area. This value does not include the number of spare sectors reserved for alternate block processing.

- Data block length

  This field indicates the length (bytes) of a logical data block on disk.

c. Page descriptor

A page descriptor consists of a 2-byte page header and a parameter field. It is classified into pages by the parameter function type. See the explanation of the MODE SELECT command for details on the page descriptor configuration and definition contents.

- PS bit

  When this bit is 1, the parameter values specified in this page descriptor can be saved on the disk. When this bit is 0, these parameter values are not saved on the disk. All page descriptors supported by the IDD may be saved. Therefore, this bit is always set to 1 for all page descriptors transferred by this command.

- Page length

  This field indicates the length of the parameter field except the page header (in byte 1). The IDD sets the same value as the definition length of the "page descriptor" irrespective of the parameter type specified in the CDB's "PC (Page Control)" field and sets all parameters fields in the page descriptor.

- Parameter field

  The parameter field from bytes 2 indicate the parameters whose type is specified in the "PC (Page Control)" field. For definitions, default values, and parameter values that can be changed, see the explanation of the MODE SELECT command.

(16) START/STOP UNIT

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	1	1	0	1	1	X'1B'
1	LUN			0	0	0	0	Immed	
2	0	0	0	0	0	0	0	0	X'00'
3	0	0	0	0	0	0	0	0	X'00'
4	0	0	0	0	0	0	0	Start	
5	0	0	0	0	0	0	Flag	Link	Control

This command controls the start and stop of the disk drive's spindle motor.

The start bit (bit 0 of CDB byte 4) is used to control the spindle motor. If this command is issued when the start bit is set to 0, the spindle motor stops. If this command is issued when the start bit is set to 1, the spindle motor starts.

The starting method of the disk drive spindle motor may be adjusted by the setting switch on the IDD. If this switch is set to inhibit motor start control, the spindle motor starts immediately after the IDD is turned on. If the setting switch is set to enable motor start control, the motor does not start if the IDD is turned on. In this case, the INIT can use this command to control start of the spindle motor.

The only function of the above setting switch is to specify the method of starting the spindle motor at power on. Accordingly, this command is effective irrespective of the position of this switch.

If this command is issued to start the spindle motor when it has already been started or is issued to stop the spindle motor when it has already stopped, this command ends normally.

When this command is issued to start the spindle motor, its end timing depends on the "Immed (Immediate)" bit (bit 0 of CDB byte 1) as follows.

- When the Immed bit is 1, the command ends in the GOOD status immediately after specifying start of the spindle motor. That is, it ends before the disk drive becomes ready.
- When the Immed bit is 0, the command ends after the disk drive becomes ready (after the spindle motor starts).

(17) RECEIVE DIAGNOSTIC RESULTS

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	1	1	1	0	0	X'1C'
1	LUN			PF	0	0	0	0	
2	0	0	0	0	0	0	0	0	X'00'
3	Transfer byte length (MSB)								
4	Transfer byte length (LSB)								
5	0	0	0	0	0	0	Flag	Link	Control

This command is used to transfer the data (response data) indicating the SEND DIAGNOSTIC command execution result from an IDD to an INIT. The format and contents of the response data are determined by the parameter list (page code) specified by the INIT with a SEND DIAGNOSTIC command.

When the "PF (Page Format)" bit of the CDB is 1, the response data sent to the INIT by this command is written in the page format described later. However, the IDD ignores this bit; it always transfers page-format response data to the INIT.

The "transfer byte length" of the CDB indicates the maximum number of response data bytes that the INIT can receive using this command. The IDD transfers the response data whose length is specified in this field or the valid response data, whichever is shorter, to the INIT. If 0 is set in this field, this command ends without transferring any data.

The response data is not valid until the "SelfTest (Self Test)" bit is set to 0 and the SEND DIAGNOSTIC command is executed with a specific operation specified in the parameter. This command transfers the response data indicating the result of the last SEND DIAGNOSTIC command executed by the IDD, to the INIT. The response data is not cleared after execution of this command. It is valid until the next SEND DIAGNOSTIC command is executed, a RESET condition arises, or an INIT issues a BUS DEVICE RESET message.

If this command is issued when there is not effective response data, the IDD transfers up to four bytes of X'00' data to the INIT according to the specification in the "transfer byte length" field of the CDB.

The format of the response data transferred from an IDD to an INIT by this command is shown below. The response data consists of a 4-byte header and page parameters.

		BIT							
		7	6	5	4	3	2	1	0
Header	BYTE 0	Page code							
	1	0	0	0	0	0	0	0	0
	2	Page parameter length (MSB)							
	3	Page parameter length (LSB)							
Page parameter	4								
	5	Parameters							
	≈	≈							
	n								

- Page code

  This field indicates the same value as that specified in the parameter list transferred from the INIT by the last executed SEND DIAGNOSTIC command, that is, it indicates the code for identifying the type of the response data transferred by this command.

- Parameter length

  This field indicates the length (bytes) of the parameters in bytes 4 through n.

  The type and contents of the response data transferred to the INIT with this command are as follows.

a. Page code list

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	X'00' (Page code)							
1	0	0	0	0	0	0	0	0
2	X'00' (Page parameter length)							
3	X'02' (Page parameter length)							
4	X'00' [Page code list]							
5	X'40' [Logical/physical address conversion]							

For this response data, the page code list of parameter pages that the IDD supports with a SEND DIAGNOSTIC or RECEIVE DIAGNOSTIC RESULTS command is set in bytes 4 and on.

b. Logical/physical address conversion

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	X'40' (Page code)							
1	0	0	0	0	0	0	0	0
2	X'00' (Page parameter length)							
3	X'0A' (Page parameter length)							
4	0	0	0	0	0	Address format before conversion		
5	RAREA	ALTSEC	ALTTRK	0	0	Address format after conversion		
6	Logical or physical address							
7								
≈								
13								

For this response data, the result of address conversion specified by the "logical/physical address conversion" parameter is set in bytes 4 and on.

The value set in the "address format before conversion" field in byte 4 or the "address format after conversion" field in byte 5 is the same as the address information representation format code specified in the parameter of the SEND DIAGNOSTIC command. However, the "address format after conversion" field indicates the format of the address information set in bytes 6 to 13 of this response data. Address format codes are as follows.

Code	Address format
000	: Logical block address format
100	: Bytes from index format
101	: Physical sector address format

Note:

The IDD adopts a 632-byte hard sector method (34 sectors/track), so the physical sector address does not depend on the logical block size; it is fixed to 632 bytes. After conversion, the distance (bytes) from the index indicates the starting position of this physical sector.

RAREA (Reserved Area), ALTSCT (Alternate Sector), and ALTTRK (Alternate Track) bits indicate the disk area and state of the data block indicated by the address information in bytes 6 to 13.

RAREA	ALTSCT	ALTTRK	
0	0	0	The data block is in the primary area. ① Normal block ② The block is slipped to an area other than a spare sector.
0	1	0	The data block is on the alternate sector assigned previously. ① The block is slipped to a spare sector. ② The block is assigned to a spare sector on the same cylinder or an alternate cylinder.
1	0	0	The data block exists in the primary area but it is a defective block for which alternate block assignment has been performed. It has not been used as a logical data block.
1	1	0	The data block is a spare sector that has not been used (not assigned or defective).

The format of the address information in bytes 6 to 13 is the same as that of the D-list which is transferred from the INIT by a FORMAT UNIT command. For further details, see the explanation of the FORMAT UNIT command. In the logical block address format, bytes 6 to 9 are used for address setting and the remaining bytes are set to 0. If the address information specified in the SEND DIAGNOSTIC command indicates a position on an unused disk for a logical data block (RAREA = 1), X'FFFFFFFF' is set as a logical block address after conversion.

The algorithm of the address conversion made by a SEND DIAGNOSTIC command and the address information (after conversion) reported to the INIT by this command are as follows.

- Logical block address → Logical block address

  The logical block address specified in the SEND DIAGNOSTIC command is set as it is, and the disk area in which the data block is located is indicated by the ALTSCT bit.

- Logical block address → Bytes from index

  The starting position of all physical sectors containing the logical data block specified in the SEND DIAGNOSTIC command is set, and the disk area in which the logical data block exists is indicated by the ALTSCT bit.

- Logical block address → Physical sector address

  All addresses of all physical sectors containing the logical data block specified in the SEND DIAGNOSTIC command are set, and the disk area in which the logical data block exists is indicated by the ALTSCT bit.

- Bytes from index → Logical block address

  All addresses of logical blocks containing the byte position specified in the SEND DIAGNOSTIC command are set, and the disk area in which the data block exists and its state are indicated by the RAREA and ALTSCT bits.

- Bytes from index → Bytes from index

  The starting position of the physical sector containing the byte position specified in the SEND DIAGNOSTIC command is set. The disk area in which the sector exists and its state are indicated by the RAREA and ALTSCT bits.

- Bytes from index → Physical sector address

  The address of the physical sector containing the byte position specified in the SEND DIAGNOSTIC command is set. The disk area in which the sector exists and its state are indicated by the RAREA and ALTSCT bits.

- Physical sector address → Physical block address

  All addresses of logical block addresses assigned to the physical sector specified in the SEND DIAGNOSTIC command are set, and the disk area in which the data block exists and its state are indicated by the RAREA and ALTSCT bits.

- Physical sector address → Bytes from index

  The starting position of the physical sector specified in the SEND DIAGNOSTIC command is set. The disk area in which the sector exists and its state are indicated by RAREA and ALTSCT bits.

- Physical sector address → Physical sector address

  The physical sector address specified in the SEND DIAGNOSTIC command is already set. The disk area in which the sector exists and its state are indicated by the RAREA and ALTSCT bits.

(18) SEND DIAGNOSTIC

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	0	1	1	1	0	1	X'1D'
1	LUN			PF	0	Self-Test	DevOfl	Unit-Ofl	
2	0	0	0	0	0	0	0	0	X'00'
3	Page parameter length								
4	Page parameter length								
5	0	0	0	0	0	0	Flag	Link	Control

This command is used to perform the self-diagnostics supported by the IDD or the operation specified by the parameter transferred from the INIT.

When the "PF (Page Format)" bit of the CDB is 1, the parameter list transferred from the INIT is edited in the page format described later. However, the IDD ignores this bit and assumes that a page-format parameter list is specified whenever a parameter list is sent by this command (SelfTest bit = 0).

When the "SelfTest (Self Test)" bit of the CDB is 1, this command performs self-diagnostics supported by the IDD. In this case, the "parameter list length" field of the CDB is meaningless and the specified value is ignored. The "DevOfl (Device Offline)" bit of the CDB specifies permission or inhibition of the operation that will affect the logical unit other than that specified in this command. Since the IDD has only one logical unit, this bit is meaningless and the specified value is ignored.

The INIT can specify the type of self-diagnostics by setting the "UnitOfl (Unit Offline)" bit of the CDB. When the SelfTest bit is set to 1, the IDD executes a self-diagnostics sequence according to the value of the UnitOfl bit as follows.

Self-diagnostic type	UnitOfl = '0'	UnitOfl = '1'
① Controller function test	×	×
② Disk drive function test		×
③ Disk medium (CE area) write/read/data comparison test		×

(× : Execution)

When all the specified self-diagnostic tests are completed, the IDD reports a GOOD status. If an error is detected in any one of the specified tests, the CHECK CONDITION status is reported and detailed error information is indicated by the sense data.

When the SelfTest bit is 0, the IDD performs the operation specified in the parameter list that is transferred from the INIT by this command. When the specified operation ends and the response data is prepared, the IDD reports a GOOD status and terminates this command. The INIT can read the execution result (response data) with a RECEIVE DIAGNOSTIC RESULTS command.

The "parameter list length" of the CDB indicates the length (bytes) of the parameter list transferred from the INIT when the SelfTest bit is 0. When 0 is set in the "parameter list length" field, this command ends without performing any operation. If the value specified in the "parameter list length" field does not match the predetermined parameter list length, the command results in the CHECK CONDITION status (ILLEGAL REQUEST/Illegal Field in CDB).

When the SelfTest bit is set to 0, the DevOfl and UnitOfl bits are meaningless and the specified values are ignored.

The format of the parameter list transferred from an INIT to an IDD by this command is shown below. The parameter list consists of a 4-byte page header and page parameters. Using this command, the INIT can specify only one parameter page.

- Page code

  This field specifies the type of a parameter list transferred from the INIT and the code of the operation to be performed by the IDD.

- Page parameter length

  This field specifies the length (bytes) of the page parameter specified in bytes 4 through n.

		BIT							
		7	6	5	4	3	2	1	0
Header	BYTE 0	Page code							
	1	0	0	0	0	0	0	0	0
	2	Page parameter length (MSB)							
	3	Page parameter length (LSB)							
Page parameter	4	Parameters							
	5								
	≈								
	n								

The parameter page and its functions that the INIT can specify in this command are as follows.

a. Page code list

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	X'00' (Page code)							
1	0	0	0	0	0	0	0	0
2	X'00' (Page parameter length)							
3	X'00' (Page parameter length)							

This parameter page specifies transfer of the page code list of the parameter pages that the IDD supports with a SEND DIAGNOSTIC or RECEIVE DIAGNOSTIC RESULTS commands, to the INIT. The page code list is transferred to the INIT by the RECEIVE DIAGNOSTIC RESULTS command which is issued after the SEND DIAGNOSTIC command that specified this parameter page.

b. Logical/physical address conversion

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	X'40' (Page code)							
1	0	0	0	0	0	0	0	0
2	X'00' (Page parameter length)							
3	X'0A' (Page parameter length)							
4	0	0	0	0	0	Address format before conversion		
5	0	0	0	0	0	Address format after conversion		
6	Logical or physical address							
7								
≈								
13								

This parameter page specifies conversion of the address information written in the logical block address, physical sector address, or bytes from index format. The INIT specifies the address information to be converted in this parameter page of the SEND DIAGNOSTIC command and reads the conversion result with a RECEIVE DIAGNOSTIC RESULTS command.

The "address format before conversion" field in the parameter page indicates the format of the address information set in bytes 6 to 13. The IDD converts this address information to the format specified in the "address format after conversion" field. Address format codes are as follows.

Code	Address format
000	: Logical block address format
100	: Bytes from index format
101	: Physical sector address format

The format of the address information set in bytes 6 to 13 is the same as the format of the D-list transferred from the INIT with a FORMAT UNIT command. For further details, see the explanation of the FORMAT UNIT command. Use bytes 6 to 9 to specify a logical block address format and set 0s in the remaining bytes.

For details on the algorithm of address conversion made by this parameter and the format of conversion result data transferred to the INIT, see the explanation of the RECEIVE DIAGNOSTIC RESULTS command.

7.2.2 Group 1 command

(1) READ CAPACITY

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	1	0	0	1	0	1	X'25'
1	LUN			0	0	0	0	0	LUN
2	Logical block address (MSB)								
3	Logical block address								
4	Logical block address								
5	Logical block address (LSB)								
6	0	0	0	0	0	0	0	0	X'00'
7	0	0	0	0	0	0	0	0	X'00'
8	0	0	0	0	0	0	0	PMI	
9	0	0	0	0	0	0	Flag	Link	Control

This command is used to transfer information about the disk drive capacity and data block size to the INIT.

When the "PMI (Partial Medium Indicator)" bit (bit 0 of CDB byte 8) is 0, the logical block address and size (bytes) of the last accessible data block is transferred to the INIT.

When the PMI bit is 1, the logical block address and size (bytes) of the data block that is located after the data block specified in the CDB's "logical block address" field and satisfies one of the following conditions are reported to the INIT.

- The data block must precede the block for which alternate block assignment processing (except block skip processing) was performed first on the cylinder having the specified block. If an alternate block is assigned to the specified block, the data block must be specified by the CDB.

- If there is no data block assigned as an alternate block on the cylinder having the specified block, the above data block must be the last one in this cylinder.

The format of the data transferred by this command is as follows.

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	Logical block address (MSB)							
1	Logical block address							
2	Logical block address							
3	Logical block address (LSB)							
4	block size (MSB)							
5	block size							
6	block size							
7	block size (LSB)							

Note:

When the PMI bit is 1, it is assumed that alternate block assignment has been completed whether the destination of the assignment is on the same cylinder or alternate cylinder.

(2) READ EXTENDED

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	1	0	1	0	0	0	X'28'
1	LUN			0	0	0	0	0	LUN
2	Logical block address (MSB)								
3	Logical block address								
4	Logical block address								
5	Logical block address (LSB)								
6	0	0	0	0	0	0	0	0	X'00'
7	Transfer block count (MSB)								
8	Transfer block count (LSB)								
9	0	0	0	0	0	0	Flag	Link	Control

This command is used to read successive logical data blocks whose count is specified in the "transfer block count" field from the logical data block (on the disk) specified in the CDB's "logical block address" field, and transfer them to the INIT.

The functions of this command are the same as those of the group-0 READ command except that the 4-byte "logical block address" and 2-byte "transfer block count" fields can be specified. If the "transfer block count" field is 0, the cylinder/track having the data block specified in the "logical block address" field is only sought; other functions are not executed.

(3) WRITE EXTENDED

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	1	0	1	0	1	0	X'2A'
1	LUN			0	0	0	0	0	LUN
2	Logical block address (MSB)								
3	Logical block address								
4	Logical block address								
5	Logical block address (LSB)								
6	0	0	0	0	0	0	0	0	X'00'
7	Transfer block count (MSB)								
8	Transfer block count (LSB)								
9	0	0	0	0	0	0	Flag	Link	Control

This command is used to write data transferred from the INIT into the successive logical data blocks (on disk), from the logical data block specified in the CDB's "logical block address" field.

The functions of this command are the same as those of the group-0 WRITE command except that the 4-byte "logical block address" and 2-byte "transfer block count" fields can be specified. If the "transfer block count" field is 0, the cylinder/track having the data block specified in the "logical block address" field is only sought; other functions are not executed.

(4) SEEK EXTENDED

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	1	0	1	0	1	1	X'2B'
1	LUN			0	0	0	0	0	LUN
2	Logical block address (MSB)								
3	Logical block address								
4	Logical block address								
5	Logical block address (LSB)								
6	0	0	0	0	0	0	0	0	X'00'
7	0	0	0	0	0	0	0	0	X'00'
8	0	0	0	0	0	0	0	0	X'00'
9	0	0	0	0	0	0	Flag	Link	Control

This command is used to seek the cylinder/track having the logical data block specified in the "logical block address" field of the CDB.

The functions of this command are the same as those of the group-0 SEEK command except that a 4-byte "logical block address" may be specified.

(5) VERIFY

		BIT								Remarks
		7	6	5	4	3	2	1	0	
BYTE	0	0	0	1	0	1	1	1	1	X'2F'
	1	LUN			0	0	0	0	0	LUN
	2	Logical block address (MSB)								
	3	Logical block address								
	4	Logical block address								
	5	Logical block address (LSB)								
	6	0	0	0	0	0	0	0	0	X'00'
	7	Transfer block count (MSB)								
	8	Transfer block count (LSB)								
	9	0	0	0	0	0	0	Flag	Link	Control

This command is used to read verify successive logical data blocks whose count is specified in the "block count" field, from the logical data block (on the disk) specified in the CDB's "logical block address" field.

The CDB's "block count" field specifies the number of data blocks subject to verification. When the "block count" field is 0, this command only seeks the cylinder/track having the logical data block specified in the "logical block address" field; it does not perform other functions.

This command performs verification by only checking whether the CRC (ID) and ECC (data) are normal. Any error detected during verification is recovered in the mode specified in the parameter (page 7: error recovery parameter) of the MODE SELECT command. If a correctable data error is detected during verification, it is assumed that the verification has been completed successfully when data correction is not inhibited.

(6) WRITE AND VERIFY

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	1	0	1	1	1	0	X'2E'
1	LUN			0	0	0	0	0	LUN
2	Logical block address (MSB)								
3	Logical block address								
4	Logical block address								
5	Logical block address (LSB)								
6	0	0	0	0	0	0	0	0	X'00'
7	Transfer block count (MSB)								
8	Transfer block count (LSB)								
9	0	0	0	0	0	0	Flag	Link	Control

This command is used to write the data transferred from the INIT into the successive logical data blocks whose count is specified in the "block count" field, from the logical data block specified in the CDB's "logical block address" field, and read this data again for verification.

The write functions of this command are the same as those of the WRITE EXTENDED command.

This command performs verification by only checking whether the CRC (ID) and ECC (data) are normal. Any error detected during verification is recovered in the mode specified in the parameter (page 7: error recovery parameter) of the MODE SELECT command. If a correctable data error is detected during verification, it is assumed that the verification has been completed successfully when data correction is not inhibited.

(7) SET LIMITS

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	1	1	0	0	1	1	X'33'
1	LUN			0	0	0	RdInh	WrInh	
2	Logical block address (MSB)								
3	Logical block address								
4	Logical block address								
5	Logical block address (LSB)								
6	0	0	0	0	0	0	0	0	X'00'
7	Transfer block length (MSB)								
8	Transfer block length (LSB)								
9	0	0	0	0	0	0	Flag	Link	Control

This command specifies the address range and executable operation type of a logical data block (on the IDD) that can be accessed by the command linked with this command. In a linked command group, this command can be issued only once.

The CDB's "logical block address" field specifies the address of the logical data block located at the beginning of the accessible address range. The "block length" field specifies the number of successive logical data blocks counted from the beginning of the accessible address range. The command linked with this command can access an address within the range from [value specified in the "logical block address" field] to [(value specified in the "logical block address" field) + (value specified in the "block count" field) − 1]. If the value of the "block length" field is 0, addresses can be accessed within the range from the logical data block specified in the "logical block address" field to the last logical data block on the IDD.

When the "RdInh (Read Inhibit)" flag (bit 1 of CDB byte 1) or the "WrInh (Write Inhibit)" flag (bit 0 of CDB byte 1) is 1, read or write operation is inhibited for the command linked with this command. (Notes)

RdInh	WrInh		Restriction on operation
0	0	:	Read/write operation is enabled within the specified range.
0	1	:	Only read operation is enabled within the specified range.
1	0	:	Only write operation is enabled within the specified range.
1	1	:	Both read and write operations are inhibited. Accessing by a SEEK or SEEK EXTENDED command is enabled only within the specified range.

Notes:

1. When the RdInh flag or the WrInh flag is 1, read or write operation is inhibited for the following commands:

Flag	Command
RdInh	READ, READ EXTENDED (*), WRITE AND VERIFY (*), VERIFY (*), READ LONG
WrInh	WRITE, WRITE EXTENDED (*), WRITE AND VERIFY (*), FORMAT UNIT, REASSIGN BLOCKS, WRITE LONG

* : If 0 is set in the "block count" field, the command is not executed.

2. If write operation is inhibited for this command, the MODE SENSE EXTENDED command sets the "WP (Write Protected)" bit to 0 for the INIT.

If a command linked with this command specifies access to a logical data block outside the address range specified by this command or it specifies an inhibited access type, it is not executed; it is terminated in the CHECK CONDITION status (DATA PROTECT/No Sense Code). If this command is issued again in a linked command group, it is rejected and the CHECK CONDITION status (DATA PROTECT/Command Sequence Error) is reported.

(8) READ DEFECT DATA

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	1	1	0	1	1	1	X'37'
1	LUN			0	0	0	0	0	LUN
2	0	0	0	PList	GList	Defect list format			
3	0	0	0	0	0	0	0	0	X'00'
4	0	0	0	0	0	0	0	0	X'00'
5	0	0	0	0	0	0	0	0	X'00'
6	0	0	0	0	0	0	0	0	X'00'
7	Transfer block length (MSB)								
8	Transfer block length (LSB)								
9	0	0	0	0	0	0	Flag	Link	Control

This command is used to transfer the list (defect data) of disk defect locations to the INIT.

There are two types of defect data lists: P-list (primary defect list) and G-list (grown defect list). The P-list indicates the disk drive defects found at delivery from the factory. On the other hand, the G-list indicates positions of the defective blocks to which alternate blocks were assigned according to the defect position information specified by the INIT during execution of a REASSIGN BLOCKS or FORMAT UNIT command.

By setting the CDB's "PList (Primary List)" or "GList (Grown List)" bit, the INIT can specify the type of defect data to be transferred to the INIT. Moreover, the INIT can specify the format of defect data in the "defect list format" field.

PList	GList		Defect data type
1	1	:	P-list and G-list (Note)
1	0	:	P-list only
0	1	:	G-list only
0	0	:	4-byte header information only (described later)

Defect list format				Defect data format
0	0	0	:	Block address format
1	0	0	:	Byte from index format
1	0	1	:	Physical sector address

Note:

When transfer of both P-list and G-list are requested, the IDD transfers the P-list first, then the G-list. (Defect information merging is not performed.)

The CDB's "transfer byte count" field specifies the length (bytes) of the defect data that the INIT can receive. The IDD terminates data transfer when all defect data with the length specified in the "transfer byte length" field or all defect data of the specified type is transferred. If 0 is specified in the "transfer byte count" field, this command ends without transferring data.

The format of the defect data transferred to the INIT by this command is as follows:

		BIT							
		7	6	5	4	3	2	1	0
Header	BYTE 0	X'00'							
	1	0	0	0	PList	GList	Defect list format		
	2	Page parameter length (MSB)							
	3	Page parameter length (LSB)							
Defect descriptor	4	Defect data							
	≈								
	n								

a. Header

- PList (Primary List) bit

  When this bit is 1, the defect descriptor transferred to the INIT actually contains the defect data of the P-list. When it is 0, the defect descriptor does not contain the defect data of the P-list. (Notes 1 and 3)

- GList (Grown List) bit

  When this bit is 1, the defect descriptor transferred to the INIT actually contains the defect data of the G-list. When it is 0, the defect descriptor does not contain the defect data of the G-list. (Notes 1, 3, and 4)

- Defect list format

  This field indicates the format of the defect descriptor actually transferred to the INIT. The IDD can transfer data written in one of three formats that can be specified in the CDB. This field specifies the same value as that specified in the CDB's "defect list format" field.

- Defect list length

  This field indicates the total number of defect descriptor list bytes that can be transferred after a 4-byte header. It is a multiple of 4 or 8 depending on the defect descriptor format. This field indicates the total number of bytes of defect data of the specified type (P-list or G-list) that is written in the specified format (defect list format) irrespective of the value specified in the CDB's "transfer byte length" field. To confirm that all defect data requested by this command has been transferred, the INIT must check that the value specified in this field plus 4 is less than the value specified in the CDB's "transfer byte length" field. The INIT can determine the number of disk defects according to the value (quotient) obtained by dividing the value specified in this field by the number of bytes (4 or 8) per defect descriptor. (Notes 1 and 2)

b. Defect descriptor list

The data transferred after the 4-byte header is a "defect descriptor" list containing defect location data whole type and format were specified in the CDB. When a block address format is used, the length of one descriptor is 4 bytes. When a byte from index format or physical sector address format is used, its length is 8 bytes. The defect descriptor is not always transferred in ascending order of defect location.

See the explanation of the FORMAT UNIT command for details on the configuration and contents of defect descriptors written in three different formats.

Notes:

1. When both PList and GList bits of the CDB are set to 0, this command transfers only the header having the following information.

   - PList bit: 0
   - GList bit: 0
   - "Defect list length" field: Total number of bytes of defect data written in the P-list and G-list in the defect list format.

2. The INIT issues this command, specifying 4 in the CDB's "transfer byte length" field to check the header information transferred from the IDD, thus finding the length (count) of defect data contained in the P-list and/or G-list.

3. Since the IDD records all defect data position information only with 632-byte-format (34 sectors/track) physical sector addresses, the defect data written in the bytes from index format is not recorded in the IDD. Therefore, if the CDB requests the defect data written in the bytes from index format, the IDD reports a representative value (first byte distance) of the defective physical sector address.

4. When the CDB specifies a G-list, this bit is set to 1 if the G-list does not contain defect data.

(9) WRITE BUFFER

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	1	1	1	0	1	1	X'3B'
1	LUN			0	0	Mode			
2	Buffer ID								
3	Buffer address (MSB)								
4	Buffer address								
5	Buffer address (LSB)								
6	Transfer byte length (MSB)								
7	Transfer byte length								
8	Transfer byte length (LSB)								
9	0	0	0	0	0	0	Flag	Link	Control

This command is used together with the READ BUFFER command to check that the IDD data buffer memory and SCSI bus are normal. This command can be executed when the disk drive is not ready. Data on the disk is not changed when this command is executed.

The IDD stores the data transferred from the INIT in the IDD data buffer. The IDD has a single 24-KB (24576-byte) data buffer. For this command, the data storage position can be specified in bytes using buffer addresses X'000000' to X'005FFF'. The CDB's "buffer ID" field must always be set to 0s. The INIT can find the IDD configuration and address specification unit with a READ BUFFER command.

The function of this command and the format of the data transferred from the INIT are specified in the "mode" field (CDB byte 1). One of the following transfer modes can be selected.

"Mode" Bit 2	1	0		Transfer mode
0	0	0	:	Header + Data, Address not specified
0	0	1	:	Header + Data, Address specified
0	1	0	:	Data only, Address specified

a. Mode = 0, 0, 0: Header + Data, Address not specified

In this mode, the data transferred from the INIT must begin with a 4-byte header (all 0s). The CDB's "buffer ID" and "buffer address" fields must be set to 0s.

The CDB's "transfer data length" field specifies the total number of bytes of data transferred from the INIT in this mode. The transfer byte count includes four bytes of the header. The IDD stores the data (except the header) transferred from the INIT (data length = transferred data bytes − 4 bytes of header) in the data buffer from the beginning (address '000000').

The value specified in the CDB's "transfer byte length" field must be less than the IDD buffer size plus 4 bytes; otherwise, data is not transferred from the INIT and this command results in a CHECK CONDITION status (ILLEGAL REQUEST). If 0 is specified in the "transfer byte length" field, data is not transferred and this command ends normally.

The format of the data transferred from the INIT in this mode is shown below.

		BIT							
		7	6	5	4	3	2	1	0
Header	BYTE 0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0
Data	4	Buffer data (byte 0)							
	5	Buffer data (byte 1)							
	≈	≈							
	n	Buffer data (byte n–4)							

b. Mode = 0, 0, 1: Header + Data, Address specified

The format of the data transferred from the INIT in this mode is the same as "Mode = 0, 0, 0". The transferred data must begin with a 4-byte header (all 0s) and the CDB's "buffer ID" field must be set to 0s.

In this mode, the CDB's "buffer address" field must specify the address of the data buffer that stores the data transferred from the INIT.

The CDB's "transfer data length" field specifies the total number of bytes of the data transferred from the INIT in this mode. The transfer byte length includes four bytes of the header. The IDD stores the data (except the header) transferred from the INIT (data length = transferred data bytes − 4 bytes of header) in the data buffer from the data buffer byte position specified in the CDB's "buffer address" field.

The value specified in the CDB's "transfer byte length" field must be equal to or less than (IDD buffer size − "buffer address" field value + 4 bytes); otherwise, data is not transferred from the INIT and this command results in a CHECK CONDITION status (ILLEGAL REQUEST). If 0 is specified in the "transfer byte length" field, data is not transferred and this command ends normally.

c. Mode = 0, 1, 0: Data only, Address specified

The data transferred from the INIT in this mode does not require a 4-byte header.

The CDB's "buffer ID" field must be set to 0s. The CDB's "buffer address" field may specify the starting address of the data buffer in which the data from the INIT is stored.

The CDB's "transfer data length" field specifies the total number of bytes of the data transferred from the INIT in this mode. The IDD sequentially stores the data transferred from the INIT in the data buffer from the byte position specified in the CDB's "buffer address" field.

The value specified in the CDB's "transfer byte length" field must be less than (IDD buffer size − "buffer address" field value); otherwise, data is not transferred from the INIT and this command results in a CHECK CONDITION status (ILLEGAL REQUEST). If 0 is specified in the "transfer byte length" field, data is not transferred and this command ends normally.

(10) READ BUFFER

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	1	1	1	1	0	0	X'3C'
1	LUN			0	0	Mode			
2	Buffer ID								
3	Buffer address (MSB)								
4	Buffer address								
5	Buffer address (LSB)								
6	Transfer byte length (MSB)								
7	Transfer byte length								
8	Transfer byte length (LSB)								
9	0	0	0	0	0	0	Flag	Link	Control

This command is used together with the WRITE BUFFER command to check that the IDD data buffer memory and SCSI bus are normal. This command can be executed when the disk drive is not ready. Data on the disk is not changed when this command is executed.

The IDD has a single 24-KB (24576-byte) data buffer. For this command, the data byte in the data buffer can be specified in bytes using buffer addresses X'000000' to X'005FFF'. The CDB's "buffer ID" field must always be set to 0s.

The function of this command and the format of the data transferred from the INIT are specified in the "mode" field (CDB byte 1). One of the following transfer modes may be selected:

"Mode" Bit 2	1	0		Transfer mode
0	0	0	:	Header + Data, Address not specified
0	0	1	:	Header + Data, Address specified
0	1	0	:	Data only, Address specified
0	1	1	:	Buffer descriptor

a. Mode = 0, 0, 0: Header + Data, Address not specified

In this mode, the data stored in the IDD data buffer is transferred to the INIT after a 4-byte header. The CDB's "buffer ID" and "buffer address" fields must be set to 0s.

The CDB's "transfer data length" field specifies the total number of bytes of the header and buffer data that the INIT can receive. The IDD transfers the data read from the beginning (address '000000') of the data buffer, to the INIT after a 4-byte header. The data transfer ends when the header with a size specified in the "transfer byte length" field has been transferred or data buffer data has been read and transferred up to the last byte position (address '00FFFF'). This commands ends normally if the value (bytes) specified in the "transfer byte length" field is greater than the total length of header and data buffer. If the "transfer byte length" field is set to 0s, this command ends normally without transferring data.

The format of the data transferred to the INIT in this mode is shown below.

		BIT							
		7	6	5	4	3	2	1	0
Header	BYTE 0	0	0	0	0	0	0	0	0
	1	Effective buffer data length (MSB)							
	2	Effective buffer data length							
	3	Effective buffer data length (LSB)							
Data	4	Buffer data (byte 0)							
	5	Buffer data (byte 1)							
	≈	≈							
	n	Buffer data (byte n–4)							

The "effective buffer data length" field specifies the size (bytes) of the IDD data buffer. This value specifies the size of the IDD data buffer that can be used for this command or WRITE BUFFER command irrespective of the size specified in the CDB's "transfer byte length " field of this command or the size of the data actually stored in the data buffer with the WRITE BUFFER command. The length of the data transferred to the INIT by this command is the value specified in the CDB's "transfer byte length" field minus 4 bytes or the value specified in the "effective buffer data length", whichever is smaller.

b. Mode = 0 ,0, 1: Header + Data, Address specified

The format of the data transferred to the INIT in this mode is the same as "Mode = 0, 0, 0". The data stored in the IDD data buffer is transferred to the INIT after a 4-byte header. The CDB's "buffer ID" field must be set to 0s.

In this mode, the address in the data buffer can be specified in the CDB's "buffer address" field.

The CDB's "transfer data length" field specifies the total number of bytes of the header and buffer data that the INIT can receive. The IDD transfers the data read from the byte position in the data buffer specified in the CDB's "buffer address" field, to the INIT after a 4-byte header. The data transfer ends when the header with a size specified in the "transfer byte length" field has been transferred or buffer data has been read and transferred up to the last byte position (address '00FFFF'). This commands ends normally if the value specified in the "transfer byte length" is greater than the total length of the header and data buffer (up to the last byte). If the "transfer byte length" field is set to 0s, this command ends normally without transferring data.

The format and contents of the 4-byte header transferred in this mode is the same as "Mode = 0, 0, 0". The "effective buffer data length" field in the header indicates the size of the data buffer between the data buffer byte position specified in the CDB's "buffer address" field and the position of the last byte of the data buffer. The length of the data transferred to the INIT by this command is the value (bytes) specified in the CDB's "transfer byte length" field minus 4 bytes or the value specified in the "effective buffer data length" field in the header, whichever is smaller.

c. Mode = 0, 1, 0: Data only, Address specified

Only the data read from the IDD data buffer is transferred to the INIT in this mode. Unlike "Mode = 0, 0, 0" and "Mode = 0, 0, 1", the header is not transferred. The CDB's "buffer ID" field must be set to 0s.

In this mode, the address in the data buffer can be specified in the CDB's "buffer address" field.

The CDB's "transfer data length" field specifies the total number of bytes of the buffer data that the INIT can receive. The IDD transfers the data read from the byte position in the data buffer specified in the "buffer address" field, to the INIT. The data transfer ends when the buffer data with a size specified in the "transfer byte length" field has been transferred or buffer data has been transferred up to the last byte position (address '00FFFF') in the IDD data buffer. This commands ends normally if the value specified in the "transfer byte length" is greater than the size of the data buffer (up to the last byte position). If the "transfer byte length" field is set to 0s, this command ends normally without transferring data.

d. Mode = 0, 1, 1: Buffer descriptor

In this mode, the IDD transfers only a 4-byte buffer descriptor to the INIT. This descriptor indicates the attributes of the IDD data buffer. When this mode is specified, CDB's "buffer ID" and "buffer address" fields must be set to 0. The IDD transfers data (buffer descriptor) with a length specified in the "transfer byte length" field or 4-byte data, whichever is shorter, to the INIT. If 0 is specified in the "transfer byte length" field, this command ends normally without transferring data.

The format of the buffer descriptor transferred in this mode is as follows.

	BIT							
	7	6	5	4	3	2	1	0
BYTE 0	X'00' Addressing boundary							
1	X'00' Buffer size (MSB)							
2	X'60' Buffer size							
3	X'00' Buffer size (LSB)							

The "addressing boundary" field in the buffer descriptor indicates the "exponent" for "power of 2" indicating the address boundary in the data buffer that can be specified with a WRITE BUFFER or READ BUFFER command. The IDD sets X'00' (= 20) to indicate that address specification at the byte boundary is enabled.

The "buffer size" field specifies the size (bytes) of the data that can be handled with a WRITE BUFFER or READ BUFFER command. The IDD sets X'006000' (= 24 KB).

(11) READ LONG

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	1	1	1	1	1	0	X'3E'
1	LUN			0	0	0	0	0	LUN
2	Logical block address (MSB)								
3	Logical block address								
4	Logical block address								
5	Logical block address (LSB)								
6	0	0	0	0	0	0	0	0	X'00'
7	Transfer byte length (MSB)								
8	Transfer byte length (LSB)								
9	0	0	0	0	0	0	Flag	Link	Control

This command reads the data and ECC bytes of the logical data block (on the disk) specified in the CDB's "logical block address" field and transfers them to the INIT. Generally, this command is combined with a WRITE LONG command to check the ECC function. This command cannot execute the ECC function.

This command can handle only one data block. The data transferred to the INIT by this command is shown below. (Note: The synchronous byte pattern is not transferred.)

Format of logical block consisting of 256 or 492 to 532 bytes

Data (n bytes)	ECC (7 bytes)

Format of logical block consisting of 984 to 1064 bytes

Data (1/2n bytes)	ECC (7 bytes)	Data (1/2n bytes)	ECC (7 bytes)

The CDB's "transfer byte length" field indicates the number of bytes of the data to be transferred to the INIT by this command. The total length (bytes) of data and ECC must be specified. If the "transfer byte length" field value is 0, this command only seeks the cylinder/track that has the logical data specified in the CDB's "logical block address" field; it ends normally without transferring data to the INIT.

If the length specified in the "transfer byte length" field does not match the format of the disk data, this command does not transfer data to the INIT and results in the CHECK CONDITION status. In this case, the sense data indicates the following information so that the INIT can find a valid transferring byte count.

- Sense key: 05 ILLEGAL REQUEST
- Sense code: 24 = Illegal Field in CDB
- VALID bit: '1'
- ILI bit: '1'
- Information byte: (CDB's "transfer byte length" field value) – (Valid "transfer byte length" field value)

Note:

A negative value is expressed by a 2's complement.

(12) WRITE LONG

	BIT								Remarks
	7	6	5	4	3	2	1	0	
BYTE 0	0	0	1	1	1	1	1	1	X'3F'
1	LUN			0	0	0	0	0	LUN
2	Logical block address (MSB)								
3	Logical block address								
4	Logical block address								
5	Logical block address (LSB)								
6	0	0	0	0	0	0	0	0	X'00'
7	Transfer byte length (MSB)								
8	Transfer byte length (LSB)								
9	0	0	0	0	0	0	Flag	Link	Control

This command writes the data transferred from the INIT into the logical data block (the disk) specified in the CDB's "logical block address" field as its data part and ECC bytes. Generally, this command is combined with a READ LONG command to check the ECC function.

This command can handle only one data block. The data transferred from the INIT by this command must have the same configuration and length as the data transferred from an IDD to an INIT by a READ LONG command.

The CDB's "transfer byte length" field indicates the number of bytes of the data to be transferred from the INIT by this command. The total length (bytes) of data and ECC must be specified. If the "transfer byte length" field value is 0, this command just seeks the cylinder/track that has the logical data specified in the CDB's "logical block address" field; it ends normally without transferring data to the INIT.

If the length specified in the "transfer byte length" field does not match the format of the disk data, this command does not transfer data to the INIT; it results in the CHECK CONDITION status. In this case, the sense data indicates the following information so that the INIT can find a valid transferring byte length:

- Sense key: 05 ILLEGAL REQUEST
- Sense code: 24 = Illegal Field in CDB
- VALID bit: '1'
- ILI bit: '1'

- Information byte: (CDB's "transfer byte length" field value) – (Valid "transfer byte length" field value)

  Note:

  A negative value is expressed by a 2's complement.

7.3 UNIT ATTENTION Condition

When the following condition occurs, the IDD maintains the UNIT ATTENTION condition.

- Not Ready to Ready or Reset

  When the IDD enter the ready state from the not ready state, or when the IDD is reset by the RESET condition or BUS DEVICE RESET message, this UNIT ATTENTION condition is created. The UNIT ATTENTION condition persists for each INIT until the condition which clears it, described later, is satisfied.

- Mode Select Parameters Changed

  The MODE SELECT parameter concerning the data block size has been changed by any INIT. This UNIT ATTENTION condition persists for each INIT other than the INIT that changed the parameters.

When the IDD maintains the UNIT ATTENTION condition for the INIT, the IDD returns the CHECK CONDITION status upon receipt of an I/O request except when the command is either INQUIRY, REQUEST SENSE, or PRIORITY RESERVE. The UNIT ATTENTION condition for that INIT is cleared by reporting the CHECK CONDITION status. At this time, the sense key of the sense data indicates a UNIT ATTENTION.

When the IDD receives the INQUIRY command during the UNIT ATTENTION condition, the INQUIRY command is executed normally. The UNIT ATTENTION condition, however is not cleared and is maintained.

When the IDD receives the REQUEST SENSE command during keeping the UNIT ATTENTION condition, the IDD sends the sense data which indicates the UNIT ATTENTION condition. At this time, the UNIT ATTENTION condition for that INIT is cleared.

When the IDD receives the PRIORITY RESERVE command during the UNIT ATTENTION CONDITION, the IDD executes the command normally. At this time, the UNIT ATTENTION CONDITION for the INIT which issued the command is cleared.

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CHAPTER 8 STATUS BYTE AND SENSE DATA

8.1 Status Byte

A status byte sent from an IDD to an INIT upon completion of each command indicates the status of the command execution. Figure 8.1 shows the format of the status byte.

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

Bit 4321	
0000	GOOD status
0001	CHECK CONDITION status
0100	BUSY status
1000	INTERMEDIATE/GOOD status
1100	RESERVATION CONFLICT status

Figure 8.1 Status byte

(1) GOOD status

This status indicates that a command has been completed successfully.

(2) CHECK CONDITION status

This status is reported either as a result of executing a command or when an I/O request issued from an INIT can not be executed. In either case, the IDD enters a sense data pending state.

(a) When reported as result of executing a command, this status indicates that the command has terminated abnormally except the case of (b) described below. This sense data then contains the details of the error.

(b) When the sense data indicates a "Recovered Error" sense key, the last command which resulted in CHECK CONDITION status has been completed successfully with some recovery operation performed by the IDD.

(c) This status is reported upon receipt of any of the following I/O requests.

- When an invalid LUN is specified except when an INQUIRY command is issued.
- When a specification error or an illegal condition is detected in the issued CDB.
- When the INIT for which the IDD is maintaining the UNIT ATTENTION condition issues an I/O request, except when REQUEST SENSE, INQUIRY, or PRIORITY RESERVE command is issued. See Section 7.3 for details.
- If a hardware error is detected while an I/O request is being transmitted.

(3) BUSY status

This status indicates that the IDD is in a BUSY status and can not accept any new I/O request. This status is reported in any of the following cases.

(a) While the IDD is executing a command issued by another INIT.

(b) When the IDD is in the following set up state.

- The IDD is reading a device information from the disk after power-on.
- The IDD has not complete the reading a device information from the disk and the IDD is reading a device information from the disk after receiving an immediate START/STOP UNIT command.
- The IDD reads a device information again caused by receiving the RESET condition or BUS DEVICE RESET message.

(4) INTERMEDIATE status

This status indicates that a command which specifies command link has been completed successfully.

(5) RESERVATION CONFLICT status

This status indicates that the IDD is reserved by another INIT and is not usable until the reservation is released. This status is, however, not returned when a REQUEST SENSE, INQUIRY, or RELEASE UNIT command is issued to the IDD reserved by another INIT. The REQUEST SENSE or INQUIRY command is executed normally. The IDD ignores the attempt to release the reservation made by mother INIT.

8.2 Sense Data

Sense data is transmitted when the IDD reports a CHECK CONDITION status, or when the IDD forces the BUS FREE phase due to a catastrophic SCSI bus related error.

The sense data implemented in IDD is an extended sense format only. The INIT can retrieve the sense data by a REQUEST SENSE command.

8.2.1 Sense data pending state

The IDD goes to sense data pending state after one of the following conditions occurs. The state continues until either of the following reset requirements are satisfied:

- When IDD responds a CHECK CONDITION status to an INIT.
- When the IDD forces a BUS FREE phase due to a catastrophic SCSI bus related error.

The sense data pending state and the sense data are maintained or the INIT subject to either of the above-mentioned actions, with respect to the LUN specified at that time (*1).

The following provide reset responses an I/O request issued to the IDD in sense data pending state and sense data pending state.

(a) I/O request from an INIT other than the INIT for which the sense data is preserved can be accepted and executed normally.

(b) I/O request from the INIT for which the sense data is preserved is normally accepted when the LUN in a sense data pending state is specified. If a command other than NO OPERATION command is issued, the sense data pending state is reset. If a REQUEST SENSE command is issued, the retained sense data is sent to the INIT. Execution of a command other than the NO OPERATION command causes the retained sense data to be cleared. Similarly, when the INIT issues an ABORT message, the sense data pending state is reset, and the sense data is lost.

If an I/O operation is issued from the INIT for which the sense data is preserved to an LUN other than the LUN which is in sense data pending state, the IDD returns a BUSY status.

If a CHECK CONDITION has been reported as a result of an invalid LUN, the incorrectly-specified LUN is set to sense data pending state. Therefore, in this case, the INIT is required to reset the sense data pending state by specifying the same LUN that caused the CHECK CONDITION.

A CHECK CONDITION status is reported if an error is detected during above-mentioned processings. The IDD then generates new sense data and goes to another sense data pending state with respect to the LUN specified at that time.

(c) The sense data is lost and the sense data pending state is reset in the following cases, in addition to the cases described above.

- If a RESET condition is detected in SCSI
- If a BUS DEVICE RESET message is received from any INIT

*1: If the SCSI ID of the INIT has not been identified, no SCSI ID of the INIT has been notified in the SELECTION phase, IDD goes to a special sense data pending state with no identified INIT. In this state, IDD regards a new I/O request with no notified SCSI ID of an INIT as an I/O request from the INIT for which the sense data is preserved.

8.2.2 Extended sense data

Figure 8.2 shows the format of extended sense data (Error class = '7', Error code = '0') implemented in the IDD. The extended sense data reports detailed information on an error.

(1) Valid

When this bit is 1, the value indicated in the information field (bytes 3 to 6) is valid. When this bit is 0, the information field does not have valid information.

(2) Error code

This field indicates the format and type of sense data. The IDD always indicates X'70' which means the extended sense data format in this field.

(3) ILI (incorrect length indicator)

When this bit is 1, the transfer byte-length requested by the command did not match the data block length on the disk. Commands that report 1 to this bit for the IDD are the READ LONG and WRITE LONG commands only.

(4) Sense key

This field indicates the cause of sense data generation. Codes indicating more detailed reasons are indicated in the sense code field and subsense code field. Table 8.1 lists sense keys and their meanings.

(5) Information

This field indicates information related to the detected error. This field is valid when the Valid bit is 1. Information indicated in this field has the following meaning depending on the ILI bit value.

(a) When the ILI bit is 0, the logical block address of the data block where the error occurred is indicated.

(b) When the ILI bit is 1, the difference between the transfer byte-count requested by the command and the actual data block count on the disk is indicated. When the difference is a negative value (i. e. the requested number of transferred bytes is smaller), it is represented with a complement of 2. Depending on the command in which the error occurs, two parameters for recovery may be needed. In such a case, parameter information is indicated in the "command specific information" field.

(6) Additional sense data length

This field indicates the length (bytes) of sense data for byte 8 and succeeding bytes. The value indicated in this field always indicates the length of sense data retained by the IDD regardless of the value specified in the ;"transfer byte count" field of the CDB in the REQUEST SENSE command. The IDD sense data length is fixed at 48 bytes, so this field always indicates X'28' (40 bytes).

(7) Command specific information

This field indicates information inherent to the command that generated the error. The command that validates this field value for the IDD is the REASSIGN BLOCKS command only.

(8) Sense code

Codes indicating the detailed reason for the error indicated by the sense key are reported to these fields. Table 8.2 lists definitions of sense codes.

(9) IDD SCSI ID

This field indicates the SCSI ID of the IDD that generates the sense data.

(10) LUN

This field indicates the logical unit number (LUN) for which the sense data is generated.

	Bit 7	6	5	4	3	2	1	0	
BYTE 0	Valid	X'70' (Error code)							
1	X'00'								
2	0	0	ILI	0	Sense key				
3	(MSB)								
4	Information								
5									
6								(LSB)	
7	X'28' Additional sense length								
8	(MSB)								
9	Command specific information								
10									
11								(LSB)	
12	Additional sense code								
13	X'00' (Additional sense code qualifier)								*
14	X'00' (Field replaceable unit code)								*
15	X'00'								
16	X'00'								
17	X'00'								
18	0	0	IDD SCSI ID			LUN			
19	X'00'								
20	Detail Information (TBD)								
~									
47									

Figure 8.2 Extended sense data

Table 8.1 Sense key

Sense Key	Name	Description
0	No Sense	No particular sense key exists for a specified LUN.
1	Recovered Error	This sense key indicates that the last command completed successfully with some recovery operation performed by the IDD. This sense key is reported only when the PER (Post Error) bit of the MODE SELECT parameters has been set to one.
2	Not Ready	The disk drive unit is not in Ready state
3	Medium Error	An unrecoverable error has been detected due to a media defect or an error in the recorded data.
4	Hardware Error	An unrecoverable hardware error was detected while the IDD executes a command or self-diagnostics.
5	Illegal Request	An illegal value was detected in either a parameter transferred by a command settling, or parameter in the CDB, or the LUN setting is incorrect. If the IDD detects an invalid parameter in the CDB, then it terminates the command without altering the disk media. However, if an invalid parameter is detected in the additional parameters supplied by DATA OUT phase, then the IDD may or may not have already alternated the media.
6	Unit Attention	One of the following conditions has been detected. For details, see Section 7.3. ● IDD has been reset by RESET condition or a BUS DEVICE RESET message. ● IDD has entered ready state from Not Ready. ● MODE SELECT parameters concerning the data format has been changed by another INIT.
7	Data Protect	An illegal operation (read or write) has been attempted for an read-inhibited or write-inhibited area. The command is not executed.
8	Blank Check	Unused.
9	(Reserved)	
A	Copy Aborted	Unused.
B	Aborted Command	The IDD has terminated a command abnormally. The INIT can re-issue the command for recovery.
C	Equal	Unused.
D	Volume Overflow	Unused.
E	Miscompare	Unused.
F	(Reserved)	

Table 8.2 Additional sense code X'00' to X'0F'

Additional sense code	Name	Explanation	Related sense key
00	No Additional Sense Information	No additional sense code is present.	all
01	No Index/Sector Signal	Unused	4
02	No Seek Complete	Seek operation not completed during the time allotted.	4
03	Write Fault	(1) Write Fault detected during write (2) Offset Write is detected.	4
04	Drive Not Ready	Drive not ready to be accessed	2
05	Drive Not Selected	Unused	2
06	No Track Zero Found	Unused	4
07	Multiple Drives Selected	Unused	4
08	Logical Unit Communication Failure	(1) Error detected in the IDD interface (2) No error attention is reported.	4
09	Track Following Error	Track following error occurred during read/write operation	1, 4
0A to 0F	(Reserved)		

Note:

To identify numbers given in the related sense key column, see Table 8.1.

Table 8.3 Additional sense code X'10' to X'1F'

Additional sense code	Name	Explanation	Related sense key
10	ID CRC Error	CRC error detected in ID field.	1, 3
11	Unrecovered Read Error	Unrecoverable error detected in the data field during read operation.	3
12	No Sync Byte Found in ID Field	SB (Sync Byte) cannot be detected in the ID field.	1, 3
13	No Sync Byte Found in Data Field	SB (Sync Byte) cannot be detected in the data field.	1, 3
14	No Record Found or Bed Block Found	Data block (sector) cannot be detected.	1, 3
15	Seek Positioning Error	① Seek error occurred in drive. ② Cylinder Address in the ID field does not correspond with address given.	1, 3, 4
16	Data Synchronization Mark Error	Unused.	3
17	Recovered Read Data with Re-Read Retries	Read data recovered using read retry.	1
18	Recovered Read Data with ECC Correction	Read data recovered using ECC correction.	1
19	Defect List Error	Error detected when defect list (G-list) was read.	1, 3, 4
1A	Parameter Overrun	Unused.	1
1B	Synchronous Transfer Error	Error detected during synchronous data transfer.	4
1C	Primary Defect List Not Found	Cannot find primary defect list (recorded at the factory)	1, 3, 4
1D	Compare Error	Unused.	E
1E	Recovered ID with ECC Correction	Unused.	1
1F	(Reserved)		

Table 8.4 Additional sense code X'20' to X'2F'

Additional sense code	Name	Explanation	Related sense key
20	Invalid Command Operation Code	Byte 0 (Operation Code) in CDB is incorrect.	5
21	Illegal Logical Block Address	Logical block address given exceeds the maximum value specified by the drive	5
22	Illegal Function for Device Type	Unused.	5
23	(Reserved)		
24	Illegal Field in CDB	Setting in the CDB is incorrect	5
25	Invalid LUN	Invalid LUN given	5
26	Invalid Field in Parameter List	Setting of the parameter list transmitted from INIT during command operation is invalid.	5
27	Write Protected	Write operation attempted in a write protected area.	7
28	Not Ready to Ready Transition	Unused.	6
29	Power On, RESET or BUS DEVICE RESET occurred	State immediately after power on. Or state immediately after resetting by the RESET condition or the BUS DEVICE RESET message.	6
2A	MODE SELECT Parameters Changed	MODE SELECT parameter of the data format was changed by another INIT.	6
2B	Copy Cannot Execute Since Host Cannot Disconnect	Unused.	5
2C	Command Sequence Error	The command issue sequence is incorrect.	5
2D to 2F	(Reserved)		

Table 8.5 Additional sense code X'30' to X'3F'

Additional sense code	Name	Explanation	Related sense key
30	Incompatible Cartridge	Unused.	3
31	Medium Format Corrupted	The medium format is different from the original one. ① Formatting was not performed after the data format setting was changed under the MODE SELECT command. ② Formatting cannot be completed, cause unknown.	3
32	No Defect Spare Location Available	No alternative blocks available for usage. (Includes table overflow)	3
33 to 36	(Reserved)		
37	Rounded Parameter	The MODE SELECT parameter specified by the command was rounded.	1
38	(Reserved)		
39	Save Parameter Not Supported	Unused.	5
3A to 3B	(Reserved)		
3C	Link/Flag Bit Not Supported	Unused.	5
3D	Defect List Not Available	Defect list format given not supported by the read defect data.	1, 3, 4
3E	Logical Unit Has Not Self-Configured Yet	Set up operations of the IDD not yet completed.	2
3F	Microcode Has Been Downloaded	Unused.	6

Table 8.6 Additional sense code X'40' to X'FF'

Additional sense code	Name	Explanation	Related sense key
40	RAM Failure	Error detected in the self-diagnostic RAM.	4
41	Data Path Diagnostic Failure	Error detected in the self-diagnostic data path.	4
42	Power on Failure	Error detected during self-diagnostic at Power on.	4
43	Unsuccessful Message Retry	The message sent from the IDD was rejected	B
44	Internal Controller Error	A hardware error was detected in the IDD	4
45	Select/Reselect Failure	Timeout occurred in the RESELECTION phase while waiting for the response from the INIT.	1, 4, B
46	Unsuccessful Soft Reset	Unused.	4
47	Interface Parity Error	A parity error was detected in the SCSI data bus.	1, B
48	Initiator Detected Error	The INITIATOR DETECTED ERROR message was received from INIT.	1, B
49	Message Out Error	An unsupported or illegal message was received	5, B
4A	(Reserved)		
4B	Data error	Unused.	B
4C	Logical Unit Failed Self-Configuration	Failure in the initial IDD set-up. Information in the SA area could not be read.	4
4D to 4F	(Reserved)		
5D to 5F	(Reserved)		
60	Status Error from Second Party on COPY Command	Unused.	A
61 to 97	(Reserved)		
98	REQ–ACK Time out	Time out occurred in REQ/ACK handshake during INFORMATION TRANSFER phase.	B
99 to 9F	(Reserved)		
DC	ROM CHECK	Error detected in ROM deta.	4
A0	Servo Data Error	Error detected in the servo information, the write operation was interrupted.	1, 3
A1	Servo Check	Offtrack write was detected; the write operation was interrupted.	1, 3
A2 to FF	(Reserved)		

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