MCM3064AP, MCM3130AP

OPTICAL DISK DRIVES

PRODUCT MANUAL

FUJITSU

FOR SAFE OPERATION

Handling of This Manual

This manual contains important information for using this product. Read thoroughly before using the product. Use this product only after thoroughly reading and understanding especially the section "Important Alert Items" in this manual. Keep this manual handy, and keep it carefully.

FUJITSU makes every effort to prevent users and bystanders from being injured or from suffering damage to their property. Use the product according to this manual.

This product is designed and manufactured for use in standard applications such as office work, personal devices and household appliances. This product is not intended for special uses (atomic controls, aeronautic or space systems, mass transport vehicle operating controls, medical devices for life support, or weapons firing controls) where particularly high reliability requirements exist, where the pertinent levels of safety are not guaranteed, or where a failure or operational error could threaten a life or cause a physical injury (hereafter referred to as "mission-critical" use). Customers considering the use of these products for mission-critical applications must have safety-assurance measures in place beforehand. Moreover, they are requested to consult our sales representative before embarking on such specialized use.

First Edition March, 2002

Revision History

Edition	Date	Revised section (*1) (Added/Deleted/Altered)	Details
01	March, 2002	—	—

*1 Section(s) with asterisk (*) refer to the previous edition when those were deleted.

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Preface

This manual describes the MCM3064AP and MCM3130AP 3.5-inch optical disk drives.

This manual provides an overview of the above optical disk drives, and explains their specifications, the requirements and procedures for installing them in a system, and how to clean them.

The manual is intended for users who have a basic understanding of optical disk drives and their use in computer systems.

See "Manual Organization" for details of the organization of manuals related to optical disk drives and the scope of this manual. Use the other manuals shown in "Manual Organization" together with this manual when necessary.

The organization of this manual, related reference manual and conventions for alert messages follow.

Overview of Manual

This manual consists of the following six chapters, glossary, and abbreviation:

Chapter 1 General Description

This chapter introduces the MCM3064AP and MCM3130AP optical disk drives and describes their features, drive configuration, and system configuration.

Chapter 2 Specifications

This chapter describes the specifications of the MCM3064AP and MCM3130AP optical disk drives and the specifications of optical disk cartridges.

Chapter 3 Installation Requirements

This chapter describes the basic environmental, mounting, power supply, and connection requirements for installing the MCM3064AP and MCM3130AP optical disk drives in a user system.

Chapter 4 Host Interface

This chapter describes the host interface of the MCM3064AP and MCM3130AP optical disk drives.

Chapter 5 Operation and Cleaning

This chapter describes how to operate and clean MCM3064AP and MCM3130AP optical disk drives. This chapter also describes how to operate and clean optical disk cartridges.

Chapter 6 Diagnostics and Maintenance

This chapter describes the self-diagnostics functions and maintenance of the MCM3064AP and MCM3130AP optical disk drives.

Glossary

The glossary describes the technical terms that need to be understood to read this manual.

Acronyms and Abbreviations

This manual contains a list of the abbreviations used in this manual and their meanings.

CONVENTIONS USED IN THIS MANUAL

Throughout this manual, the MCM3064AP and MCM3130AP optical disk drives are described as an "ODD," "drive," "unit," "target (TARG)," or "device."

Decimal values are indicated without any modifiers added.

Hexadecimal values are indicated as X'17B9', 17B9h, 17B9H, and 17B9H.

Binary values are indicated as "010" and 010b.

If "BUSY LED" is described in this manual, this refers to the LED that is located on the front side (cartridge-loading side) and that indicates the BUSY state of the device. It is described as "LED on the front panel."

Conventions for Alert Messages

This manual uses the following conventions to show the alert messages. An alert message consists of an alert signal and alert statements. The alert signal consists of an alert symbol and a signal word or just a signal word.

The following are the alert signals and their meanings:

⚠DANGER This indicates a hazardous situation *likely* to result in *serious personal injury* if the user does not perform the procedure correctly.

⚠WARNING This indicates a hazardous situation *could* result in *serious personal injury* if the user does not perform the procedure correctly.

⚠CAUTION This indicates a hazardous situation *could* result in *minor* or *moderate personal injury* if the user does not perform the procedure correctly. This alert signal also indicates that damages to the product or other property, *may* occur if the user does not perform the product correctly.

IMPORTANT This indicates information that could help the user use the product more efficiently.

In the text, the alert signal is centered, followed below by the indented message. A wider line space precedes and follows the alert message to show where the alert message begins and ends. The following is an example:

(Example)

IMPORTANT

While the write cache feature is enabled, a write error is reported in the completion status of another command that is subsequent to the concerned write command. Note that, if the host performs only retry of an error-reporting command, data in the block in which the error has occurred is not correctly written.

The main alert messages in the text are also listed in the "Important Alert Items."

Attention

Please forward any comments you may have regarding this manual.

To make this manual easier for users to understand, opinions from readers are needed. Please write your opinions or requests on the Comment at the back of this manual and forward it to the address described in the sheet.

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Important Alert Items

Important Alert Messages

The important alert messages in this manual are as follows:

⚠ CAUTION A hazardous situation *could* result in *minor* or *moderate personal injury* if the user does not perform the procedure correctly. Also, damage to the product or other property, *may* occur if the user does not perform the procedure correctly.

Task	Alert message	Page
Assembly and Installation	**Device damage:** 1) Do not expose to the drive any shock or vibration exceeding the specification because it will fatally damage the drive. Be particularly careful of this point when unpacking the drive. 2) Do not leave the drive in a dirty or contaminated environment. 3) Since the drive contains CMOS components that may be destroyed by static discharge, keep the following points in mind after unpacking: • Use an antistatic mat and wear a wrist strap when handling the drive. • Hold the mounting frame when handling the drive. Do not touch the printed wiring board unit except when required to make the settings. 4) When handling the drive, hold both sides of the mounting frame. When touching any part of the drive other than both sides of the mounting frame, avoid applying force on the location. 5) When handling the drive or making settings, do not press hard on the tip of the header pin of the printed circuit board unit.	3-16

Task	Alert message	Page
Assembly and Installation	**Device damage:** Before moving the drive, remove any optical disk cartridge in it. If the drive is moved with the optical disk cartridge loaded in it, the head may move back and forth in the drive to damage the head or disk, consequently disabling data from being read later.	3-17
	Device damage: Do not connect or disconnect any cable except the USB I/F cable while the drive power is on.	3-22
	Device damage: Before demounting the optical disk drive, turn off the system power. While the power is on, do not remove screws securing the cables and drive.	3-23
Cleaning cartridge	**Device Damage:** Be sure to use the dedicated head cleaner shown above.	5-5
	Disk damage: To clean a disk, use the cleaning solution and cleaning cloth specified in Table 5.2.	5-9
	Disk damage: Do not use this cleaning kit on a floppy disk or an optical disk cartridge to be used on other optical disk drives.	5-10
	Disk damage: Clean a cartridge in a dust-free environment. Fujitsu recommends wearing disposable gloves during cleaning so that no fingerprints are left on a disk.	5-10
	Disk damage: Do not press hard or apply excessive shock to an optical disk cartridge case while setting it in the setting case.	5-11
	Eye inflammation: If the cleaning solution gets into your eyes, immediately wash the solution away with water.	5-11
Maintenance and Repair	**Data loss:** For a repair request, you normally do not need to include any optical disk cartridge with an optical disk drive. However, you do need to include a cartridge if errors keep occurring with a specific cartridge. In such a case, be sure to save data stored in the cartridge before sending it in. Fujitsu shall bear no responsibility for any data lost during service or repair.	6-3

MANUAL ORGANIZATION	
OPTICAL DISK DRIVES PRODUCT MANUAL (C156-E227) <This manual>	1. GENERAL DESCRIPTION 2. SPECIFICATIONS 3. INSTALLATION REQUIREMENTS 4. HOST INTERFACE 5. OPERATION AND CLEANING 6. DIAGNOSTICS AND MAINTENANCE

REFERENCED STANDARDS

The product specifications and functions described in this manual conform to the following standards:

Specification (document) number	Name	Concerned organization
X3T13/1321D Revision 3	AT Attachment with Packet Interface -5 (ATA/ATAPI-5)	American National Standards Institute (ANSI)
SFF-8070I Revision 1.2	ATAPI Rmovavle Rewritable Media	Small From Factor Committee (SFF)
ISO/IEC 10090	90mm Optical Disk Cartridges, rewritable and read only, for data interchange.	ISO/IEC (*1)
ISO/IEC 13963	Data Interchange on 90mm Optical Disk cartridges Capacity: 230 megabytes per cartridges.	ISO/IEC (*1)
ISO/IEC 15041	Data Interchange on 90mm Optical Disk Cartridges Capacity: 640 megabytes per cartridges.	ISO/IEC JTC1 (*1)
Cherry Book Version 1.0	GIGAMO 1.3GB 90mm Magneto-Optical Disk System.	FUJITSU LIMITED SONY CORPORATION

*1 ISO= International Organization for Standardization

IEC= International Electrical for Commission

JTC1= Joint Technical Committee 1

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CHAPTER 1 General Description

1.1   Features

1.2   Configuration of Optical Disk Drive

This chapter describes the features and configuration of the MCM3064AP and MCM3130AP optical disk drives.

As successors to the MCE3064AP and MCE3130AP optical disk drives, the MCM3064AP and MCM3130AP optical disk drives (hereafter called the optical disk drives) achieve high-speed operation while maintaining compatibility with the MCE3064AP and MCE3130AP.

The flexibility and expandability realized through ATAPI interfaces as well as the high performance and command sets of the optical disk drives allow the user to construct disk subsystems featuring advanced functions, high performance, large-scale storage and high reliability.

1.1 Features

This section describes the features of the optical disk drives in terms of performance, reliability, maintainability/operability, adaptability, and interface.

1.1.1 Performance and Functions

(1) Half-height standard 90mm(3.5-inch) size (25.4 mm height)

The optical disk drives can be directly connected to the system EIDE bus. The drive employs the same form factor as that for the 90mm(3.5-inch) 25.4-mm height hard disk drive.

(2) High-speed data transfer

The MCM3130AP rotates a disk at 3,637 revolutions per minute when a 1.3 GB disk is used. When other media are used, the speed is 5,455 revolutions per minute.

The MCM3064AP rotates a disk at 5,455 revolutions per minute.

In the disk drive, the MCM3130AP realizes high-speed data transfers at rates of 3.92 to 6.70 MB/s (1.3 GB) and the MCM3064AP realizes at rates of 3.52 to 5.87 MB/s (640 MB). The data transfer rates on the buses are 16.6 MB/s in PIO mode 4, 16.6 MB/s in multiword DMA mode 2, and 33.3 MB/s in Ultra-DMA mode 2.

The data transfer capacity can be used effectively through a large capacity data buffer of the optical disk drive.

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(3) High-speed mean seek time

This drive features a linear voice coil motor for high-speed head positioning.

The average seek time per 1,000 random seeks is 23 ms. (However, this does not include command overhead or address check.)

(4) Compatibility with international standards (media interchangeability)

The MCM3130AP optical disk drive supports the use of 90mm(3.5-inch) optical disks in the 1.3 GB format as well as in the 128-MB, 230-MB, 540-MB and 640-MB formats compatible with ISO standards.

The MCM3064AP optical disk drive supports the use of optical disks in the 128-MB, 230-MB, 540-MB and 640-MB formats compatible with ISO standards.

(5) Direct-overwrite media support

The optical disk drive supports the use of optic modulation direct-overwrite (not requiring an erase operation) 230-MB, 540-MB and 640-MB disks compatible with ISO standards.

(6) Dust resistance

With this optical disk drive, the need for a cooling fan has been eliminated owing to its low power consumption. The optical disk drive also has a simple sealed structure. The device is sealed with a metal plate. The drive conforms to class 5 million or less particle level. (Class 5 million: This means there are 5 million dust particles of 0.5 mm diameter or larger per cubic foot. This is equivalent to 0.15 mg/m3.)

(7) Lower power consumption

The power consumption of the MCM3130AP and MCM3064AP optical disk drive is 5.8 W, eliminating the need for a cooling fan. (These power consumption values are typical values during read and write operation.)

The minimum power consumption in the power save modes are 1.8 W.

(8) Automatic spindle stop function

If the optical disk drive is not accessed for a certain duration, it stops disk rotation to minimize dust accumulation on the disk. This duration can be specified using the MODE SELECT command.

1.1.2 Reliability

(1) Mean time between failures (MTBF)

> The mean time between failures (MTBF) for this optical disk drive is 120,000 hours or more.

(2) Enhanced error recovery

> If an error occurs on the optical disk drive, the system executes appropriate retry processing to recover from it. This drive features enhanced Reed-Solomon error correction code (ECC) to assure error-free operation.

(3) Automatic allocation of alternate data blocks

> This drive features a function which automatically allocates alternate data blocks in cases where defective data blocks are detected while data is being written to an optical disk.

1.1.3 Maintainability/operability

(1) Diagnostics function

> This drive has a diagnostics function for checking optical disk drive operations. The diagnostics function facilitates test and restoration.

(2) Five-year service life (no overhaul)

> This drive will not require overhaul within the first five years of installation if appropriately maintained (both disks and optical parts cleaned using cleaning tools) and handled as recommended.

1.1.4 Adaptability

(1) Wide-ranging operating environments

> This drive, requiring low power consumption because of LSIs adopted, can be used in wide-ranging environments (5 to 45°C for drive's ambient environment and a general office environment). The ambient cleanliness must be class 5 million or less particle level.

(2) Low noise

> This drive operates quietly at 30 dB or less (A-character) during seek operations and will not degrade the office environment (except when an optical disk is ejected).

(3) Safety standards

The optical disk drive is certified under the following standards:

- UL1950 (U.S. safety standard)

- CDRH (U.S. laser standard) (Class 1)

- CSA C22.2 No. 950 (Canada safety standard)

- EN60950 (European safety standard)

- EN60825-1 (European laser standard) (Class 1)

(4) Radio wave standards

This optical disk device, while installed, is certified under the following standards:

- EN55022 class B, EN55024 (European EMC standard)

- AS/NZS3548 class B (Australian EMC standard)

- CNS13438 class B (Taiwanese EMC standard)

1.1.5 Interface

(1) Conformation to ATA/ATAPI-5

The optical disk drives conform to the basic specifications of ATA/ATAPI-5.

ATAPI commands specify data with logical block addresses, thus allowing data to be manipulated independent of the physical characteristics of the optical disk derives. This facilitates easy development of software whose functions can be flexibly expanded in the future.

In the optical disk drives, PIO mode 4, multiword DMA mode 2, and Ultra-DMA mode 2 are supported.

(2) Continuous block processing

Logical block addresses are used for data block addressing. Irrespective of the physical attributes of track boundaries, you can have the initiator access data by specifying a block number in logically continuous data space.

(3) High-capacity data buffer

This drive has a 1,844-KB data buffer. This data buffer is used to transfer data between the EIDE bus and a disk. Since data is stored in this buffer, the host can execute input-output processing effectively by using the data transfer capability of the EIDE bus irrespective of the effective data transfer rate of the optical disk drive.

(4) Read-ahead cache feature

The read-ahead cache feature enables high-speed sequential data access as follows:

After executing a command to read data from the disk, the drive automatically reads the next data block and stores it in the data buffer (pre-reading). If the next command requests this data, the drive can transfer data from the buffer without accessing the disk again.

(5) Write cache feature

When the host system issues the write command to the optical disk drive, this drive would report completion of the command after completion of the write and verify operations if the write cache feature were not used. If the write cache feature is used, this drive reports completion of the command when data transfer to buffer is completed, without waiting for completion of the write and verify operations. This drive performs the write and verify operations asynchronously with the interface operation. Therefore, enabling the write cache reduces the apparent write command processing time recognized by the host system and improves the I/O performance of the host system.

Enable or disable the write cache feature using the MODE SELECT command.

IMPORTANT

While the write cache feature is enabled, a write error is reported in the completion status of another command that is subsequent to the concerned write command. Note that, if the host performs only retry of an error-reporting command, data in the block in which the error has occurred is not correctly written.

(6) Defective block slipping

While initializing a disk, the optical disk drive slips defective data blocks to reallocate logical data blocks so they are physically continuous. This enables high-speed continuous data block processing without rotational delay due to defective data blocks.

1.2 Configuration of Optical Disk Drive

1.2.1 Appearance

Figures 1.1 and 1.2 show the optical disk drive.
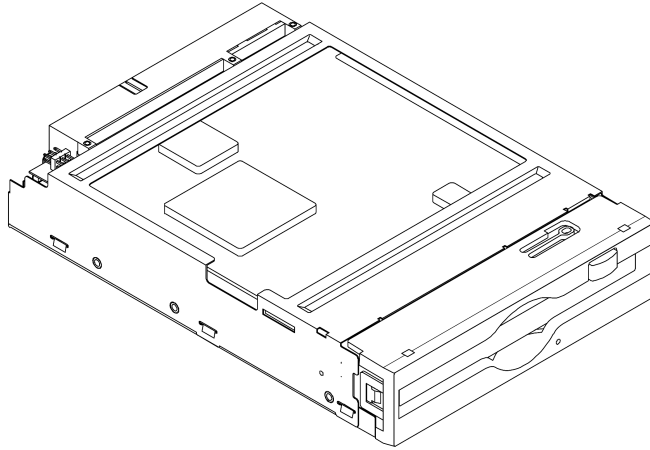
Figure 1.1 The optical disk drive (with panel)
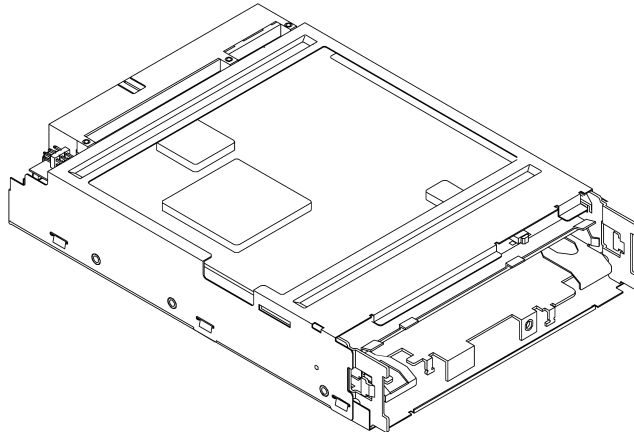
Figure 1.2 The optical disk drive (without panel)

1.2.2 Configuration

Figure 1.3 shows the configuration of the optical disk drive.

The optical disk drive consists of a mechanical section, a fixed optics section, a control circuit section, and an actuator.

The mechanical section includes the spindle motor, actuator section, bias magnet, and cartridge holder vertical motion mechanism.

The fixed optics section consists of the optical components, position detector, and LD controller.

The control circuit section includes the drive control circuit section and I/F circuit section.
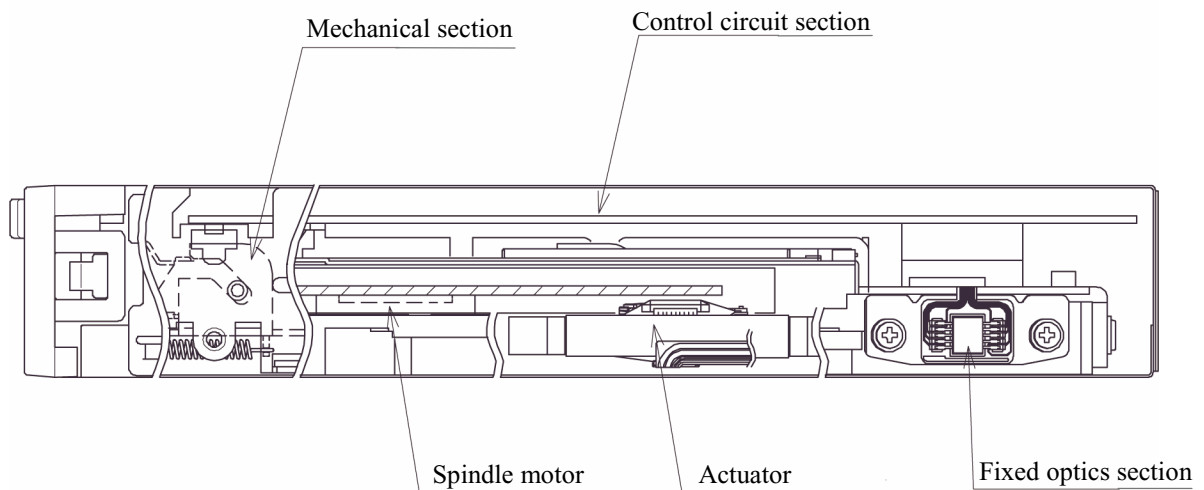
Figure 1.3 Configuration of optical disk drive

1.2.3 Mechanical section

(1) Loading and ejecting an optical disk cartridge

The optical disk drive includes a cartridge load mechanism and an auto eject mechanism. If an optical disk cartridge is manually inserted in the drive's slot as far as it will go, the cartridge load mechanism automatically lowers the cartridge and mounts it on the spindle motor. If the Eject button on the front panel is pressed, the auto eject mechanism automatically ejects the cartridge.

(2) Spindle motor

An optical disk cartridge hub and the spindle motor shaft are magnetically combined. Therefore, a disk rotates as fast as the spindle motor shaft rotates. The spindle motor, a DC brushless motor, provides high-speed rotation at 5,455 rpm and 3,637 rpm and high-accuracy rotation at $\pm\,0.1\%$.

(3) Actuator section

> The actuator section consists of a focus actuator and a tracking actuator. The former focuses a laser beam on the surface of an optical disk while the latter moves the beam spot along the radius, on the surface of an optical disk (seek operation).

> The actuator section is directly driven by a linear voice coil motor. The tracking actuator is based on the pulse-width modulation (PWM) system and realizes low power consumption and high-speed access.

(4) Separate optical sections

> The optical head section has a split structure in which the fixed optics section is separated from the moving optics section to minimize seek time and positioning error. This reduces the weight of the moving parts.

> The fixed optics section consists of the laser diodes, collimator lens, separation prism, condensing lens, and the optical detector.

> A laser diode for recording and playback transmits one laser beam to the actuator section.

(5) Panel

> The central part of the panel is hollowed out to provide enough space to enable the cartridge to be inserted by pushing it with a finger, thereby facilitating insertion.

> The panel is also simply designed using an eject button that also serves as LED light emitting part.

1.2.4 Control circuit section

> Figure 1.4 is a block diagram of the control circuit section and the peripheral sections.
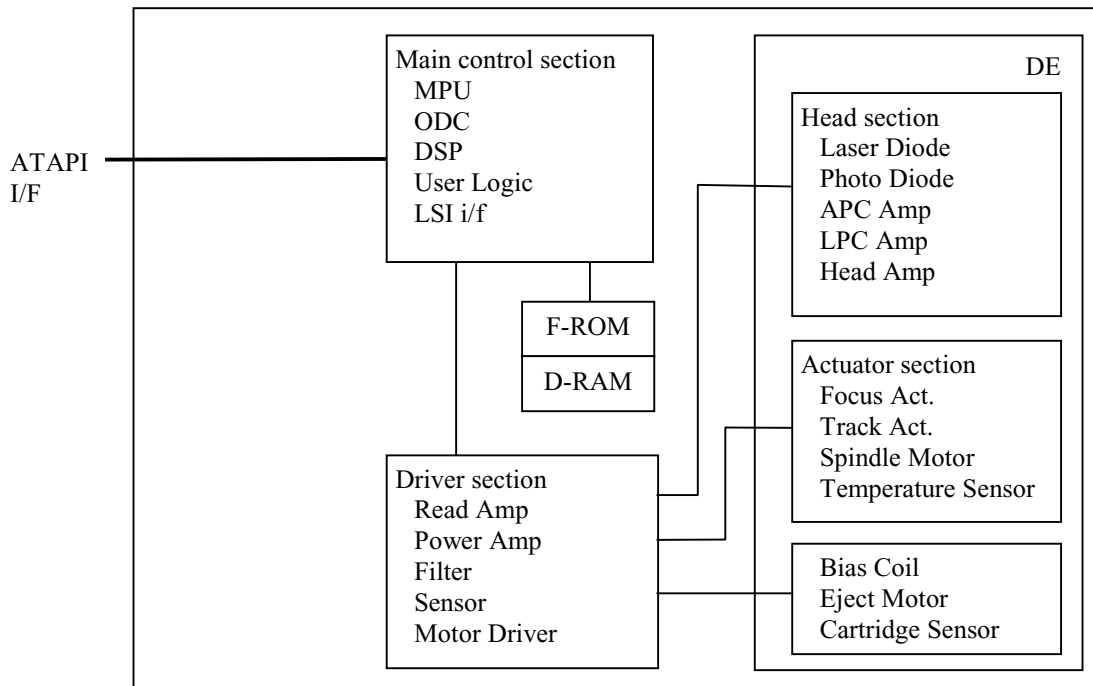
Figure 1.4 Block diagram of the control circuit section

The control circuit section is divided roughly into two parts: an ATAPI controller section that controls between the ATAPI interface and drive interface, and a drive circuit section that controls the drive section.

(1) ATAPI controller circuit section

The ATAPI controller circuit, which uses an LSI for improved reliability, controls the drive through ATAPI interface control, read-write control, beam control, etc., by using one high-speed microprocessor (MPU).

(2) Drive circuit section

The drive circuit section consists of the laser diode light emitting control circuit, signal reproduction circuit, servo/seek control circuit, rotation control circuit, and other control circuits. In particular, the servo/seek control circuit consists of a DSP (digital signal processor) for circuit reduction and the realization of a simple configuration.

The drive circuit section performs the seek, erase, record, and playback operations while controlling the focus tracking of the beam.

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CHAPTER 2 Specifications

2.1   Specifications of Optical Disk Drives

2.2   Specifications of Optical Disk Cartridges

2.3   Defect Management

This chapter provides the specifications of the optical disk drives and the optical disk cartridge.

2.1 Specifications of Optical Disk Drives

2.1.1 Catalog and order numbers

Table 2.1 lists the model names (catalog numbers) and order numbers of optical disk drives.

Table 2.1   Representative model names and order numbers

Model name (catalog number)	Order No.	Panel	Panel color	Mounting screws
MCM3064AP	CA06086-B331	With panel	Light gray (2.5Y 7.2/0.4)	Metric screws (M3)
MCM3130AP	CA06123-B331	With panel	Light gray (2.5Y 7.2/0.4)	Metric screws (M3)

2.1.2 Specifications of drives

Table 2.2 lists the specifications of MCM3064AP, MCM3130AP optical disk drives.

Table 2.2   Specifications (1 of 2)

[MCM3064AP, MCM3130AP]

Item		Specifications				
Optical disk media		128 MB media	230 MB media	540 MB media	640 MB media	1.3 GB media (*6)
Storage capacity (one side)	Unformatted	181 MB	325 MB	819 MB	818 MB	1.688 GB
	Formatted	128 MB	230 MB	538 MB	643 MB	1.283 GB
Capacity per track	Unformatted	18,100 bytes	18,100 bytes (logical track capacity)	19,450 bytes (logical track capacity)	43,928 bytes (logical track capacity)	45,798 bytes (logical track capacity)
	Formatted	12,800 bytes	12,800 bytes (logical track capacity)	12,800 bytes (logical track capacity)	34,816 bytes (logical track capacity)	34,816 bytes (logical track capacity)
Capacity per sector	Unformatted	725 bytes	725 bytes	778 bytes	2,584 bytes	2,631 bytes
	Formatted	512 bytes	512 bytes	512 bytes	2,048 bytes	2,048 bytes
Number of user tracks/side (*1)		10,000	17,940	42,042	18,480	36,855
Number of alternate sectors/side		≤1,024	≤1,025	≤2,250	≤2,244	≤4,437
Number of sectors/track		25	25	25	17	17
Data transfer rate		1.65 MB/s (maximum) 0.39 MB/s continuous writing (execution) 1.16 MB/s continuous reading (execution)	2.00 to 3.16 MB/s (maximum) 0.47 to 0.75 MB/s continuous writing (execution) 1.40 to 2.23 MB/s continuous reading (execution)	3.54 to 5.94 MB/s (maximum) 0.78 to 1.30 MB/s continuous writing (execution) 2.33 to 3.91 MB/s continuous reading (execution)	3.52 to 5.87 MB/s (maximum) 0.93 to 1.55 MB/s continuous writing (execution) 2.79 to 4.66 MB/s continuous reading (execution)	3.92 to 6.70 MB/s (maximum) 0.99 to 1.70 MB/s continuous writing (execution) 2.98 to 5.09 MB/s continuous reading (execution)
Average seek time (*2)		23 ms (typ)				
Average latency		5.5 ms				8.2 ms
Rotational speed		5,455 rpm ±0.1%				3,637 rpm ±0.1%
Heads		Positioner + Separated optical components				
Positioner type		1 (Linear voice coil motor)				
Servo tracking method		ISO continuous servo method				
Recording density		24,424 bpi (1.04μm/bit) 15,875 TPI	29,308 bpi (0.87μm/bit) 18,275 TPI	52,900 bpi (0.48μm/bit) 23,090 TPI		89,100 bpi (0.285μm/bit) 28,200 TPI
Loading time (*3)		8 sec. (typ)				12 sec. (typ)
Unloading time (*4)		4 sec. (typ)				
Load/unload life		20,000				
Host interface		ATAPI (conforming to the ATA/ATAPI-5 standard)				
Transfer mode		PIO mode 4, multiword DMA mode 2, and Ultra-DMA mode 2				
Data transfer rate		PIO mode: 16.6 MB/s				
		Multiword DMA mode 2: 16.6 MB/s				
		Ultra-DMA mode 2: 33.3 MB/s				

Table 2.2   Specifications (2 of 2)

Item	Specifications				
Optical disk media	128 MB media	230 MB media	540 MB media	640 MB media	1.3 GB media (*6)
Data buffer	1,844 KB				
Error correction (*5)	Correctable up to 8-byte/interleave Bit error rate: 10^{-12} or less				

*1   The number of user tracks indicates the maximum user zone which includes the spare area and slipping area.

*2   Mathematical average of 1,000 times of random seek, which does not include command overhead or track address recognition time. Furthermore, it may depend on the quality of the media and the drive installation environment.

*3   Loading time is the time that elapses from the time an optical disk cartridge is inserted, to the time the optical disk drive is ready for processing of an access command.

*4   Unloading time is the time that elapses from the time the eject button is pressed or the eject command is issued, to the time an optical disk cartridge is ejected.

*5   The bit error rate must be 10^{-12} or less using a disk whose raw error rate is 10^{-4} or less.

*6   The MCM3064AP does not support 1.3-gigabyte MO disks.

2.1.3 Environmental and power requirements

Table 2.3 lists the environmental and power requirements.

Table 2.3   Environmental and power requirements (1 of 2)

Item		Specification
Power requirements	Average	+5 VDC±5% 1.2 A (2.7 A max) (*1) Ripple requirement 100mV pp (DC-1 MHz)
Power consumption (Average)	Ready	3.9 W (typ) (*2)
	Random seek, read or write	5.8 W (typ) (*2)
	Power save mode	Pre-idle mode Idle mode Standby mode Sleep mode	3.9 W (typ) (*2) 2.0 W (typ) (*2) 1.2 W (typ) (*2) 1.2 W (typ) (*2)
Outer dimensions (W × D × H)	With panel	101.6×150.0×25.4 mm
	Without panel	101.6×148.4×25.4 mm
Weight		410 g (with panel)
Environmental requirements	Operating	Temperature: 5 to 45°C (gradient 15°C /h or less) (*3) Relative humidity: 10 to 85% (No condensation) Maximum wet bulb temperature: 29°C or lower
	Idle	Temperature: 0 to 50°C Relative humidity: 10 to 85% (No condensation) Maximum wet bulb temperature: 36°C or lower
	Transport	Temperature: –40 to 60°C (24 hours or less) Temperature: –20 to 60°C (24 hours or more) Relative humidity: 5 to 90% (No condensation) Maximum wet bulb temperature: 41°C or lower
Installation	Tilt angle	–5° to +10° (*3)

Table 2.3   Environmental and power requirements (2 of 2)

Item		Specification
Vibration/ shock	Operating	3.92 m/s^2 {0.4 G} (5 to 500 Hz, Sine Sweep) Shock 19.6 m/s^2 {2 G} (10 ms, Half Sine Pulse)
	Idle No cartridge, power ON	9.8 m/s^2 {1.0 G} (5 to 500 Hz, Sine Sweep) Shock 49 m/s^2 {5 G} (10 ms, Half Sine Pulse)
	Transport	Shock 490 m/s^2 {50 G} (10 ms, Half Sine Pulse) Requirement: Packing specifications specified by Fujitsu
Altitude	Operating	3,000 m (10,000 ft) or less
	Idle	12,000 m (40,000 ft) or less
Ambient cleanliness	Air flow	Not required
	Air purity	General office environment or better (dust particle level: Class 5 million or less particle level)

*1   During random seek or read/write but excluding pulse waveform at 500 μs or less

*2   Average value at an ambient temperature of 25°C and a voltage of 5 V

*3   The performance is specified at an ambient temperature of 25°C and level placement at 0°.

Note:

1.   The current limiter value on the power supply must not exceed 5 A.

2.   The specifications for during transport are under the packaging conditions specified by Fujitsu.

3.   Note that, concerning the power requirements, a voltage drop may occur depending on the power cable in use.

2.1.4 Error rate

Data blocks to be accessed should be evenly distributed on the disk. Errors due to disk defects are not included.

(1) Bit error rate after ECC processing

The error rate after ECC processing must be 10-12 or less. An optical disk whose raw error rate is 10-4 or less should be used.

(2) Positioning error rate

The positioning error rate must be 10-6 or less (with retry).

2.1.5 Reliability

(1) Mean time between failures (MTBF)

The MTBF is 120,000 hours or more. Failures due to disk errors are not included.

Conditions

- Power-on time: 200 hours/month or less

- LD-on time: 20% or less of power-on time

- Ambient temperature: 25°C

Note: The MTBF is defined as follows:

$$MTBF = \frac{\text{Total operating time in all fields (hours)}}{\text{Number of device failure in all fields}}$$

1) Operating time is the total time in which power is supplied.

2) Device failures include failures requiring repair, readjustment, or replacement. However, they do not include failures that are not due to the optical disk drive itself but to external factors such as careless device handling, nonsupport of environmental requirements, power failures, host system errors, and interface cable errors.

(2) Service Life

This drive will not require overhaul within the first five years of installation if properly maintained (both disk media and optical parts cleaned) and handled as recommended.

⚠CAUTION

Data loss:

Data is not guaranteed if a power failure occurs or the I/F cable is pulled out while:

- Data is being written to a data block

- A disk is being initialized (formatted)

- Defect processing is in progress

Data is not guaranteed either if the drive is moved with the optical disk cartridge inserted or the drive is exposed to excessive shock or vibration.

2.2 Specifications of Optical Disk Cartridges

2.2.1 Recommended optical disk cartridges

Optical disk cartridges basically comply with the ISO/IEC 10090 standard for 128 MB capacity, ISO/IEC 13963 standard for the 230 MB capacity, and ISO/IEC 15041 standard for the 540 and 640 MB capacity.

Table 2.4 shows the specifications of the optical disk cartridges recommended for this optical disk drive. The specified drive performance may not be obtained if other disk cartridges are used.

Table 2.4   Recommended optical disk cartridges

Model	Model number	Drawing number
Optical disk cartridge (128 MB)	0242110	CA90002-C010
Optical disk cartridge (230 MB)	0242210	CA90002-C011
Optical disk cartridge (540 MB)	0242410	CA90002-C012
Optical disk cartridge (640 MB)	0242610	CA90002-C013
Optical disk cartridge (1.3 GB)	0242810	CA90002-C015
Overwrite optical disk cartridge (230 MB)	0242310	CA90002-C041
Overwrite optical disk cartridge (540 MB)	0242510	CA90002-C042
Overwrite optical disk cartridge (640 MB)	0242710	CA90002-C043

2.2.2 Appearance

Figure 2.1 shows an optical disk cartridge. The names of the components of an optical disk cartridge are also shown.

(a) Shutter closed
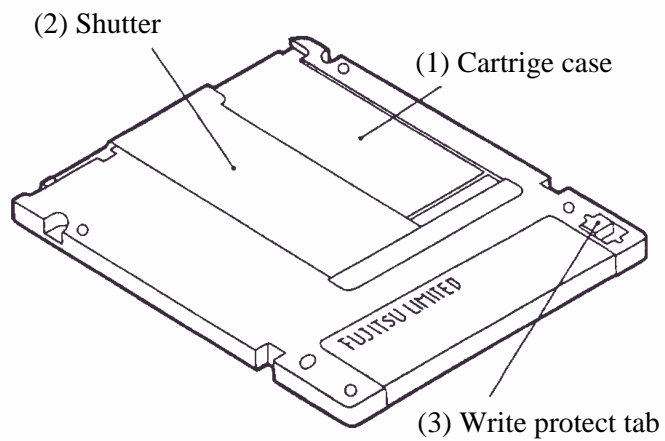
Figure 2.1 Optical disk cartridge (1/2)

(b) Shutter open
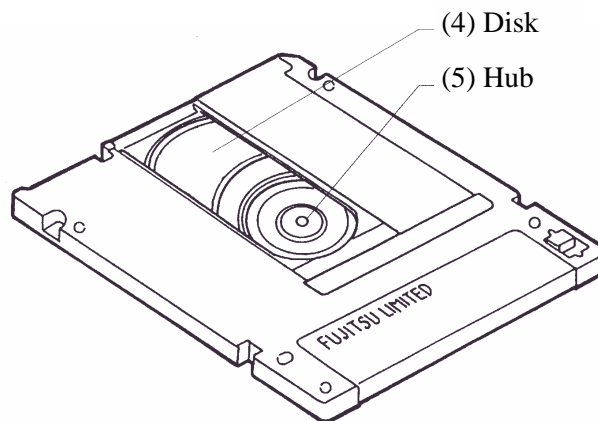
Figure 2.1 Optical disk cartridge (2/2)

The following explains the components of the optical disk cartridge shown in Figure 2.1.

1) Cartridge case

   The disk housing is provided to protect the disk from damage when handling it, and facilitates replacement of the disk.

   The cartridge case has a label and a write protect tab on it.

2) Shutter

   The shutter protects the disk from contamination. This metallic door opens when the cartridge is inserted into the optical disk drive.

3) Write protect tab

   Slide the write protect tab to enable or disable writing to the disk.

4) Disk

   Stores data that can be read or written using a laser beam.

5) Hub

   The hub is the central disk part to be connected to the spindle of the optical disk drive.

   The hub is used for radial centering and axial positioning.

2.2.3 Specifications of disk

Table 2.5 lists the disk specifications.

Table 2.5 Disk specifications

Item		Specification
Reliability	Read cycle	$>10^8$
	Erase/write/read cycle	$>10^6$
	Load/nload cycle	25,000
	Archival life (in accordance with acceleration test results)	>10 years (*1)
	Shelf life (in accordance with acceleration test results)	>10 years (*2)
Environmental requirements	Operating temperature	5 to 55°C
	Operating relative humidity	3 to 85% RH (*3)
	Storage temperature	–20 to 55°C
	Storage humidity	3 to 90% RH (*3)

*1 Archival life indicates the maximum period during which recorded information can be read from a disk.

*2 Shelf life indicates the maximum period during which information can be written to an unrecorded disk.

*3 Maximum wet bulb temperature = 29°C.

Note: Non-recommended disks, if used, must be subject to a compatibility check by the customer.

(1) 128 MB media

> The ISO/IEC10090 defines 128-MB media specification.

(2) 230 MB media

> The ISO/IEC13963 defines 230-MB media specification.

(3) 540 MB/640 MB media

> The ISO/IEC15041 defines 540 MB/640 MB media specification.

(4) 1.3 GB media

> The Cherry Book version 1.0 defines 1.3 GB media specification.

2.3 Defect Management

2.3.1 Defect management schematic diagram

Defective sectors on the disk must be replaced with good sectors in accordance with the defect management scheme as follows: Sectors found defective during surface inspection are handled using a sector slipping algorithm. Sectors found defective after initialization are replaced using a linear replacement algorithm.

Figure 2.2 shows the sector slipping and linear replacement algorithms.

(a) Sector slipping algorithm   (b) Linear replacement algorithm
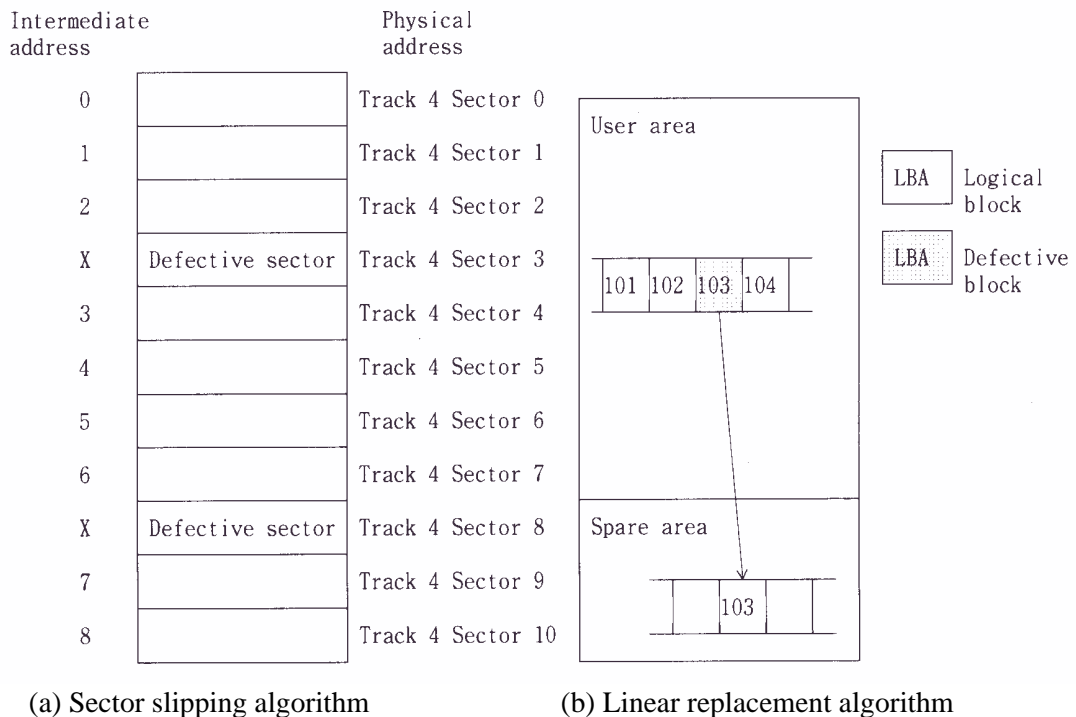
Figure 2.2 Algorithms for alternate processing

During initialization, the user area is divided into several groups. Each of the groups contains data sectors and spare sectors. Spare sectors are used as replacements for defective data sectors. During initialization, the surface inspection over the user area can be performed.

Figure 2.3 shows an example of alternate processing.

SB : spare band
UB : user band

Sector resigned by the linear replacement argorithm.

Defective sector detected by the linear replacement argorithm.

Defective sector detected by the sector slipping argorithm.

Slipping area

Unused area
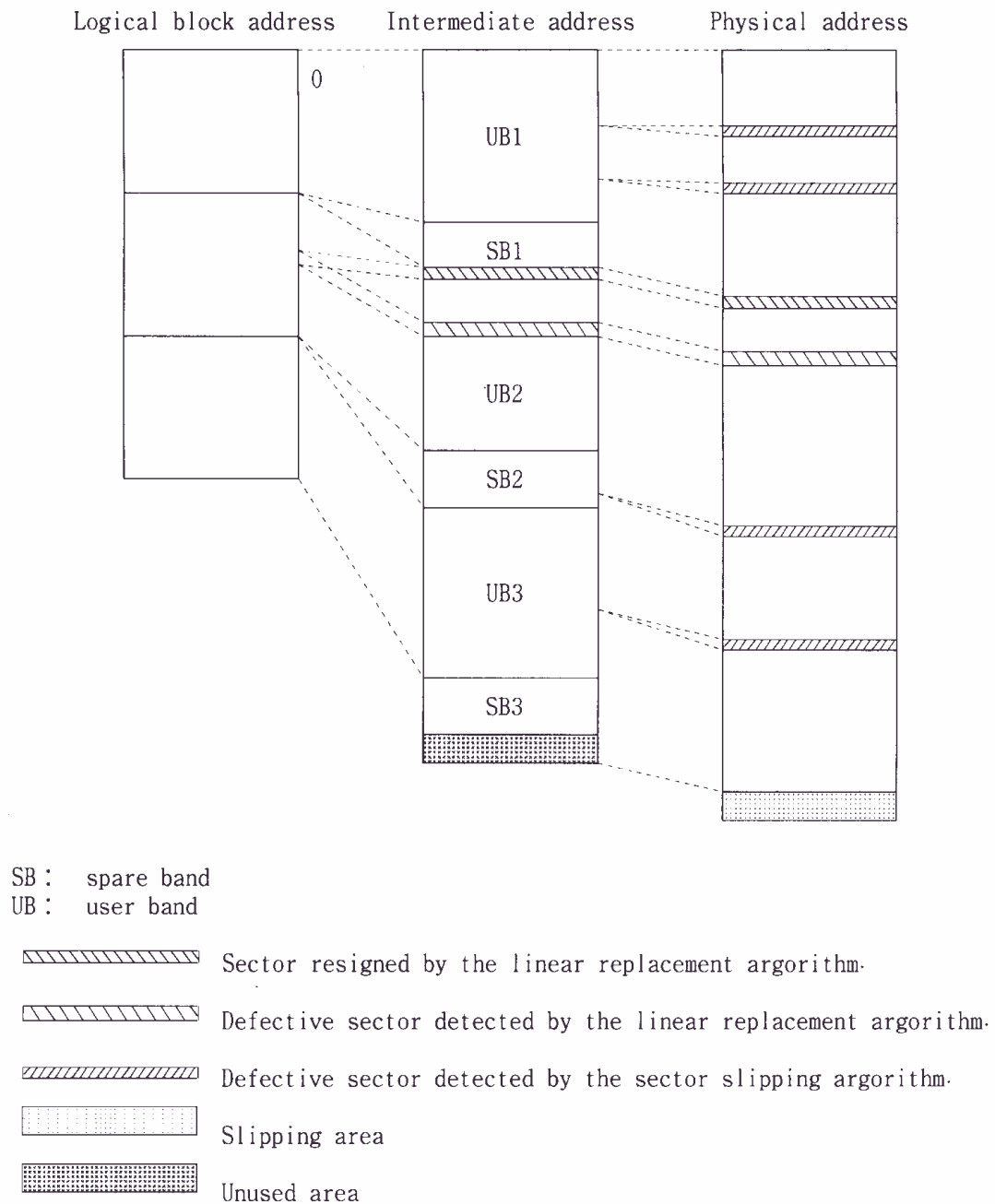
Figure 2.3 Example of alternate processing

CHAPTER 3 Installation Requirements

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

3.1 Environmental Requirements

The optical disk drive must be installed in an environment complying with the ambient environmental requirements defined in Section 2.1.3.

3.1.1 Temperature measurement points

While the drive is operating, the ambient temperatures measured 3 cm away from the surfaces of the optical disk drive must satisfy the ambient environmental requirements specified in Section 2.1.3. As for the surface temperatures during operation, the contact temperatures measured at the points shown in Figure 3.1 must satisfy the temperature requirements specified in Section 3.1.2.

(a) Inside optical disk cartridge

Hole for inserting thermocouple

Opening of disk outer wall

Tip of thermocouple
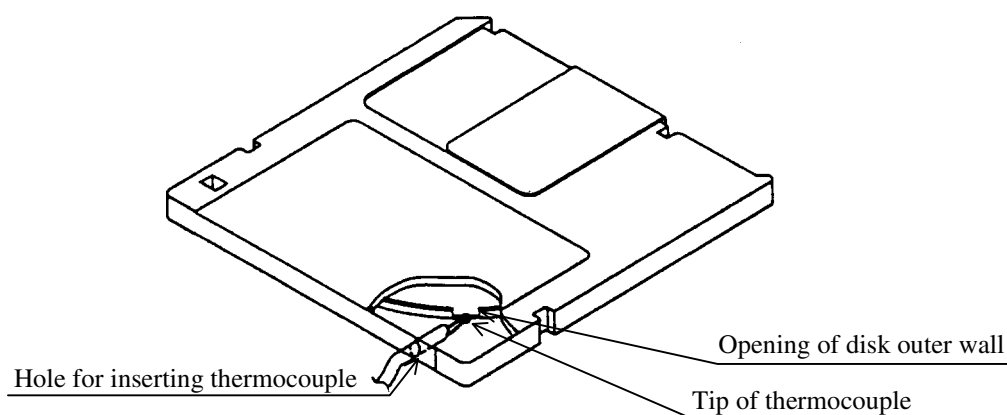
Figure 3.1 Surface temperature measurement point

3.1.2 Temperature requirements

Table 3.1 shows the temperature requirement at the measurement point shown in Figure 3.1.

Table 3.1   Temperature requirements at measurement points

Measurement point	Maximum allowable surface temperature
Inside the cartridge	55°C (*1)
IC (controller) surface	95°C
IC (read amp.) surface	85°C

*1   60°C for the optical disk cartridges recommended by Fujitsu (except 1.3 GB).

The following describes a procedure for measuring the temperature inside a cartridge.

1)   At the bottom of the cartridge, open a hole large enough for the thermocouple to be inserted as shown in Figure 3.1.

2)   Disassemble the cartridge.

3)   Cut off part of the wall surrounding the optical disk (disk outer wall) as shown in Figure 3.1.

At this point, cut off a section 5 to 10 mm in width from the disk outer wall.

4)   Using an adhesive agent, affix the tip of the thermocouple to the opening of the disk outer wall.

5) Pass the thermocouple through the hole in the cartridge and reassemble the cartridge.

Using an adhesive agent, etc., fill any gap between the hole and the thermocouple.

Note: The surface of the cartridge shown in Figure 3.1 has been cut away to illustrate the elements inside the cartridge. Do not actually cut away the surface.

If the external environment temperature rises above the specified value, the drive will take protective action to deal with the temperature increase by automatically placing an interval between commands before responding to a command.

3.1.3 Temperature rise

Table 3.2   Temperatures at measuring points (Reference)

[Ambient temperature of the optical disk drive: 45°C]   (°C)

Measurement point	Random seek	Criteria
Inside cartridge	54.0°C	55°C
IC (controller) surface	70.5°C	95°C
IC (read amp.) surface	72.4°C	85°C
Thermal sensor	54.2°C	—

Notes:

1. The above data was taken in a constant temperature chamber in which the temperature around the optical disk drive was kept at 45°C. The data was not taken with the drive installed in a box in which the drive is actually used.

2. Note that, when installed in a box, the ambient temperature around the drive will differ depending on the air circulation conditions of the box, and the temperature increase inside the cartridge will differ accordingly.

3.1.4 Air cleanliness

The air cleanliness in the device environment is expressed by the number of dust particles per unit area. Fujitsu recommends using the optical disk drive in the environment of class 5 million or less particle level. (Class 5 million: This means there are 5 million dust particles of 0.5 ?m diameter or larger per cubic foot. This is equivalent to 0.15 mg/m3.)

3.2 Mounting Requirements

3.2.1 Outer dimensions

Figures 3.2 to 3.3 show the outer dimensions of the optical disk drive and the positions of the mounting holes.

Figure 3.2 Outer dimensions (1/2)

Position after a cartridge is loaded

Position when loading a cartridge

Center of a cartridge when loaded

(14.15)

8.4

Bottom of
the frame

4.3

(25±0.5)
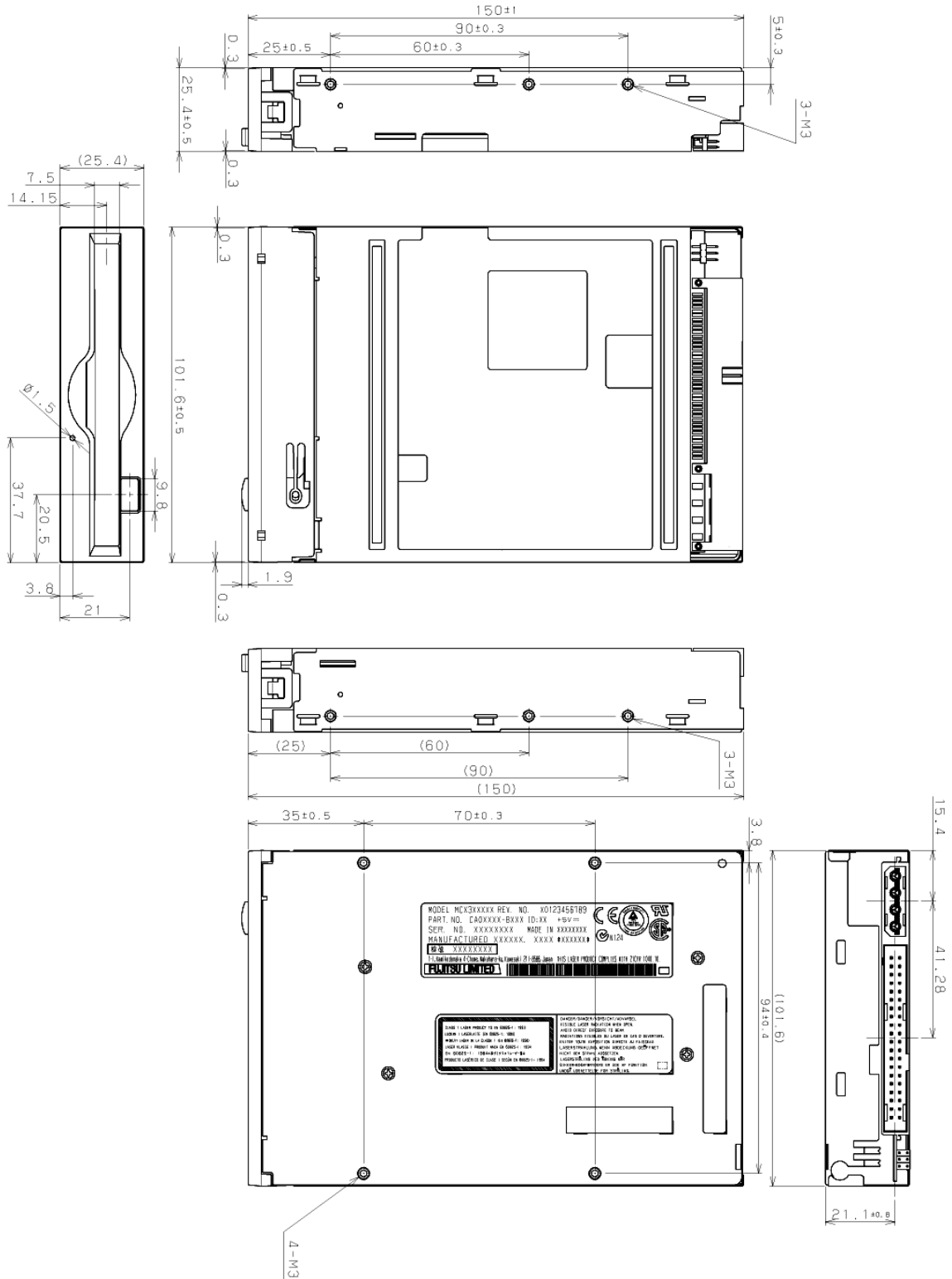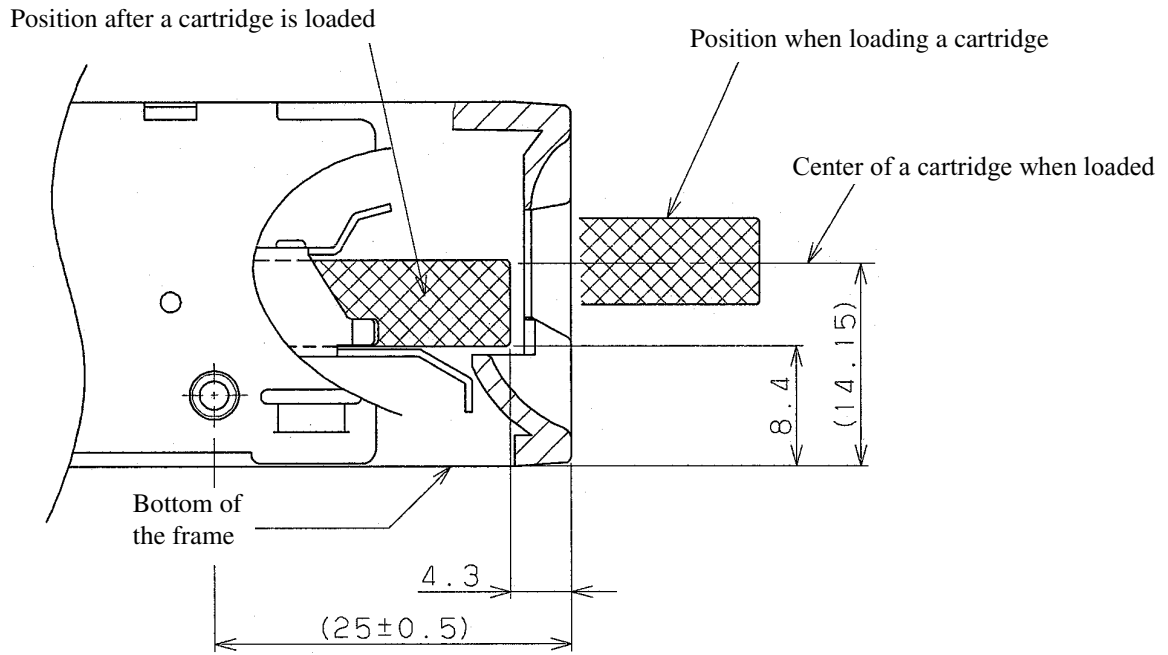
Figure 3.2 Outer dimensions (2/2)

Figure 3.3 Outer dimensions (1/3)

Oblong hole: 2±0.1 (width)
           × 2.5±0.1 (length)

(Width of C 0.5)

Details of C part

Details on D part
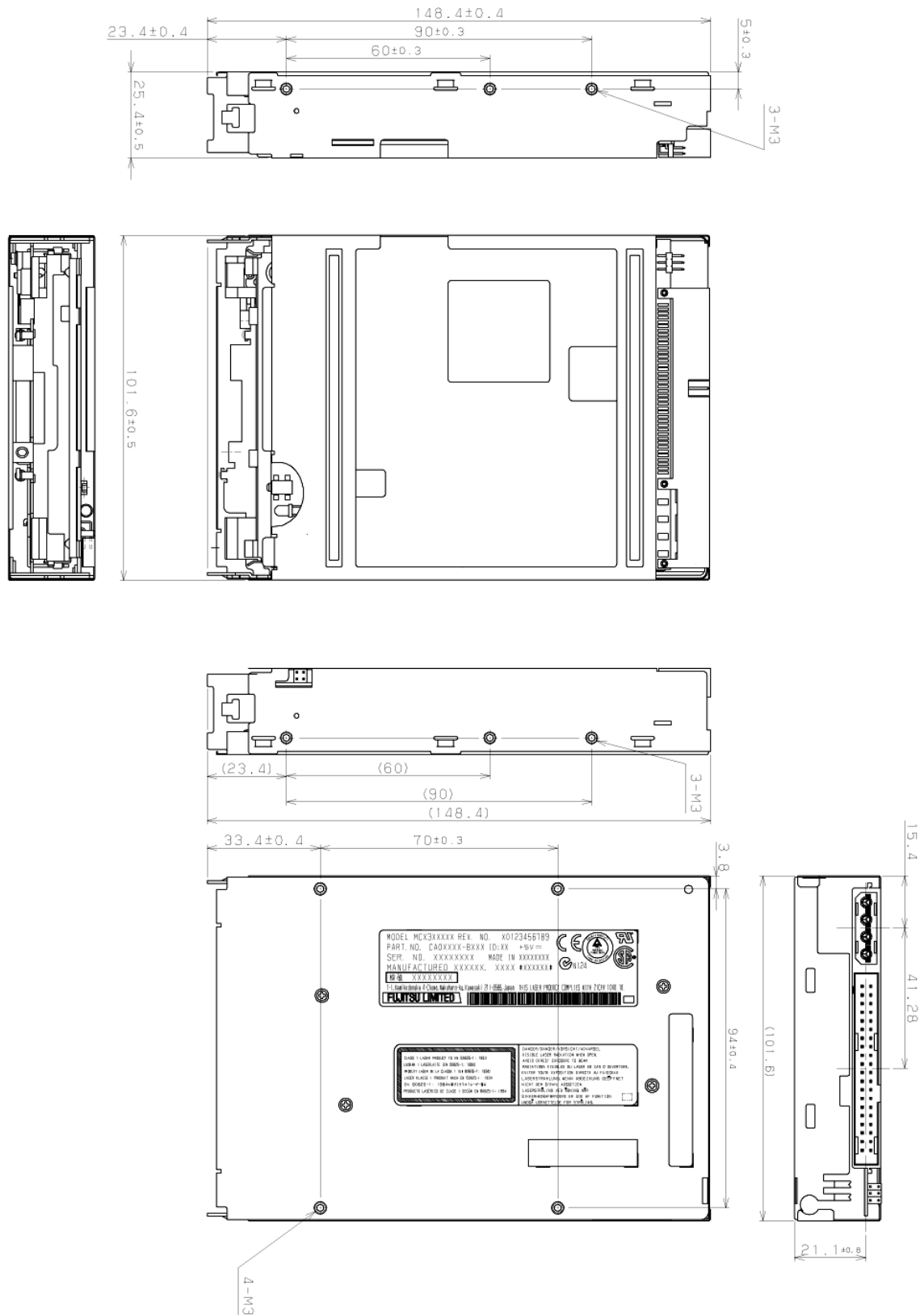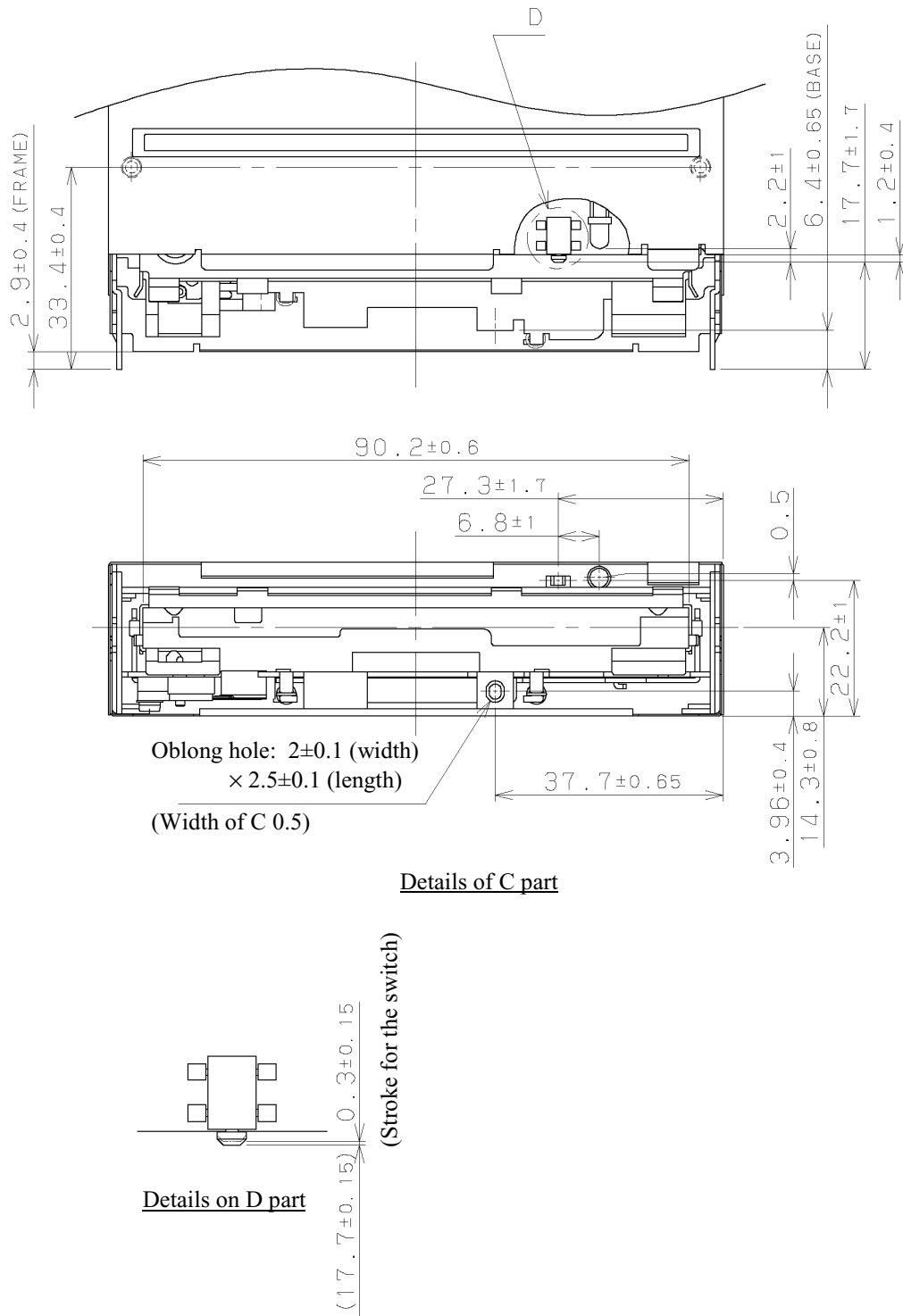
Figure 3.3 Outer dimensions (2/3)
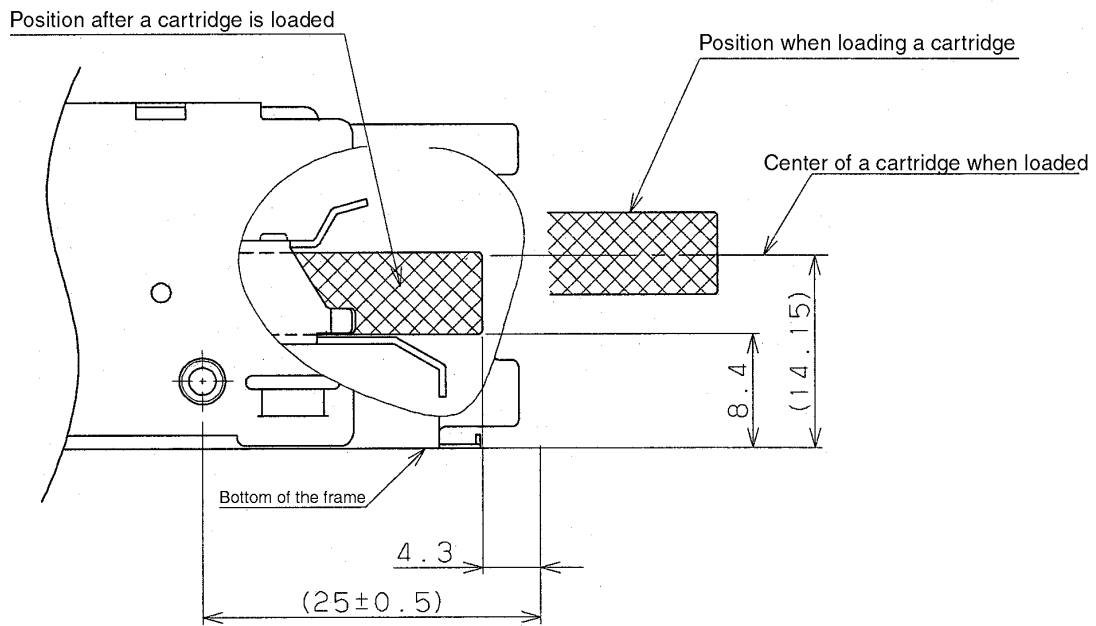
Figure 3.3 Outer dimensions (3/3)

3.2.2 Installation direction

Figure 3.4 shows the permissible installation directions for the optical disk drive. The mounting angle tolerance must be within -5(to 10(relative to the horizontal plane.

(-) shows that the cartridge insertion slot faces downward.

Horizontal

Disk insertion slot

Eject button/Busy LED

Manual eject hole

Vertical
(Two orientations)
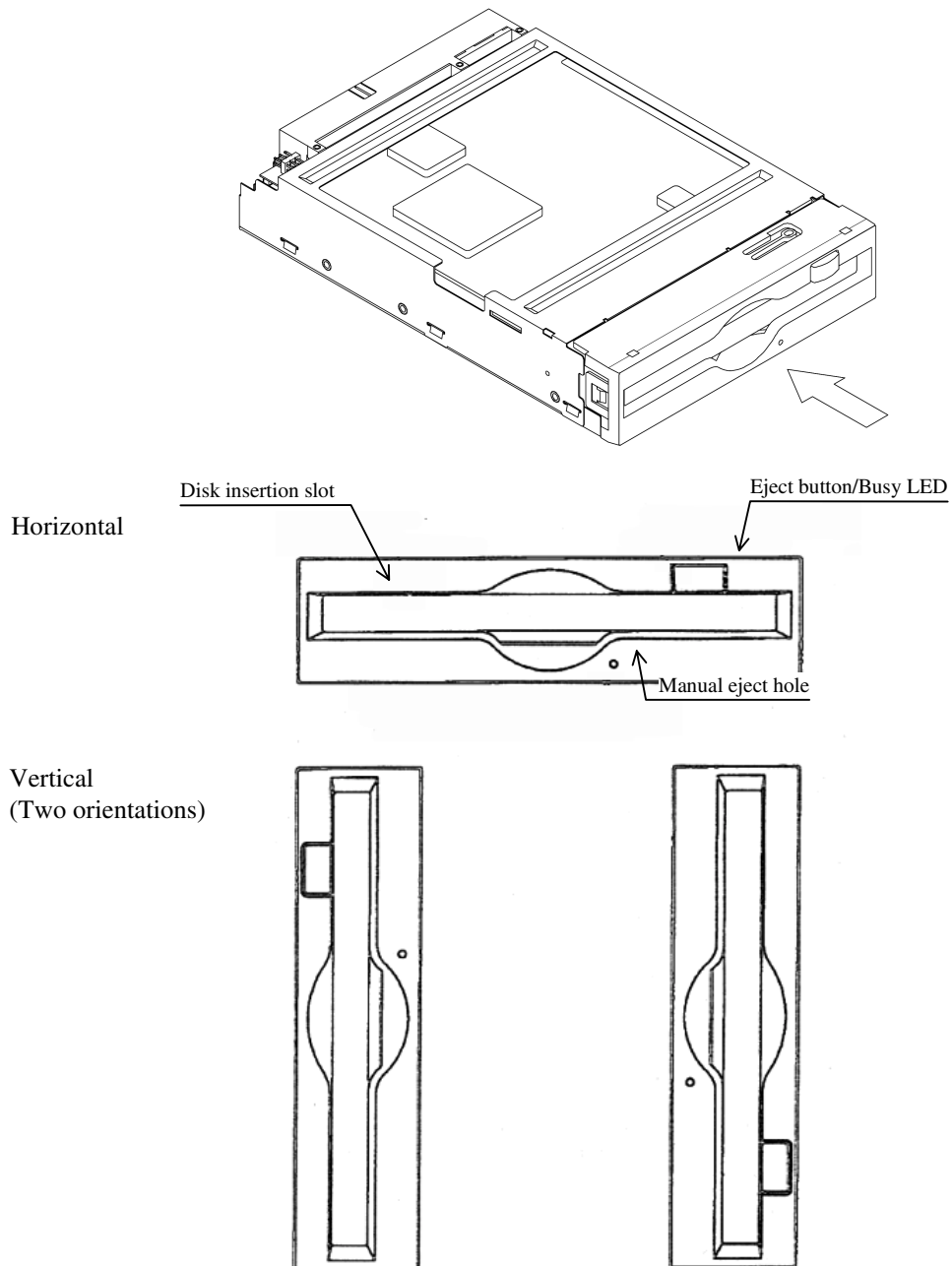
Figure 3.4 Installation directions

3.2.3 Center of gravity

Figure 3.5 shows the center of gravity of the optical disk drive.
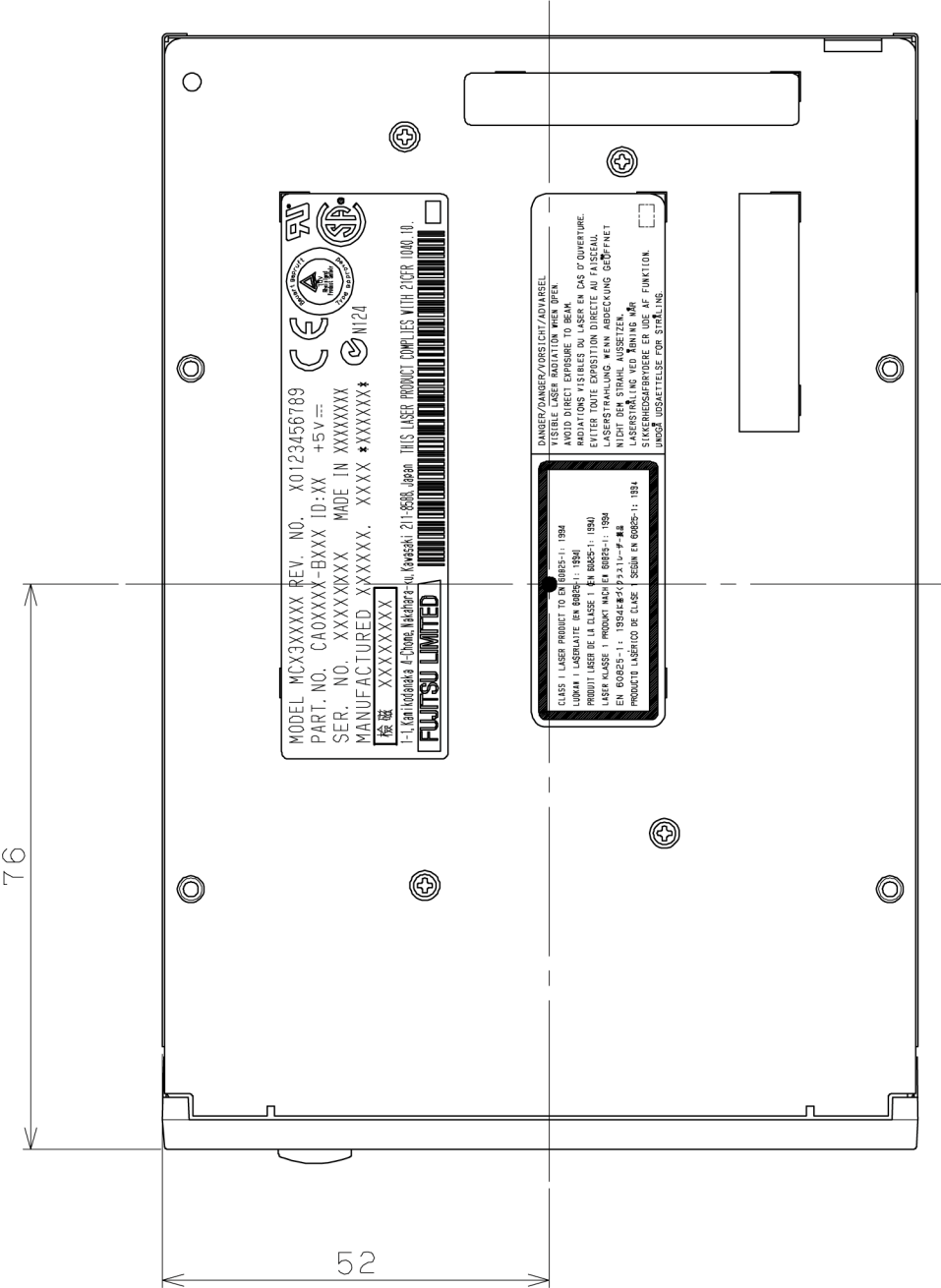
Figure 3.5 Center of gravity

3.2.4 Precautions on mounting

(1) Mounting frame structure and clearance

    a) For vibration resistance and heat dissipation, mount this optical disk drive using a frame having an embossed structure shown in Figure 3.6 or a similar structure providing an equivalent function.

    b) A mounting screw must have an inward projection (entry depth) of 3 mm or less from the outer surface of the mounting frame of the optical disk drive as shown in Figure 3.6.

    c) The upward-downward and left-right clearance between the external surface of the mounting frame of the optical disk drive and the user's emboss-structure frame must be at least 1.5 mm.

    d) The floating clearance of the optical disk drive must be 1.5 mm or more.

    e) When mounting the optical disk drive, the screw tightening torque must be 0.4 to 0.45Nm (4 to 4.6kgf-cm).

    f) When the optical disk drive (with a panel) is mounted in a cabinet, there should be no distortion or deformation in the target housing or the mounting fittings. Furthermore, the optical disk drive's panel must not be deformed.

    If the drive is used with the panel deformed, ejection of the cartridge will be faulty.

    Make sure that the door closes from any position after mounting the optical disk drive.
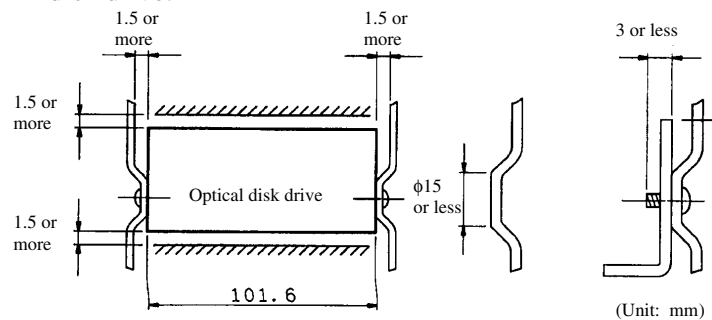
Mounted on the side
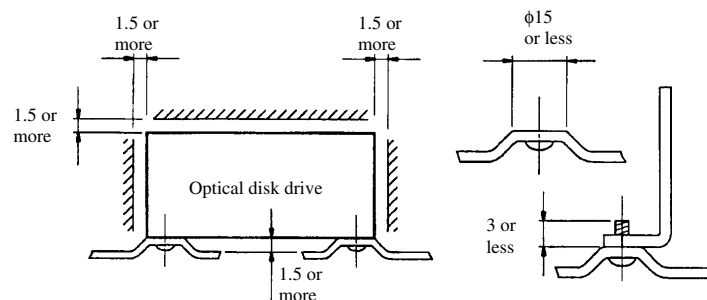
Mounted on the bottom

Figure 3.6 Mounting frame structure

(2) Checking the panel function

There must not be any deformation in the panel after the optical disk drive is installed in a cabinet. Make sure that the door of the disk insertion slot closes from any location with the drive installed in the cabinet.

(3) Service areas

Figure 3.7 shows the locations that need to be accessed for installation, and after installation is carried out.

[P side]
- Cable connection

[R side]
- Monitoring screw hole

[Q side]
- Monitoring screw hole

`
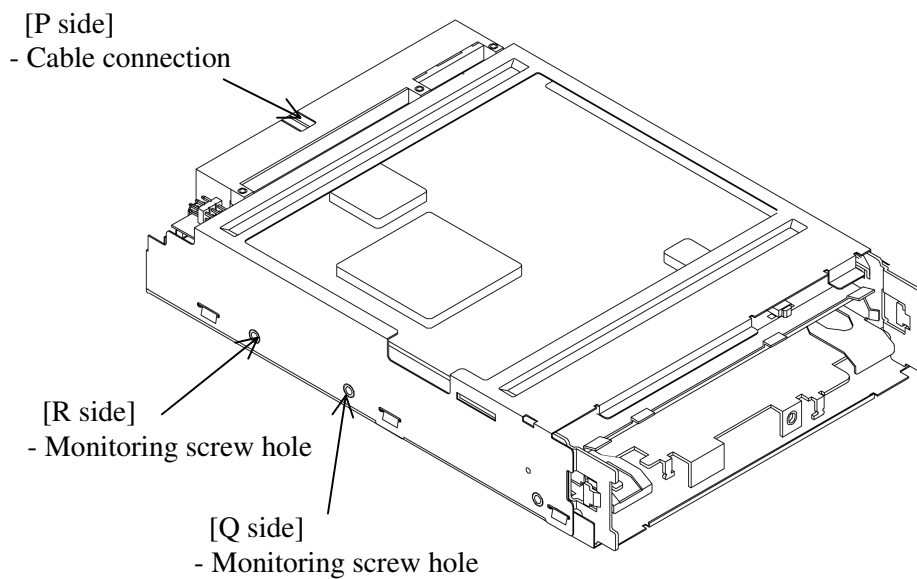
Figure 3.7 Service areas

(4) External magnetic fields

Mount the optical disk drive away from powerful magnetic materials (e.g., a speaker) to avoid any adverse effects from external magnetic fields.

(5) Leak magnetic field

The VCM drive magnetic circuit may leak a magnetic field (Up to 2.5 mT at a distance of 4 mm from the drive surface).

IMPORTANT

Do not place any devices sensitive to a magnetic field near the optical disk drive.

(6) External light source

Mount the optical disk drive away from strong light sources (e.g., camera flash).

(7) System ground (handling of SG and FG)

The optical disk drive must be grounded to the signal ground (SG) of the power supply of the user's system. This SG line must be supplied with the system as well as the power line.

IMPORTANT

The optical disk drive can be mounted in a 120 mm (5 inch) device bay of the PC chassis using either a metal frame or a plastic (nonconductive material) frame.

If a plastic frame is used, the personal computer's FG and the optical disk drive's FG are not shorted. Consequently, the static electricity tolerance is inferior to that realized when a metal frame is used.

Fujitsu recommends using a metal frame. In particular, a metal frame must be used especially when high static electricity tolerance is required.

3.3 Power Supply Requirements

(1) Allowable input voltage and current

The DC power supply input voltage must satisfy the requirements described in Section 2.1.3, "Environmental and power requirements" when measured at the power supply connector pin (receiving end) of the optical disk drive (For other requirements, see items (4) and (5) below).

(2) Current waveform (reference)

Figure 3.8 shows the current waveform while a disk is inserted.
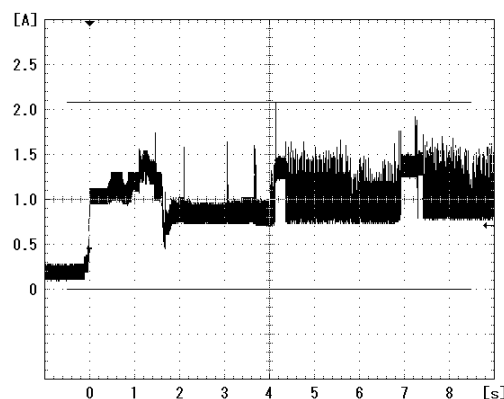
Figure 3.8 MCM3130AP current waveform (+5 VDC)

3.4 Cable Connections

3.4.1 Drive connectors

The optical disk drive (ODD) has the following connectors. Figure 3.9 shows the location of the connectors.

-    AT interface connector (40 pins) and power connector (4 pins) CN1

Power connector

1	+12 VDC or no connection
2	+12 VDC return (GND) or no connection
3	+5 VDC RETURN (GND)
4	+5 VDC
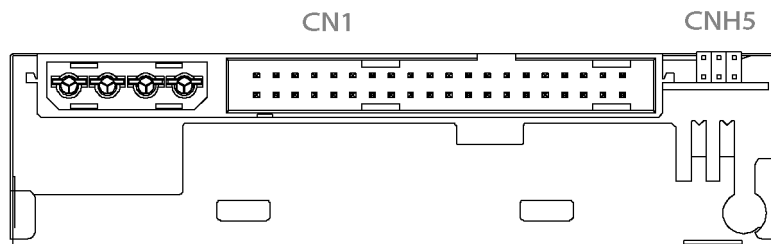
Figure 3.9 Connector and terminal locations

3.4.2 Cable connector specifications

Table 3.3 lists the recommended cable connector specifications.

Table 3.3   Cable connector specifications

Cable name	Name	Model name	Vendor
AT interface cable (40 pins)	Cable socket (closed end type)	FCN-707B040-AU/B	Fujitsu
	Cable socket (through end type)	FCN-707B040-AU/0	Fujitsu
	Signal cable	445-248-40	SPECTRS STRIP
Power cable	Cable socket housing	1-480424-0	AMP
	Contact	170121-4	AMP
	Signal cable	AWG18	

IMPORTANT

Use a cable that is flat over the whole length as the host interface cable (do not use a cable with only the crimp section flat, with separate conductors from halfway, or with twisted pair type conductors).

3.4.3 Drive connections

Figure 3.10 shows cable connections between devices.
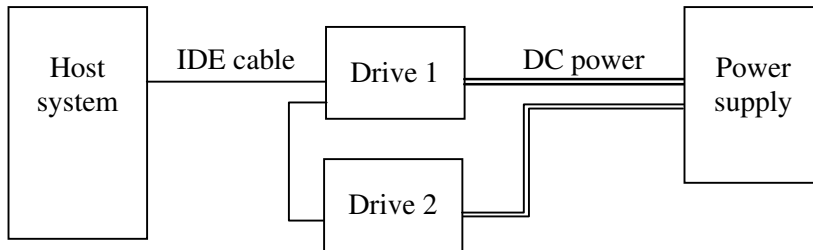
Figure 3.10   Cable connection diagram

3.5 Jumper Settings

3.5.1 Factory shipment settings

Figure 3.11 shows the jumper wire settings at factory shipment.
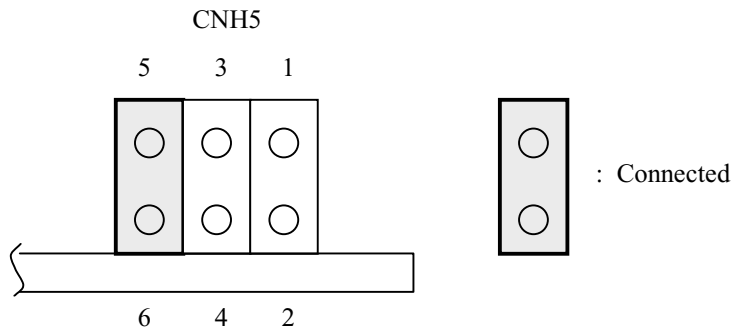
5-6 (connected): Master device setting

Figure 3.11   Jumper wire settings at factory shipment

3.5.2 Mode settings

(1) Master device mode setting

Figure 3.12 shows the setting that enables a master device (device 0) to be detected.

CNH5
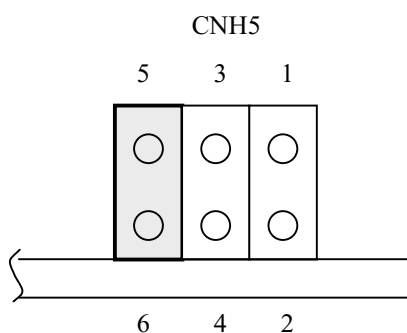
Figure 3.12   Master device setting

(2) Slave device mode setting

Figure 3.13 shows the setting that enables a slave device (device 1) to be detected.

CNH5
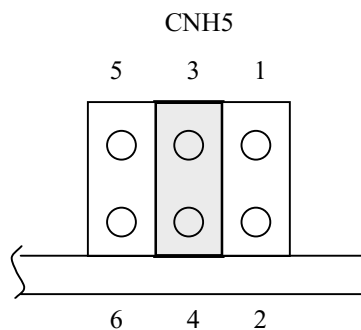
Figure 3.13   Slave device setting

(3) Cable selection mode setting

Figure 3.14 shows the master/slave device setting that is set by connecting the CSEL signal line to the interface. The special interface connector shown in the example in Figure 3.14 is also required.

CNH5
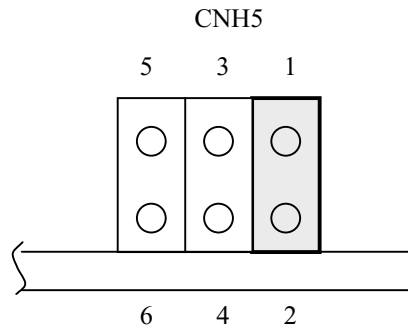
Figure 3.14   Cable selection mode setting

Figure 3.15 shows an example of cable selection with the special interface cable.

In the figure, master CSEL is connected to the cable-side CSEL line (conductor) and then connected to GND. By this, the master drive detects itself as a master. At the same time, the slave device detects itself as a slave because the conductor of slave CSEL is removed and slave CSEL has no connection to cable-side CSEL.
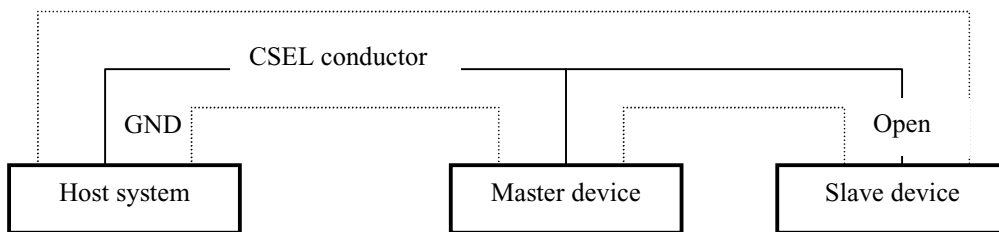
Example (1)
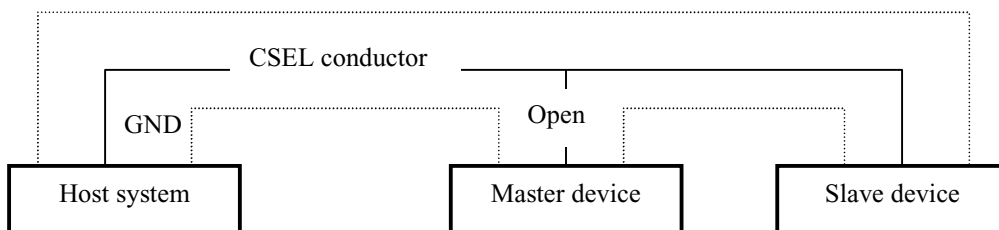
Example (2)

Figure 3.15   Cable selection example

3.6 Precautions on Handling of Drive

(1) General precautions

Keep the following points in mind to ensure the performance and reliability of the optical disk drive:

⚠CAUTION

Device damage:
1) Do not expose to the drive any shock or vibration exceeding the specification because it will fatally damage the drive. Be particularly careful of this point when unpacking the drive.
2) Do not leave the drive in a dirty or contaminated environment.
3) Since the drive contains CMOS components that may be destroyed by static discharge, keep the following points in mind after unpacking:

- Use an antistatic mat and wear a wrist strap when handling the drive.

- Hold the mounting frame when handling the drive. Do not touch the printed wiring board unit except when required to make the settings.

4) When handling the drive, hold both sides of the mounting frame. When touching any part of the drive other than both sides of the mounting frame, avoid applying force on the location.
5) When handling the drive or making settings, do not press hard on the tip of the header pin of the printed circuit board unit.

(2) Unpacking the drive

a) Find a level work space. Place the carton properly on the floor by making sure that the UP label on the carton is pointing upward. Handle the drive on a soft surface such as a rubber mat, not on a hard surface such as a desk.

b) When removing the cushions, be careful not to apply excessive force to the drive inside.

c) When removing the drive from the antistatic bag, be extra careful not to apply excessive force to the printed circuit board unit surface and interface connectors.

d) When moving the drive to any location 10 degrees hotter or colder than the temperature at the current location, leave the drive in the new location for at least two hours before unpacking it.

(3) Installation

    a)   While the power is on, do not connect or disconnect the connectors or change the terminal settings.

    b)   While the power is on, do not move the drive.

    c)   Before moving the drive, first eject and remove any optical disk cartridge in it and then turn off the power.

<div align="center">⚠ CAUTION</div>

Device damage: Before moving the drive, remove any optical disk cartridge in it. If the drive is moved with the optical disk cartridge loaded in it, the head may move back and forth in the drive to damage the head or disk, consequently disabling data from being read later.

(4) Packing

    a)   Remove an optical disk cartridge from the drive before packing it.

    b)   Place the drive in an antistatic plastic bag with a desiccant (silica gel).

    c)   Fujitsu recommends using the same cushions and carton supplied by Fujitsu with the drive. If they are not available, ensure the use of a carton with an adequate shock absorbent structure that can prevent shock or vibration from being directly applied to the drive. In this case, provide sufficient protection on the printed circuit board unit surface and the interface connectors to avoid damages.

    d)   Apply "UP" and "Handle With Care" labels to the outside of the package.

Figure 3.14 gives an overview of packing drives individually or in sets. Note that different cushions of different forms and materials but with equivalent functions may be used when packing drives in the future.

Drive

Holder

Desiccant

Ejecting jig

Packing box for
each individual
unit

Box

Figure 3.16   Packing styles (1/2)

Drive

Desiccant

Holder

Ejecting jig

Carton of
packing boxes
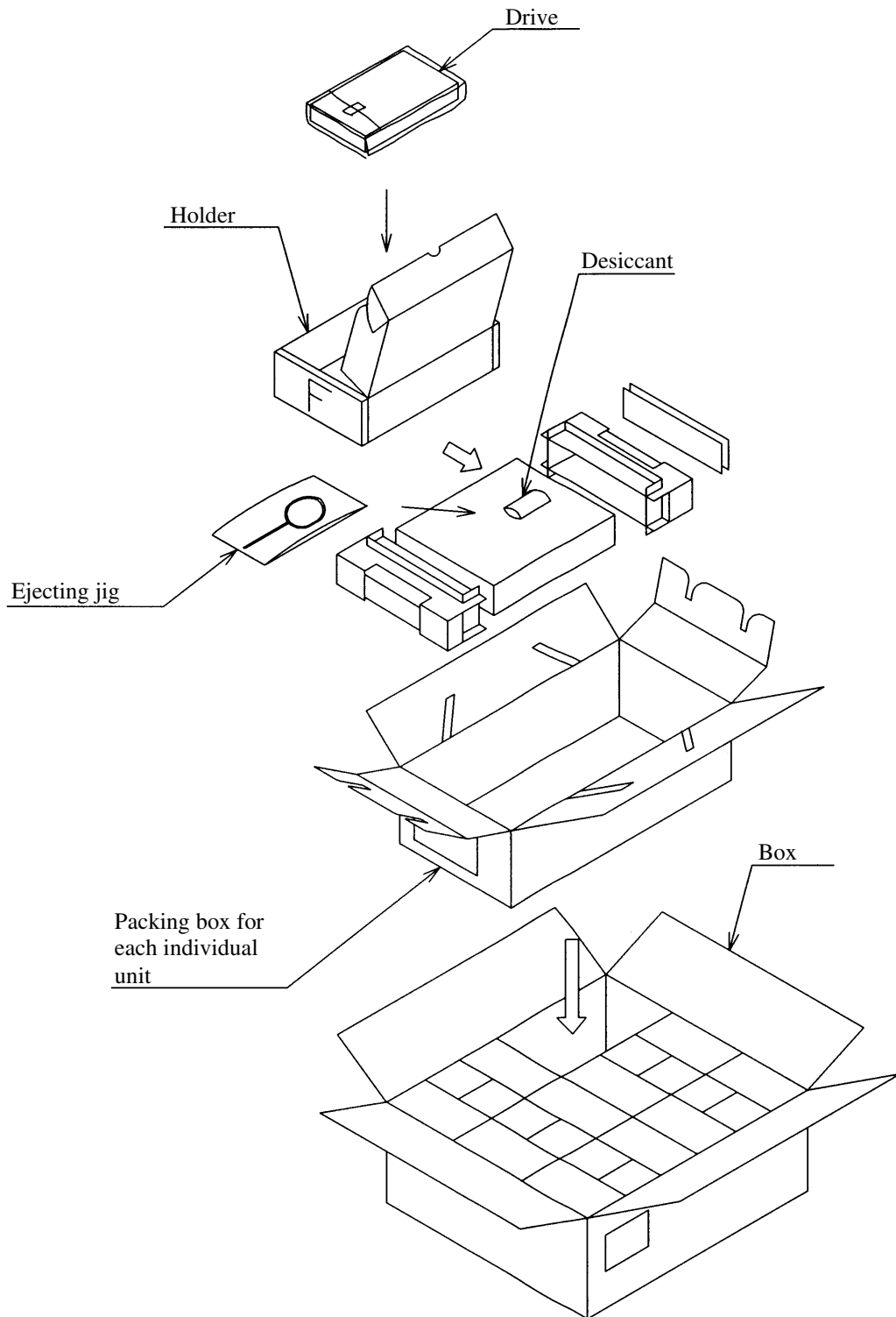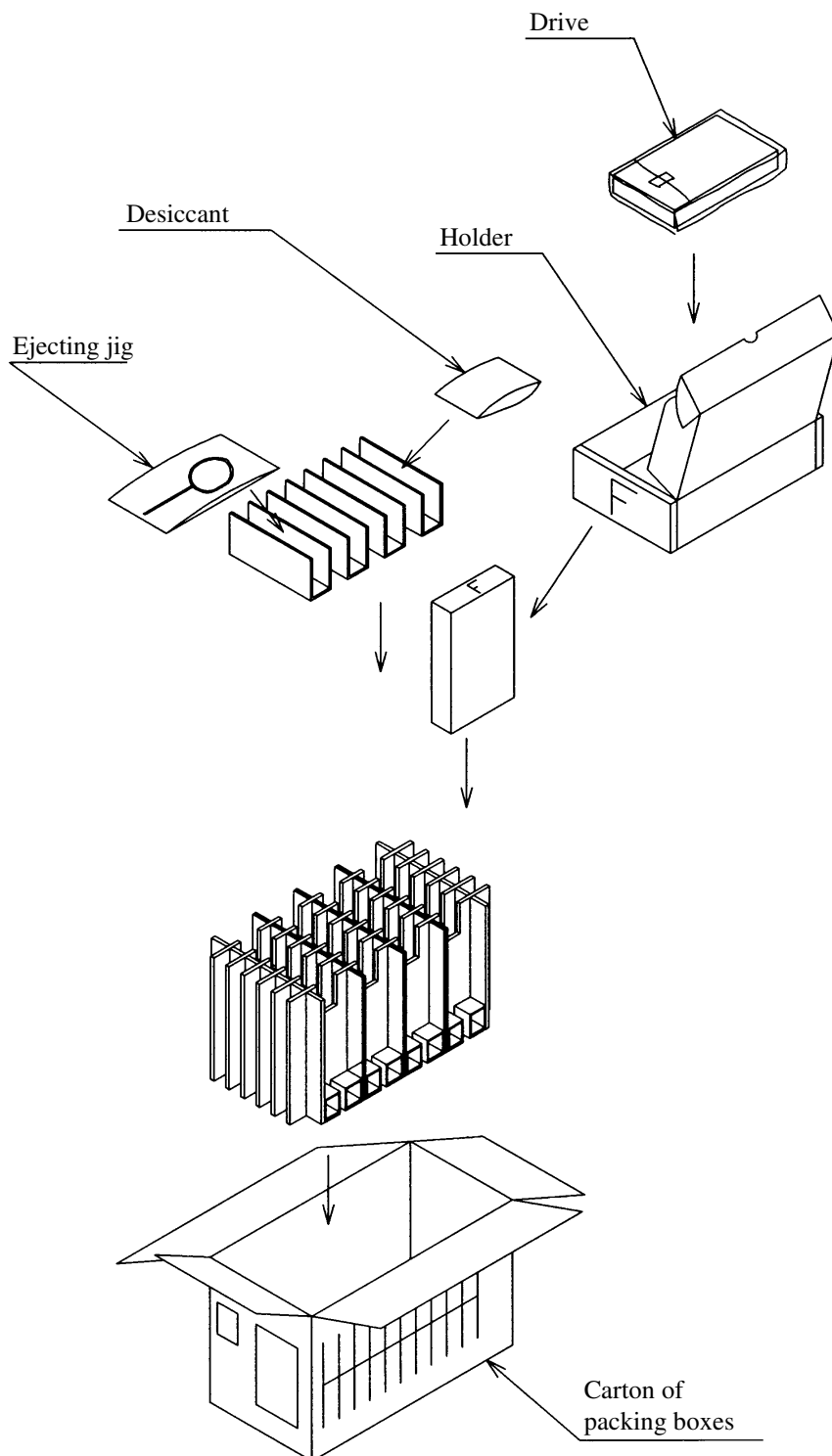
Figure 3.16   Packing styles (2/2)

(5) Transportation

     a) In principle, transport the drive while it is packed with the UP sign pointing upward.

     b) Transport the drive, after it is unpacked, only for a short distance. While doing so, use cushions to avoid applying shock and vibration. Transport the drive, after it is unpacked, in one of the orientations described in Section 3.2.2, "Installation orientation." (The horizontal orientation is recommended.)

(6) Storage

     a) Use moisture-proof packing when storing the drive.

     b) The storage environment must satisfy the requirements during non-operation specified in Section 2.1.3, "Environmental and power requirements."

     c) To prevent condensation, avoid exposing the drive to extreme temperature changes.

3.7 Mounting of Drive

3.7.1 Mounting procedure

The method of and procedure for mounting the drive vary depending on the system cabinet structure, etc. Determine the mounting procedure in accordance with the requirements of your system.

This section describes the general mounting procedure and check items.

See Section 3.2, "Mounting Requirements" for details on mounting the optical disk drive.

1) Tighten four mounting screws to secure the drive in the system cabinet.

- The drive has ten mounting holes (both sides: 3 (2, bottom: 4). Secure the drive by using the four mounting holes on either of the two sides or the bottom.

- Use mounting screws whose entry depth is 3 mm or less from the outer surface of the mounting frame of the drive after they are tightened. (See Figure 3.6)

- When mounting the drive with screws, the screw tightening torque should be 0.4 to 0.45Nm (4 to 4.6kgfcm).

- Be extra careful not to damage the parts on the printed circuit board unit while you mount the drive.

2) After securing the drive, make sure that the drive does not come into contact with the chassis of the system cabinet. There must be at least a 1.5-mm clearance between the drive and the chassis. (See Figure 3.6.)

3.8 Cable Connections

Use the following cables to connect the optical disk drive to the system. See Section 3.4, "Cable Connections" for details on the connector positions and cable connection requirements.

- Power supply cable

- AT interface cable

The general procedure for and precautions on connecting cables are given below. Be extra careful regarding the insertion direction of each cable connector.

<div align="center">⚠CAUTION</div>

Device damage:

- Make sure that the system power is off.

- Do not connect or disconnect any cable while the drive power is on

1) Connect the power cable.

2) Connect the AT interface cable.

3) After inserting the connector of a cable, hold the cable properly so that it neither touches a part on the device and PC board unit nor prevent the cooling air from flowing in the system cabinet.

3.9 Post-installation Operation Check and Preparation for Use

3.9.1 Initial operation check

This section provides the operation check procedures after power-on.

(1) Initial operation upon power-on

- When the power is turned on, the drive starts initial self-diagnostics. The LED on the front panel is on for 1 second during initial self-diagnostics.

- If an error is detected during initial self-diagnostics, the LED on the front panel blinks. If the initial self-diagnostics normally terminates, the LED goes off.

- If the power is turned on with no cartridge inserted, the eject motor automatically turns once.

(2) Items to confirm if an error occurs in initial self-diagnostics

- Make sure that the cables are correctly connected.

- Make sure that the power voltage is supplied normally. (Measure the voltage at the power supply connector of the optical disk drive.)

- Make sure that all of the setting terminals are correctly set.

- Continuous blinking of the LED on the front panel indicates that an error has been detected during initial self-diagnostics. Fujitsu recommends issuing, wherever possible, the REQUEST SENSE command from the initiator (host system) to collect information (sense data) for error analysis.

IMPORTANT

The LED is on while the optical disk drive is performing the seek, write, or read operation. However, because an LED goes on only momentarily, it may seem to blink or remain off.

Upon power-on, the eject motor turns once to correct the position of the eject motor (in case it deviates due to shock or vibration applied to the drive during transportation), and allows a cartridge to be inserted normally.

If you cannot insert a cartridge properly, remove the cartridge and turn on the drive power to have the eject motor turn once before reinserting the cartridge.

3.9.2 Connection check

When the initial operation check terminates normally after power-on, check whether the drive is correctly connected by issuing a command from the host system. The checking procedure depends on the host system configuration. The following describes a general check procedure.

(1) Check to be made if the initial operation check terminates abnormally:

a) Analyze sense data if any has been collected due to the REQUEST SENSE command. If the error is recoverable, retry the processing.

b) On AT interface cable connections, make sure that:

- All connectors, including those of other devices, are correctly connected.

- Correct cables are being used (whether they support the cable selection mode setting).

c) Reconfirm that the jumper wire settings are correct.

3.10 Demounting of Drive

The procedure for demounting an optical disk drive (to check the setting terminals, change the settings, or replace the drive, for example) depends on the system cabinet configuration. Determine the demounting procedure by considering the requirements unique to your system. This section describes the general demounting procedure and precautions to follow when demounting a drive.

<div align="center">⚠CAUTION</div>

Device damage: Before demounting the optical disk drive, turn off the system power. While the power is on, do not remove screws securing the cables and drive.

1) Remove the power cable.

2) Remove the AT interface cable.

3) Remove the four screws securing the drive, then remove the drive from the system cabinet.

4) While storing or transporting the drive, put the drive into an antistatic bag. (See Section 3.6.)

CHAPTER 4 Host Interface

4.1 Pin Assignment

4.2 Signal Description

4.3 Interface Registers

4.4 Various Processes

4.5 ATA Commands

4.6 Packet Commands

4.7 Timing

This chapter describes host interface specification.

4.1 Pin Assignment

The table below lists pin assignments of the interface connector.

Although the MCG3xxxAP has power-related pins, they are omitted in this specification.

Table 4.1   Connector pin assignments (1/2)

Description	PIN	Signal name
Reset	1	RESET-
Ground	2	Ground
Data bus bit 7	3	DD7
Data bus bit 8	4	DD8
Data bus bit 6	5	DD6
Data bus bit 9	6	DD9
Data bus bit 5	7	DD5
Data bus bit 10	8	DD10
Data bus bit 4	9	DD4
Data bus bit 11	10	DD11
Data bus bit 3	11	DD3
Data bus bit 12	12	DD12
Data bus bit 2	13	DD2
Data bus bit 13	14	DD13
Data bus bit 1	15	DD1
Data bus bit 14	16	DD14
Data bus bit 0	17	DD0
Data bus bit 15	18	DD15
Ground	19	Ground
(keypin)	20	Reserved
DMA Request	21	DMARQ
Ground	22	Ground
I/O Write Stop during Ultra DMA data bursts	23	DIOW- STOP
Ground	24	Ground

Table 4.1   Connector pin assignments (2/2)

I/O Read DMA ready during Ultra DMA data in bursts Data strobe during Ultra DMA data out bursts	25	DIOR- HDMARDY- HSTROBE
Ground	26	Ground
I/O Ready DMA ready during Ultra DMA data out bursts Data strobe during Ultra DMA data in bursts	27	IORDY DDMARDY- DSTROBE
Cable Select	28	CSEL
DMA Acknowledge	29	DMACK-
Ground	30	Ground
Interrupt Request	31	INTRQ
16 Bit I/O	32	IOCS16-
Device Address Bit 1	33	DA1
PASSED DIAGNOSTICS Cable assembly type identifier	34	PDIAG- CBLID-
Device Address Bit 0	35	DA0
Device Address Bit 2	36	DA2
Chip Select 0	37	CS0-
Chip Select 1	38	CS1-
Device Active or Slave (Device 1) Present	39	DASP-
Ground	40	Ground

4.2 Signal Description

Table 4.2 Signal description (1/2)

PIN	Signal name	I/O	Description
1	RESET-	I	Reset signal
3, 5, 7, 9, 11, 13, 15, 17, 18, 16, 14, 12, 10, 8, 6, 4	DD7-0 DD15-8	I/O	The low-order bus is a 8-bit bidirectional bus signal for exchanging the status, data, and control data between the host and ODD. The high-order bus is used for 16-bit data transfers only.
21	DMARQ	O	Data request signal for DMA transfer
23	DIOW- STOP	I	Write strobe signal. Indicates that transfer has ended at Ultra DMA transfer.
25	DIOR- HDMARDY- HSTROBE	I	Read strobe signal. Indicates that the host can receive Ultra DMA data at Ultra DMA in transfer. The ODD latches data at both edges of this signal at Ultra data out transfer.
27	IORDY DDMARDY- DSTROBE	O	This is the ready signal for the host computer. The ODD uses this signal to request an extension of the transfer cycle when it cannot prepare a response to a data transfer request from the host computer in time. Indicates that the ODD can receive Ultra DMA data at Ultra DMA out transfer. The host latches data at both edges of this signal at Ultra data in transfer.
28	CSEL	I	Sets the ODD to the master (device 0) or slave (device 1). Effective by jumpering.
29	DMACK-	I	Answer signal in response to DMARQ during DMA transfer
31	INTRQ	O	Interrupt signal to the host
32	IOCS16-	O	Indicates that the ODD is ready for 16-bit transfer when the host addresses the 16-bit data port during PIO transfer.
36, 33, 35	DA2, 1, 0	O	Address signal used by the host to address the ODD task file register
34	PDIAG-	I/O	Used by the slave (device 1) to notify the master (device 0) that diagnostics ended

Table 4.2 Signal description (2/2)

PIN	Signal name	I/O	Description
37	CS0-	O	Select signal used to select the command block register
38	CS1-	O	Select signal used to select the control block register
39	DASP-	I/O	When reset, slave (device 1) output signal indicating that the slave (device 1) exists. Otherwise, the signal indicates that the master (device 0) and slave (device 1) is performing mechanical operation or a failure occurred.
2, 19, 22, 24, 26, 30, 40	Ground	-	Ground signal

4.3 Interface Registers

4.3.1 I/O registers

This section provides the I/O register functions and mapping. Definitions of each register vary depending on which ATA or ATAPI commands are used.

Table 4.3   I/O port functions and mapping

Address signal					Function	
CS0-	CS1-	DA2	DA1	DA0	READ (DIOR-)	WRITE (DIOW-)
N	N	x	x	x	High impedance state	Ineffective
					Control block register	
N	A	0	x	x	High impedance state	Ineffective
N	A	1	0	x	High impedance state	Ineffective
N	A	1	1	0	Alternate Status	Device Control
N	A	1	1	1	Drive Address	Ineffective
					Command block register	
A	N	0	0	0	Data	
A	N	0	0	1	Error	ATA Features (ATA) ATAPI Features (ATAPI)
A	N	0	1	0	Sector Count (ATA)	
					ATAPI Interrupt Reason (ATAPI)	Ineffective
A	N	0	1	1	Sector Number	
A	N	1	0	0	Cylinder Low (ATA) ATAPI Byte Count (bits 0-7) (ATAPI)	
A	N	1	0	1	Cylinder High (ATA) ATAPI Byte Count (bits8-15) (ATAPI)	
A	N	1	1	0	Device/Head (ATA) ATAPI Block Device Select (ATAPI)	
A	N	1	1	1	ATAPI Status	ATA Command
A	A	x	x	x	Ineffective	Ineffective

The letter A indicates that the bit is asserted, N indicates that the bit is negated, and X indicates that the bit is ignored.

4.3.1.1 Alternate Status register

This register contains the same information as that of the ATAPI Status register, except that the ODD does not recognize interrupts when reading this register. Therefore, the ODD does not clear the INTRQ signal and does not clear interrupts during the pending.

Table 4.4   Bit definitions of Alternate Status register

7	6	5	4	3	2	1	0	
BSY	DRDY	Reserved (0b)	SERVICE	DRQ	CORR (0b)	Reserved (0b)	CHECK	Read

4.3.1.2 ATA Command register

This register contains a command to be passed to the ODD. The ODD starts executing a command immediately after the command is written in this register. For executable commands and required parameters, see Table 4.37.

4.3.1.3 Data register

The data register is used for data transfer. The data width is always 16 bits.

4.3.1.4 Device Control register

This register's bits are defined as shown below.

Table 4.5   Bit definitions of Device Control register

7	6	5	4	3	2	1	0	
Reserved	Reserved	Reserved	Reserved	Reserved	SRST	nIEN	0	Write

- Bits 7 to 3 are reserved. The ODD ignores all value sets in these bits.

- SRST is a reset bit for host software.

- nIEN is an enable bit for device interrupts to the host. When nIEN is 0 and the device is selected, the INTRQ signal is enabled by the tri-state buffer. When nIEN is 1 or the device is not selected, the INTRQ signal is in the high-impedance state.

4.3.1.5 Drive Address register

This register's bits are defined as shown below.

Table 4.6   Bit definitions of Drive Address register

7	6	5	4	3	2	1	0	
HiZ	nWTG	nHS3	nHS2	NhS1	nHS0	nDS1	nDS0	Read

- HiZ is always in the high-impedance state.

- nWTG indicates the status of the ODD internal data write control signal (Write Gate).

- nHS3 indicates a binary complement of bits 3 to 0 of the drive select register.

- nDS1 is the device select bit for device 1. It is 0 when device 1 is selected.

- nDS0 is the device select bit for device 0. It is 0 when device 0 is selected.

4.3.1.6 ATAPI Byte Count register

This register's bits are defined as shown below.

Table 4.7   Bit definitions of ATAPI Byte Count register

7	6	5	4	3	2	1	0	
Byte Count (Bits 7-0)								R/W
Byte Count (Bits 15-8)								R/W

- This register is used for PIO transfer only. The ODD sets the byte count to be transferred by the host in this register and sets DRQ to 1. The ODD does not update this register until transfer starts.

4.3.1.7 ATAPI Block Device Select register

This register's bits are defined as shown below.

Table 4.8   Bit definitions of ATAPI Block Device Select register

7	6	5	4	3	2	1	0	
Unused	Unused	Unused	Dev	Unused	Unused			R/W

- Bits 7, 6, 5, 3, 2, 1, and 0 are not used. The ODD ignores all value sets in these bits.

- Dev indicates the device address. When Dev is 0, device 0 is selected and when Dev is 1, device 1 is selected.

- Logical unit numbers (LUNs) are not supported. The ODD ignores all such set values.

4.3.1.8 Error register

This register indicates the status of the final command.

The value of this register is effective when the ERR bit of the Status register is 1 at completion of a command other than EXECUTE DEVICE DIAGNOSTIC.

The value of this register indicates the diagnostic code at power-on, reset, and execution of the EXECUTE DEVICE DIAGNOSTIC command. For details on diagnostic codes, see Section 4.5.5.

Table 4.9   Bit definitions of Error register

7	6	5	4	3	2	1	0	
Sense Key				MCR (0b)	ABRT	EOM (0b)	ILI (0b)	Read

- For the Sense Key, see Table 4.99.

- MCR (Media Change Requested) is not used. It is always 0.

- ABRT (Aborted Command) indicates that the value of the ATA command code or task file register is incorrect.

- EOM (End of Media) is not used. It is always 0.

- ILI (Illegal Length Indication) is not used. It is always 0.

4.3.1.9 ATA Features register

This register is used for the SET FEATURES command.

4.3.1.10 ATAPI Features register

This register's bits are defined as shown below.

Table 4.10 Bit definitions of ATAPI Features register

7	6	5	4	3	2	1	0	
Reserved						OVERLAP	DMA	Write

- All values in bits 7 to 2 are ignored.

- OVERLAP is not used. The ODD ignores the value set in this bit.

- When DMA is 1, the ODD performs DMA transfer for data transfer.

4.3.1.11 ATA Sector Count register

This register is used for the SET FEATURES command.

4.3.1.12 ATAPI Interrupt Reason register

This register's bits are defined as shown below.

Table 4.11 Bit definitions of ATAPI Interrupt Reason register

7	6	5	4	3	2	1	0	
Reserved (0b)	Reserved (0b)	Reserved (0b)	Reserved (0b)	Reserved (0b)	RELEASE	I/O	C/D	Read

- When RELEASE is 1, the ODD releases the ATA bus before a command being executed is completed.

- I/O indicates the direction of data transfer. See Table 4.12.

- C/D indicates the type of transfer. See Table 4.12.

Table 4.12 I/O and C/D

I/O	C/D	Meaning
0	1	Packet command transfer
1	0	Data or parameter transfer (from the ODD to the host)
0	0	Data or parameter transfer (from the host to the ODD)
1	1	The completion status in the Status register is effective.

4.3.1.13 Sector Number register

This register is not used. The ODD ignores all specified values.

4.3.1.14 ATAPI Status register

This register indicates the status of the ODD. It is updated to reflect the current ODD status and the progress of the current command. When the BSY bit is 0, other bits of the register are effective and some other command block registers may be set with significant information. When the BSY bit is 1, the other bits of this register and all other command block registers are ineffective.

While the ODD is in sleep mode, the ATAPI Status register and all other command block registers are ineffective.

If the host reads this register during interrupt pending, the interrupt is cleared.

Table 4.13 Bit definitions of ATAPI Status register

7	6	5	4	3	2	1	0	
BSY	DRDY	Reserved (0b)	SERVICE	DRQ	CORR (0b)	Reserved (0b)	CHECK	Read

- BSY (Busy) is set during command block register control. When BSY is 1, the ODD ignores all command block registers other than the Device Reset command.

The ODD updates the DRQ and CHECK values only when BSY is 1. After the final block of the PIO data-in command is transferred, the BSY bit setting is canceled and the DRQ bit is cleared.

When BSY is 0, the ODD may update the SERVICE bit of the ATAPI Status register and the Data register. The ODD does not update all other command block registers and the ATAPI Status register bits.

The ODD sets BSY:

a) After RESET- is negated or within 400 ns of setting the SRST bit of the Device Control Register

b) Within 400 ns of receiving a command when the DRQ bit is not set

c) Between data transfer blocks of the PIO data-in/PIO data-out command when the DRQ bit is not set

d) After data block transfer with the PIO data-out command when the DRQ bit is not set

e) During DMA transfer when the DRQ bit is not set

In all other cases, the ODD does not set BSY.

If BSY is set after RESET- is negated, the SRST bit is set, or a Device Reset command is issued, it remains set until the ODD completes the internal reset process.

- DRDY (Device Ready) is always 1, except at the time after reset is made until the next command is issued.

- For SERV, set the same value as that of DRDY. The SERV bit should be ignored from the standpoint of compatibility.

- DRQ (Data Request) indicates that the ODD can transfer one byte or one word to or from the host. When DRQ is 1, the ATAPI Interrupt Reason register of the current packet command is effective.

- CORR (Corrected Data) is always 0.

- CHECK indicates that an error occurred in command processing. The Error register contains additional information on the cause of the error. When the ODD sets CHECK to 1, the items below are not changed until a new command is received or the ODD is reset.

  − CHECK bit of the Status register

  − Error register

  − Device/Head register

4.4 Various Processes

4.4.1 Reset response

There are four types of resets.

- Power-on reset

    − The ODD performs initialization such as initial diagnostics and default setting. If any media is mounted, it also spins up media.

- Hardware reset

    − The ODD is reset when the RESET- signal is asserted. The ODD initializes the interface controller by setting default values.

- ATA software reset

    − The ODD is reset when the SRST bit of the Device Control register is set.

    − The device driver should not use the SRST bit to reset the ODD (except for restore from sleep mode).

    − After ATA software reset, the ODD initializes the task file as shown below.

        Status = 00h

        Error = (Depending on the SRST sequence)

        Sector Count = 01h

        Sector number = 01h

        Cylinder Low = 14h

        Cylinder High = EBh

        Drive/Head = 00h

    − DRDY is set to 1 with the first command after ATA reset.

    − If ATA software reset is issued while the ODD is selected and a command is being executed (BSY = 1 or DRQ = 1), the command is interrupted. Otherwise, the ODD continues command processing.

    − The contents set with the MODE SELECT and Set Features commands remain unchanged.

- ATAPI reset

    − The ODD is reset with a DEVICE RESET command. The ODD interrupts the current command.

4.4.2 Defect sector management

Sector mapping is executed based on the ISO/IEC 10090 standard for 128 MB media, the ISO/IEC 13963 standard for 230 MB media, the ISO/IEC 15041 standard for 540 and 640 MB media, and GIGAMO 1.3 GB 90 mm Magneto-optical Disk System-System Description for 1.3 GB media. Basically, possibly defective sector management is not required for the host.

Defective sectors cannot be deleted from the host, except for certifying recordable areas. Recordable areas can be certified with the FORMAT UNIT command.

4.4.3 Automatic alternate sector assignment function

The ODD automatically assigns an alternate sector if a verify error is detected in the ID or data section during the WRITE (I0) command, WRITE (12) command, or WRITE AND VERIFY and ERASE command. Alternate sector information is registered in SDL (Secondary Defect List) on media.

After automatic alternate assignment terminates successfully, the ODD does not report any error.

For the criteria for executing alternate sector assignment processing, see Table 4.14, "Alternate sector assignment criteria."

Table 4.14 Alternate sector assignment criteria

Processing	Alternate sector assignment processing	Remarks
ID read error	128/230 MB media: 3 read errors in 3 sectors 540/640 MB or 1.3 GB media: 2 read errors in 2 sectors	-
Data error	5 or more bytes per interleave	Verify Check is not performed unless it is valid. This criterion is inapplicable to the ERASE command.

4.4.4 Data error detection criteria

Table 4.15 lists the ID and data error detection criteria for data access commands and for error processing.

Table 4.15 ID and data error detection criteria and error processing details

Command	ID read error	Data error	Error processing details
FORMAT UNIT	128/230 MB media: 3 read errors in 3 sectors 540/640 MB or 1.3 GB media: 2 read errors in 2 sectors	4 or more bytes per interleave	Defective sectors are registered in PDL (Primary Defect List). When there are a large number of detective sectors, the sectors are also registered in SDL (Secondary Defect List).
WRITE(10) WRITE(12) WRITE AND VERIFY ERASE	128/230 MB media: 3 read errors in 3 sectors 540/640 MB or 1.3 GB media: 2 read errors in 2 sectors	5 or more bytes per interleave (Inapplicable to the ERASE command.)	Defective sectors are registered in SDL.
READ(10) READ(12)	Free of errors (If all IDs could not be read, repositioning processing is generated.)	9 or more bytes per interleave	Responds with Check Condition. Sense Key indicates Medium Error.
WRITE LONG	128/230 MB media: 3 read errors in 3 sectors 540/640 MB or 1.3 GB media: 2 read errors in 2 sectors	No check	Responds with Check Condition. Sense Key indicates Medium Error.
READ LONG	Free of errors (if all IDs could not be read, they are read using an offset from the preceding or succeeding sector; therefore, repositioning processing is generated.)	No check	Responds with Check Condition. Sense Key indicates Medium Error.
VERIFY	128/230 MB media: 3 read errors in 3 sectors 540/640 MB or 1.3 GB media: 2 read errors in 2 sectors	9 or more bytes per interleave	Responds with Check Condition. Sense Key indicates Medium Error.

4.4.5 Cache function

The ODD supports the read cache and MO write cache.

The read cache consists of the read ahead cache and the LRU cache that reads write data remaining in the data buffer.

The read ahead cache allows for data transfer at a near effective transfer speed during continuous read operation without causing any delay owing to rotation latency. LRU allows for data transfer with no mechanical operation if write and read operations are executed frequently on the same sector.

The MO write cache writes data in batch mode during continuous write operation, thus reducing positioning operations depending on the buffer size and recovering the write throughput.

4.4.5.1 Data buffer

The ODD uses part of the buffer area as work memory for control firmware and the remaining area as a buffer. The data buffer consists of plural segments and contains write data of plural segments.

4.4.5.2 Read cache

The ODD enables the read ahead cache and LRU cache when the cache function is enabled. When the read cache is enabled, the ODD contiguously pre-reads the specified sector, then pre-reading the next sector when receiving the READ (10) or READ (12) command (called Read command in this document). While pre-reading the next sector, the ODD transfers the data in the sector specified by the command.

When data in the sector specified by the host hits pre-read data, the ODD transfers data directly from the buffer without any mechanical operation.

Pre-read stops under the following conditions:

- Processing for access to alternate sectors

- Read error and retry processing

- Media physical zone boundary

- Read command reception for a sector that is not contiguous from the specified sector of the previous Read command operation

- Non-Read command reception

- Full data buffer

- Media ejection request issued using the eject switch

- Hardware/software reset, DEVICE RESET command reception, or power-off

When the cache is enabled, the buffer contains data transferred from the host with a write command. If a read command is issued to the sector address at this time, the ODD directly transfers data to the high-level equipment from the data buffer without reading it from media. If the cache is hit with a read command, the ODD makes the data in the hit segment being kept in the highest priority.

The data listed below cannot be stored in the read cache.

- Data that is transferred to a host during pre-reading

- Data that is being read before hardware/software reset, DEVICE RESET command reception, or the power-off sequence

- Data already stored before media is mounted

All buffer data is discarded under the following conditions:

- At hardware/software reset, DEVICE RESET command reception, or power-off

- When media is ejected

- When the FORMAT UNIT command is received

- In idle mode

- In standby mode

- In sleep mode

- When the system receives the MODE SELECT and SET FEATURES command that may change the reading mode

4.4.5.3 MO write cache

When the write cache is enabled, the ODD responds to the host with command end. This occurs when the data transfer is done with the WRITE (10), WRITE (12), or WRITE AND VERIFY command (hereafter "Write command" in this document).

When the Write command is issued consecutively, the ODD responds to the host with command end. This occurs if the specified sector logically contiguous to the sector specified by the previous command operation, at the end of the succeeding data transfer.

The ODD writes data kept in the buffer to media under the following conditions:

- When data can be written to media during data transfer processing with a write command or in the command wait state

- When all data buffer segments are in use, and a command requiring a new segment is received

- When the Eject switch is pressed

- When the SYNCHRONIZE CACHE command is received

- When software is reset or the DEVICE RESET command is received

Under the condition given below, the command end response to host and data transfer processing may wait until writing to media is completed:

- When all data buffer segments are in use, and a command requiring a new segment is received

Under the conditions given below, write data in the buffer may not be written properly on media:

- Power-off

- Hardware reset

- Forced media ejection (mechanical ejection)

4.4.6 Media status notification function

The media status notification function notifies the host of various information on the removable media device. The function is enabled or disabled with the SET FEATURES command.

When the media status notification function is enabled, the functions below will be added or changed.

- The GET MEDIA STATUS command is enabled.

- The Eject switch is disabled.

The media status notification function is disabled at power-on reset, software reset, when the DEVICE RESET command is received, or when the EXECUTE DEVICE DIAGNOSTIC command is received.

4.4.7 Power management function

The ODD provides the power management function that minimizes the power consumed. For this function, the ODD has some control commands and a timer. The host uses the functions below to control the power management function.

1) Standby timer

2) Idle Immediate command

3) Sleep command

4) Standby Immediate command

4.4.7.1 Power mode

The ODD supports power modes shown below. The ODD uses a power mode equivalent to standby mode, except that the DRDY bit is 0 while media is not mounted.

- Active mode

- Pre-idle mode

- Idle mode

- Standby mode

- Sleep mode

4.4.7.2 Active mode

In active mode, all circuits are enabled. The ODD requires the shortest time to start processing a command.

4.4.7.3 Pre-idle mode

In pre-idle mode, the read/write circuits stop. The ODD can receive a command from the host, but since some circuits stop, the command requires 20 ms to access media.

The ODD automatically enters pre-idle mode if no command is issued within a specified time (0.5 second) in active mode. When it receives an access command, the ODD automatically enters active mode. The pre-idle mode cannot be controlled from the host computer.

4.4.7.4 Idle mode

In idle mode, the servo and read/write circuits stop. The ODD can receive a command from the host, but because some circuits stop, the ODD takes 1 s seconds (standard) to access media.

If no command is issued within a specified time (180 s) in active mode, the ODD automatically enters pre-idle mode, then enters idle mode. When it receives an access command, the ODD automatically returns active mode. The Idle Immediate command can shift the ODD from active mode or standby mode to idle mode.

4.4.7.5 Standby mode

In standby mode, the spindle motor stops. The ODD can receive a command from the host, but since the spindle motor stops, the recovery to access media takes 5 s (standard).

The ODD automatically enters standby mode from active mode if no command is issued within a specified time when the standby timer is enabled. When it receives a command, the ODD automatically returns active mode. The Standby Immediate command can also directly shift the ODD from active or idle mode to standby mode.

4.4.7.6 Sleep mode

Sleep mode minimizes power consumption. To set the ODD in sleep mode, the host must issue the Sleep command. To restore the ODD from sleep mode, hardware reset or software reset is required. The host must not issue any command after the Sleep command. The ODD requires 15 s (standard) to respond.

4.4.7.7 Standby timer

The standby timer is used to count the time during which the host issues no command.

The standby timer value is programmable with the MODE SELECT command. The default value is 32 minutes (including the transition time to idle mode).

4.4.7.8 Power mode transition

The power mode transits as shown in Figure 4.1.
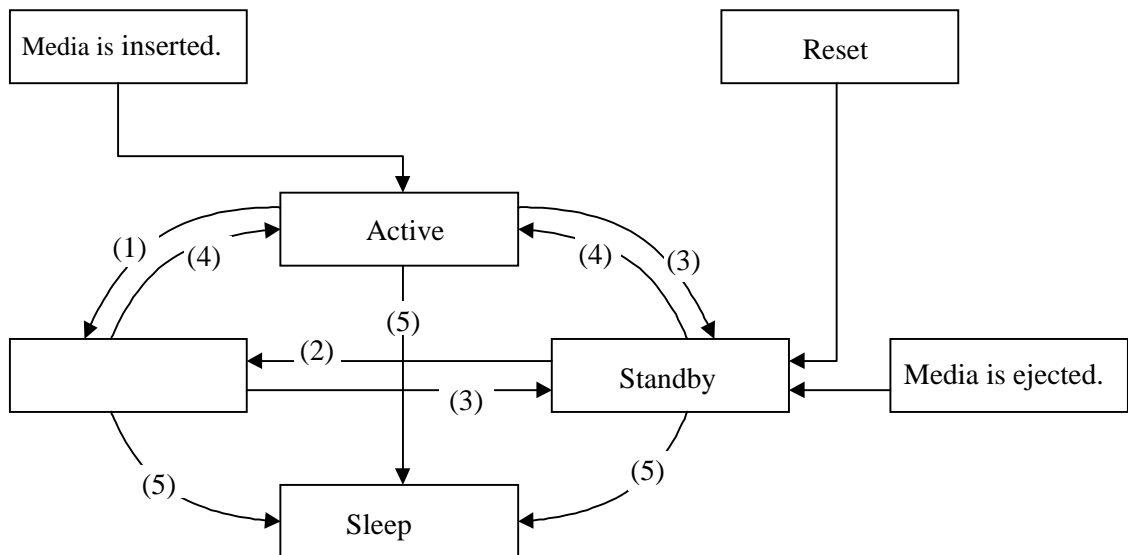
(1) The ODD enters idle mode because it receives the Idle Immediate command or because it receives no commands within a specified time.

(2) The ODD enters idle mode with the Idle Immediate command.

(3) The ODD enters standby mode with the Standby Immediate command and standby timer.

(4) The ODD enters active mode because it receives a media access command.

(5) The ODD enters sleep mode with the Sleep command.

Figure 4.1 Power mode

4.4.8 LED Indications

The ODD notifies the operator of a serious error by turning on or blinking the LED lamp. Table 4.16 lists indication modes and operation.

Table 4.16 LED indications

LED blink cycle	Operation
Off	Command wait state
On	Command processing
	Seek operation
	Read/write processing (including cache processing)
	Formatting
	Power-on diagnostics
	Spinning up (Including return from standby mode)
	Spinning down (Including shifting to standby mode)
Blinking (on for 1 second and off for 1 second repeatedly)	Starting the download only firmware (*1)
Blinking (on for 0.25 seconds and off for 0.25 seconds repeatedly)	A power-on diagnostics error occurred.
Blinking (on for 0.5 seconds and off for 0.5 seconds repeatedly)	A thermal alarm occurred.

*1   The ODD control firmware is stored on the flash ROM and can be downloaded from the host with the WRITE BUFFER command. However, if any problem occurs during downloading, such as power failure, downloading is interrupted and the microcodes in the control firmware may be damaged. To download microcode data again in such a case, the ODD starts the emergency download firmware that simply supports only the WRITE BUFFER command and other basic commands.

4.5 ATA Commands

Table 4.17 lists supported ATA commands.

This section represents ODD registers as shown below.

Cylinders High/Low registers: CY

Sector register: SC

Device/Head register: DH

Sector Number register: SN

Features register: FR

Table 4.17 Command codes and parameters

Protocol	Command name	Command code	Parameters used					Section
			FR	SC	SN	CY	DH	
PI	IDENTIFY PACKET DEVICE	A1h					D	4.5.1
–	PACKET	A0h	y	y	y	y	D	4.5.2
ND	DEVICE RESET	08h					D	4.5.3
ND	CHECK POWER MODE	E5h		y			D	4.5.4
ND	EXECUTE DEVICE DIAGNOSTIC	90h					D*	4.5.5
ND	GET MEDIA STATUS	DAh					D	4.5.6
ND	IDLE IMMEDIATE	E1h					D	4.5.7
ND	NOP	00h					y	4.5.8
ND	SERVICE (Not supported)	42h					D	4.5.9
ND	SET FEATURES	EFh	y	y			D	4.5.10
ND	SLEEP	E6h					D	4.5.11
ND	STANDBY IMMEDIATE	E0h					D	4.5.12
——	RESERVED: Other codes							

Notes:

1. y - This register contains parameters effective to run the command.

    D - Indicates that only the Device parameter is effective and the LUN parameter is ineffective.

    D* - Device 0 is addressed, but both devices execute the command.

2. The protocol above indicates the command protocol used.

ND - A non data command

PI - A PIO data-in command

4.5.1 IDENTIFY PACKET DEVICE (A1h)

Table 4.18 IDENTIFY PACKET DEVICE command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	0	1	0	0	0	0	1
DH	X	X	X	DRV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

When the ODD receives this command, it transfers device parameter information to the host. It accepts this command even if in standby mode.

Table 4.19 lists the transfer data format. The reserved word indicates a value of 0.

The transfer byte length is 512 bytes.

One-word information uses DD15 as MSB (Most Significant Bit) and DD0 as LSB (Least Significant Bit).

For ASCII character information such as base serial number, firmware version number, and product number, the first character code in the string uses word 1, DD15 to 8; the second character code uses word 1, DD7 to 0; the third character code uses word 2, DD15 to 8; and so on.

Table 4.19 Device parameter information (1/5)

Word	Value	Bits	Description
0	80C0h		General configuration information
		15-14	Protocol type (10b = ATAPI device)
		13	Reserved
		12-8	Device type 00000b = Direct access unit
		7	Replaceable media device 1b
		6-5	CMD DRQ type (10b = Accelerated DRQ)
		4-2	Reserved
		1-0	Command packet size (00b = 12 bytes)
1-9	0000h		Reserved
10-19	"xxx...xxx"		Base serial number (Left justified, ASCII codes)
20-22	0000h		Reserved
23-26	"aaab"		Firmware version number aaa: Major level version number (000 - 999) b: Minor level version number (0 - 9, a - z, and A - Z) (Left justified, ASCII codes, blank indicating space character)
27-46	"FUJITSU MCM3130AP" for MCM3130AP, "FUJITSU MCM3064AP" for MCM3064AP		Product number (Left justified, ASCII codes, blank indicating space character)
47-48	0000h		Reserved
49	0F00h	15-14	Reserved (0b)
		13	Overlap function supported (0b)
		12	Reserved (0b)
		11	IORDY supported (1b)
		10	IORDY can be disabled (1b)
		9	LBA mode supported (1b)
		8	DMA transfer mode supported (1b)
		7-0	Reserved (0b)

Table 4.19 Device parameter information (2/5)

Word	Value	Bits	Description
50	0000h		Reserved
51	0200h	15-8	PIO data transfer cycle timing mode
		7-0	Reserved
52	0000h	15-0	Reserved
53	0007h	15-3 2 1	Reserved Information in word 88 is valid. (1b) Information in words 64 to 70 is valid. (1b)
		0	Information in words 54 to 58 is valid. (1b)
54-62	0000h		Reserved
63	0407h		Multiword DMA transfer mode Active mode
		15-11	Reserved (0b)
	(Default value)	10	Indicates 1 if mode 2 is selected.
		9	Indicates 1 if mode 1 is selected.
		8	Indicates 1 if mode 0 is selected.
			Supported.Multiword DMA transfer mode
		7-3	Reserved (0b)
		2	Mode 2 (1b)
		1	Mode 1 (1b)
		0	Mode 0 (1b)
64	0003h		Flow control PIO transfer mode
		15-8	Reserved
			Supported PIO transfer mode
		7-2	Reserved (0b)
		1	Mode 4 (1b)
		0	Mode 3 (1b)
65	0078h (120)		Minimum multiword DMA transfer time per word (ns)
66	0078h (120)		Recommended multiword DMA transfer time (ns)
67	0078h (120)		Minimum PIO transfer cycle time when flow control is disabled (ns)
68	0078h (120)		Minimum PIO transfer cycle time when flow control using IORDY is enabled (ns)
69-70	0000h		Reserved
71	07D0h (2000)		Required time after the PACKET command is received until the bus is released (μs) (Typical)

Table 4.19 Device parameter information (3/5)

Word	Value	Bits	Description
72	03E8h (1000)		Required time after the SERVICE command is received until BSY is cleared (μs) (Typical)
73-79	0000h		Reserved
80	0010h		Major Version number (ATA/ATAPI-5)
81	0000h		Minor Version number (ATA/ATAPI-5 T13 1321D revision 1)
82	4278h		Command set supported (A value of less than 1 indicates that the command is supported.)
		15	IDENTIFY DEVICE DMA command (0b)
		14	NOP command (1b)
		13	READ BUFFER command (0b)
		12	WRITE BUFFER command (0b)
		11	WRITE VERIFY command (0b)
		10	Host protect area function (0b)
		9	DEVICE RESET command (1b)
		8	SERVICE command interrupt (0b)
		7	Interrupt at release (0b)
		6	Read ahead cache (1b)
		5	Write cache (1b)
		4	Packet command function (1b)
		3	Power management function (1b)
		2	Removable media function (0b)
		1	Security mode (0b)
		0	SMART function (0b)
83	4000h		Command set supported (A value of less than 1 indicates that the command is supported.)
		15	0b.
		14	1b
		13-1	Reserved
		0	DOWNLOAD MICROCODE command supported (0b)
84	4000h		Command set supported
		15	0b

Table 4.19 Device parameter information (4/5)

Word	Value	Bits	Description
84		14	1b
		13-0	Reserved
85	4278h (Default value)		Command set supported and whether the function is enabled or disabled
			(A value of less than 1 indicates that the command is supported and enabled.)
		15	IDENTIFY DEVICE DMA command support (0b)
		14	NOP command support (1b)
		13	READ BUFFER command support (0b)
		12	WRITE BUFFER command support (0b)
		11	WRITE VERIFY command support (0b)
		10	Host protect area function support (0b)
		9	DEVICE RESET command support (1b)
		8	SERVICE command interrupt is enabled (0b: Default value)
		7	Interrupt at release is enabled (0b: Default value)
		6	Read ahead cache is enabled (1b: Default value)
		5	Write cache is enabled (1b: Default value)
		4	Packet command function support (1b)
		3	Power management function support (1b)
		2	Removable media function support (0b)
		1	Security mode enabled (0b)
		0	SMART function is enabled (0b)
86	0000h		Command set supported and whether the function is enabled or disabled (A value of less than 1 indicates that the command is supported and enabled.)
		15-1	Reserved (0b)
		0	DOWNLOAD MICROCODE command supported (0b)

Table 4.19 Device parameter information (5/5)

Word	Value	Bits	Description
87	4000h		Command set supported and whether the function is enabled or disabled
			(A value of less than 1 indicates that the command is supported and enabled.)
		15	0b
		14	1b
		13-0	Reserved
88	0007h	15-0	Ultra DMA transfer mode is active.
	(Default value)	15-11	Reserved (0b)
		10	Indicates 1 if mode 2 is selected.
		9	Indicates 1 if mode 1 is selected.
		8	Indicates 1 if mode 0 is selected.
			Ultra DMA transfer mode is supported.
		7-3	Reserved (0b)
		2	Mode 2 (1b)
		1	Mode 1 (1b)
		0	Mode 0 (1b)
89-126	0000h		Reserved
127	0001h	15-9	Reserved
		8	Device protect
			Indicates 1 in the device-protect state.
			See Section 4.6.5.6, "Timer & Protect Page."
		7-2	Reserved
		1-0	Media status notification function is supported (01b).
128-255	0000h		Reserved (0b)

4.5.2 PACKET (A0h)

Table 4.20 PACKET command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	0	1	0	0	0	0	0
DH	X	X	X	DRV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The PACKET command issues the ATAPI packet command. The OVL bit is ignored.

When the DMA bit is 1, data is transferred in the DMA mode specified in the Set Features command.

4.5.3 DEVICE RESET (08h)

Table 4.21 DEVICE RESET command

	Bit							
	7	6	5	4	3	2	1	0
CM	0	0	0	0	1	0	0	0
DH	X	X	X	DRV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The DEVICE RESET command resets the ODD.

When the ODD receives the DEVICE RESET command, it sets the BSY bit to 1. After reset is completed, the ODD sets the BUSY bit to 0. INTRQ is not asserted.

4.5.4 CHECK POWER MODE (E5h)

Table 4.22 CHECK POWER MODE command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	1	1	0	0	1	0	1
DH	X	X	X	DRV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The CHECK POWER MODE command sets the ODD power mode status in the SC register, then notifies the host of the value in Table 4.23. When the drive is in sleep mode, the interface is inactive and the ODD cannot receive this command.

Table 4.23 Power mode indication

Power mode status	SC register
Standby mode	00h
Entering standby mode	00h
Returning from standby mode	00h
Idle mode	FFh
Active mode	FFh

4.5.5 EXECUTE DEVICE DIAGNOSTIC (90h)

Table 4.24 EXECUTE DEVICE DIAGNOSTIC command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	0	0	1	0	0	0	0
DH	X	X	X	X	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

When the ODD receives this command, it recognizes self-diagnostics.

When the ODD receives this command, it responds to the command regardless of the DEV bit value; this means that the drive is unit 0 or 1.

When the ODD is device 0 (master), its response after the command is received depends on whether device 1 (slave) is connected.

When no device 1 is connected

The ODD sets 01h in the Error register and terminates the command.

When device 1 is connected

The ODD monitors the PDIAG- signal sent from device 1 for six seconds. If device 1 asserts the PDIAG- signal within this time, the ODD recognizes that the device 1 self-diagnostic test ends successfully. Otherwise, the ODD recognizes that the device 1 self-diagnostic test ended abnormally and the ODD makes OR-operation to its self-diagnostics results of unit 0 (Device 0) with 80h and sets it in the Error register. If device 1 ends abnormally, the ODD sets the CHECK bit of the Status register.

When the ODD is device 1

The ODD asserts the PDIAG- signal within five seconds. It sets 01h in the Error register and ends the command.

Table 4.25 Self-diagnosis detailed code

Detailed code	Meaning
01h	Normally end
02h-7Fh	Hardware error (For power-on and hardware reset only)
8xh	Device 1 ended abnormally. (For device 0 only)

4.5.6 GET MEDIA STATUS (DAh)

Table 4.26 GET MEDIA STATUS command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	1	0	1	1	0	1	0
DH	X	X	X	DRV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The GET MEDIA STATUS command respond with the ODD status.

The command ends abnormally in either of the conditions given below and sets the value shown in Table 4.27 in the Error register.

- When no media is inserted

- When media is exchanged

- When the Eject switch is pressed

- When media is write-protected

Otherwise, the command ends normally. If a hardware error by which the command cannot be executed occurs, as is the case with other commands, the command ends with Aborted Command.

Table 4.27 Error register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	WRT_PT	MC	0	MCR	0	NOMED	0

WRT_PT: Set to 1 when write-protected.

MC: Set to 1 when media is exchanged. Reported only once.

MCR: Set to 1 when the Eject switch is pressed. Reported only once.

NOMED: Set to 1 when no media is inserted.

If this command is received while the media status notification function is disabled, this command responds with the ODD status assuming that the media status notification function is enabled. Subsequently, this command operates assuming that the media status notification function is enabled until it is set to disabled.

4.5.7 IDLE IMMEDIATE (95h/E1h)

Table 4.28 IDLE IMMEDIATE command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	0	0	1	0	1	0	1
	1	1	1	0	0	0	0	1
DH	X	X	X	DRV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The ODD sets the power mode to idle mode.

4.5.8 NOP (00h)

Table 4.29 NOP command

	Bit							
	7	6	5	4	3	2	1	0
CM	0	0	0	0	0	0	0	0
DH	X	X	X	DRV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The NOP command enables 16-bit access for Status register checking. The ODD judges an unsupported command. The command ends with Aborted Command.

4.5.9 SERVICE (A2h)

Table 4.30 SERVICE command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	0	1	0	0	0	1	0
DH	X	X	X	DRV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The SERVICE command is not supported.

4.5.10 SET FEATURES (EFh)

Table 4.31 SET FEATURES command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	1	1	0	1	1	1	1
DH	X	X	X	DRV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	Setting value							
FR	Setting value							

The SET FEATURES command changes the ODD operating mode to the mode set in the SC and FR registers. If the specified value is not supported by the ODD or an invalid value, the ODD reports Aborted Command.

Table 4.32 FR register setting value

Setting value	Function	Default value
02	Enables the write cache.	*
03	Supports data transfer depending on the value of the SC register. See Table 4.33.	
31	Disables the media status notification function.	*
55	Disables the read ahead cache.	
5D	Enables the interrupt signal to release processing of the Overlap command after the signal is received. (This request is ignored.)	
5E	Enables the DRQ interrupt signal of the SERVICE command. (This request is ignored.)	
66	Does not enable a software reset to reset different setting values to the power-on default values. (The media status notification function is reset normally.)	*
82	Disables the write cache.	
95	Enables the media status notification function.	
AA	Enables the read ahead cache.	*
CC	Returns various setting values to the power-on default value by software reset.	
DD	Enables the interrupt signal to release processing of the Overlap command after the signal is received. (This request is ignored.)	*
DE	Enables the DRQ interrupt signal of the SERVICE command. (This request is ignored.)	*

Table 4.33 Transfer setting values in the SC register

Setting value		Function	ODD response
Bit 7 to bit 3	Bit 2 to bit 0		
0000	000	PIO default transfer mode	Ends normally.
00000	001	PIO default transfer mode (The IORDY signal is not used.)	Ends normally.
	010 to 111		Reports Aborted Command.
00001	000	PIO flow control transfer mode (The IORDY signal is used.)	Ends normally.
	001		Ends normally.
	010		Ends normally.
	011		Ends normally.
	100		Ends normally.
	101 to 111		Reports Aborted Command.
00010	000 to 111	Reserved	Reports Aborted Command.
00100	000	Multiword DMA transfer mode	Sets multiword DMA mode as the ODD internal transfer mode and ends normally
00100	001		Sets multiword DMA mode as the ODD internal transfer mode and ends normally
00100	010		Sets multiword DMA mode as the ODD internal transfer mode and ends normally
00100	011 to 111		Reports Aborted Command.
01000	000	Ultra DMA transfer mode	Sets Ultra DMA mode as the ODD internal transfer mode and ends normally.
	001		Sets Ultra DMA mode as the ODD internal transfer mode and ends normally.
	010		Sets Ultra DMA mode as the ODD internal transfer mode and ends normally.
	011 to 111		Reports Aborted Command.
10000	000 to 111	Reserved	Reports Aborted Command.

When the FR register is 95h, the ODD responds as follows at the end of the command:

- The CL register responds with 00h.

- The CH register responds with the following values.

Table 4.34 Cylinder High register

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	0	0	0	0	POWER_EJ	LOCK	PRV_ENAB

POWER_EJ: Sets 1.

LOCK: Sets 1.

PRV_ENAB: Sets 1 when the media status notification function is enabled.

4.5.11 SLEEP (99h/E6h)

Table 4.35 SLEEP command

				Bit				
	7	6	5	4	3	2	1	0
CM	1	0	0	1	1	0	0	1
	1	1	1	0	0	1	1	0
DH	X	X	X	DRV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The SLEEP command sets the ODD in sleep mode. The ODD enters sleep mode by following the steps given below.

1. The ODD spins down media.

2. The ODD issues an interrupt to the host to report command end. After the host receives the interrupt, the ODD deactivates the interface. Once the interface becomes inactive, the ODD ignores all resets except software reset and hardware reset and Device Reset command.

A software reset, or hardware reset or Device Reset command is required for a return from sleep mode.

Software reset is recommended for returning from sleep mode.

4.5.12 STANDBY IMMEDIATE (94h-E0h)

Table 4.36 STANDBY IMMEDIATE command

	Bit							
	7	6	5	4	3	2	1	0
CM	1	0	0	1	0	1	0	0
	1	1	1	0	0	0	0	0
DH	X	X	X	DRV	X	X	X	X
CH	X	X	X	X	X	X	X	X
CL	X	X	X	X	X	X	X	X
SN	X	X	X	X	X	X	X	X
SC	X	X	X	X	X	X	X	X
FR	X	X	X	X	X	X	X	X

The ODD sets the power mode to standby mode.

4.6 Packet Commands

The ODD supports the packet commands listed below.

Table 4.37 Packet command codes and parameters

Command	Operation code	Section
ERASE (10)	2Ch	4.6.2
FORMAT UNIT	04h	4.6.3
INQUIRY	12h	4.6.4
MODE SELECT	55h	4.6.5
MODE SENSE (10)	5Ah	4.6.6
MODE SENSE (6)	1Ah	4.6.7
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	4.6.8
READ (10)	28h	4.6.9
READ (12)	A8h	4.6.10
READ CAPACITY	25h	4.6.11
READ FORMAT CAPACITIES	23h	4.6.12
READ DEFECT DATA	37h	4.6.13
READ LONG	3Eh	4.6.14
RECEIVE DIAGNOSTIC RESULTS	1Ch	4.6.15
REQUEST SENSE	03h	4.6.16
SEND DIAGNOSTIC	1Dh	4.6.17
SEEK (10)	2Bh	4.6.18
START STOP UNIT	1Bh	4.6.19
SYNCHRONIZE CACHE	35h	4.6.20
TEST UNIT READY	00h	4.6.21
VERIFY	2Fh	4.6.22
WRITE (10)	2Ah	4.6.23
WRITE (12)	AAh	4.6.24
WRITE AND VERIFY	2Eh	4.6.25
WRITE BUFFER	3Bh	4.6.26
WRITE LONG	3Fh	4.6.27

4.6.1 Logical Unit Number

Logical unit numbers (LUNs) other than 0 are not supported. The specified value must always be 0.

4.6.2 ERASE command

Table 4.38 ERASE command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Ch)							
1	Logical Unit Number			Reserved				
2-5	Logical Block Address							
6	Reserved							
7-8	Transfer Length							
9-11	Reserved							

The ERASE command erases data of the specified number of blocks from the specified logical block address.

Logical Block Address specifies the head logical block address from which the ODD starts writing.

Transfer Length specifies the number of blocks to be transferred and written.

When Transfer Length is specified as 0, the command does not carry out data transfer. The ERASE command erases no data of the blocks and ends normally.

4.6.3 FORMAT UNIT command

Table 4.39 FORMAT UNIT command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (04h)							
1	Logical Unit Number			FmtData	CmpList	Defect List Format		
2	Reserved							
3-4	Interleave							
5-11	Reserved							

The FORMAT UNIT command formats media physically on the basis of the specified parameter values.

When the FmtData bit is 1, the FORMAT UNIT parameter list must be transferred. Defect List Format is ignored.

When the FmtData bit is 0, the ODD does not transfer the FORMAT UNIT parameter list and formats media using the internal default values instead.

The CmpList is ignored.

The interleaving is set to the internal default value even if a value is specified.

Table 4.40 FORMAT UNIT parameter list

Bit Byte	7	6	5	4	3	2	1	0
0-3	Defect List Header							

Table 4.41 Defect list header

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved							
1	Reserved		DCRT	Reserved			IMMED	Reserved
2	Defect List Length							

When the DCRT (Disable Certification) bit is 1, the ODD formats media without checking it.

When the IMMED (Immediate) bit is 1, the ODD responds with immediate end after the command is received and before formatting is completed. At this time, during formatting, the Ready bit of the Status register is set to 0, and then set to1 after formatting is completed.

Defect List Length must be 8. If any other value is set, the command responds with Check Condition.

Table 4.42   Format Descriptor

Bit Byte	7	6	5	4	3	2	1	0
0-3	Number of Blocks							
4	Reserbed							
5-7	Block Length							

The Format Descriptor value must be exactly the same as the Formattable Descriptor value reported to the host by the READ FORMAT CAPACITIES command. If a different value is specified, the command responds with Check Condition.

4.6.4 INQUIRY command

Table 4.43 INQUIRY command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (12h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Allocation Length							
5-11	Reserved							

The INQUIRY command transfers device information to the host.

If the INQUIRY command is issued while the ODD contains the Unit Attention condition, the ODD responds normally, but does not clear the Unit Attention condition.

Table 4.44 INQUIRY data

Bit Byte	7	6	5	4	3	2	1	0
0	Reserved				Peripheral Device Type Optical memory Device (07h)			
1	RMB (1b)	Reserved						
2	ISO Version (00b)		ECMA Version (000b)			ANSI Version (000b)		
3	Reserved				Response data format (2h)			
4	Additional length (23h)							
5-7	Reserved							
8-15	Vendor Information "FUJITSU" (in ASCII) Left justified. The rightmost data field not used is filled with space characters. (20h)							
16-31	Product identification "MCM3130AP" "MCM3064AP" (in ASCII) Left justified. The rightmost data field that is not used is filled with space characters. (20h)							
32-35	Firmware Revision Level "0000" - "999z" (in ASCII)							
36	Firmware Local Revision 00h - FFh (in HEX)							
37	Boot Firmware Revision Level 00h - FFh (in HEX)							
38-39	Signature "MO" (in ASCII)							

4.6.5 MODE SELECT command

Table 4.45 MODE SELECT command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (15h)							
1	Logical Unit Number			PF	Reserved			SP
2-6	Reserved							
7-8	Parameter List Length							
9-11	Reserved							

The MODE SELECT command sets various device operating modes.

The PF (Page Format) bit must be 1. If the PF bit is 0, the command responds with Check Condition.

When the SP (Save Pages) bit is 1, the ODD saves all parameter values transferred to the flash ROM.

Parameter List Length specifies the number of bytes in the mode parameters to be transferred. If it is 0, the command does not carry out transfer and ends normally.

If the transferred mode parameters are insufficient, the command responds with Check Conditions.

Table 4.46 lists mode parameters supported.

Table 4.46 Mode parameters

Definition	Page Code	Section
Drive Operation Mode Page	00h	4.6.5.1
Read-Write Error Recovery Page	01h	4.6.5.2
Flexible Disk Page	05h	4.6.5.3
Caching Page	08h	4.6.5.4
Removable Block Access Capacities Page	1Bh	4.6.5.5
Timer & Protect Page	1Ch	4.6.5.6

Table 4.47 lists the mode parameter list.

Table 4.47 Mode parameter list

Bit Byte	7	6	5	4	3	2	1	0
0-4	Mode Parameter Header							
0-7	Block Descriptor							
0-n	Page Descriptor(s)							

The mode parameter list consists of a mode parameter header Block Descriptor and Mode Page (s). Table 4.48 lists the mode parameter header.

Table 4.48 Mode parameter header

Bit Byte	7	6	5	4	3	2	1	0
0-1	Mode Data Length							
2	Medium Type Code							
3	WP	Reserved						
4-5	Reserved							
6-7	Block Description Length							

Mode Data Length must be 0. If any other value is specified, the command ends with an error or Check Condition.

The values specified for Medium Type Code and WP are ignored.

Block Descriptor Length indicates the byte length of the block descriptor to transfer.

Table 4.50 summarizes the block descriptors.

Table 4.49 Block descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	Density Code (00h)							
1-3	Number of Blocks							
4	Reserved							
5-7	Block Length							

All the values specified for Block Descriptor are ignored.

Table 4.50 lists the page descriptors.

Table 4.50 Page Descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	PS	0	Page Code					
1	Page Length (n-1)							
2-n	Mode Parameters							

4.6.5.1 Drive Operation Mode Page

Table 4.51 Drive Operation Mode Page

Bit Byte	7	6	5	4	3	2	1	0
0	PS	0	Page Code (00h)					
1	Page Length (02h)							
2	SLM	SLR	DVW	Reserved				
3	Reserved			DDE	Reserved			

When the Disable Verify for Write (DVW) bit is 1, Verify processing is not executed for the Write (10) and Write (12) commands. When the Disable Verify for Write (DVW) bit is 0, Verify processing is executed.

The Select LUN Mode (SLM) and Select LUN for Rewritable (SLR) bits are always 0 because these bits do not have two or more LUNs.

The Disable Deferred Error (DDE) bit indicates whether or not to report a write cache error. Regardless of the value of this bit, however, the write cache error is reported as a deferred error in the next command operation.

Drive Operation Mode Page can be saved.

Table 4.52 Drive Operation Mode Page variable

Bit Byte	7	6	5	4	3	2	1	0
2	0	0	1	00000b				
3	000b			1	0000b			

Table 4.53 Drive Operation Mode Page default value

Bit Byte	7	6	5	4	3	2	1	0
2	0	0	0	00000b				
3	000b			1	0000b			

4.6.5.2 Read-Write error recovery page

Table 4.54 Read-Write error recovery page

Bit Byte	7	6	5	4	3	2	1	0
0	PS	0	Page Code (01h)					
1	Page Length (0Ah)							
2	AWRE	Reserved	Reserved	RC	Reserved	PER	Reserved	DCR
3	Read Retry Count							
4-7	Reserved							
8	Write Retry Count							
9-11	00h							

When the AWRE (Automatic Write Reallocation Enable) bit is 0, no automatic alternate block assignment is made for the WRITE (10) WRITE (12), or WRITE AND VERIFY command. When the bit of AWRE is 1, automatic alternate block assignment is made.

When the RC (Read Continuous) bit is 0, the command reports an error if an uncorrectable data error is detected in the READ (10) command. When the bit of RC is 1, the command transfers the wrong data and ends normally even if an uncorrectable error is detected.

When the PER (Post Error) bit is 0, the command reports the GOOD status when it recovers the normal state by using the error recovery process. When the bit of PER is 1, the command reports the CHECK CONDITION status when it recovers the normal state by using the error recovery process. At this time, Sense key is set with RECOVERED ERROR.

RECOVERED ERROR is reported:

- When 7 to 8 error bytes per interleaving was corrected by the ECC correction during read operation

- When a defect sector is detected and replaced with an alternate sector during a write operation

- When an error occurs in one of four sets of media data during media management information (DMA) write operation with the FORMAT UNIT command (MEDIUM ERROR is set if an error occurs in two, three, or four sets of four sets.)

When the DCR (Disable Correction) bit is 0, the command corrects errors if a correctable error is detected in the READ (10) and READ (12) command. When the bit of DCR is 1, the command does not correct errors even if a correctable error is detected.

Read Retry Count must not be 3 or smaller. If a value of 3 or smaller is specified, the command assumes 4 and reports Recovered Error.

Write Retry Count must not be a value other than 3. If a value other than 3 is specified, the command assumes 3 and reports Recovered Error.

To assure media compatibility, the read-write error recovery page should be set to the default value, except for diagnostics purposes.

The read-write error recovery page can be saved.

Table 4.55 Changeable values in the read-write recovery page

Bit Byte	7	6	5	4	3	2	1	0
2	1	0	0	1	0	1	0	1
3	FFh							
4-7	00h							
8	FFh							
9-11	00h							

Table 4.56 Default values for the read-write recovery page

Bit Byte	7	6	5	4	3	2	1	0
2	1	0	0	1	0	1	0	1
3	1Fh							
4-7	00h							
8	03h							
9-11	00h							

4.6.5.3 Flexible disk page

Table 4.57 Flexible disk page

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	Page Code (05h)					
1	Page Length (1Eh)							
2-3	Transfer Rate							
4	Number of Heads							
5	Sectors per Track							
6-7	Data Bytes per Sectors							
8-9	Number of Cylinders							
10-19	Reserved							
20	Motor off Delay							
21-27	Reserved							
28-29	Medium Rotation Rate							
30-31	Reserved							

This page is supported for compatibility of device driver.

Recommendation: A device driver should not be used this page, because if device driver uses of this page and it is not able to keep compatibility for logically of media (No guarantee).

"Transfer Rate" defines "kbits/sec".

"Number of Heads, Sectors per Track and Number of Cylinders" define logical value. It does not show physical numbers. No guarantee for logical compatibility of media when device driver or application is used this value.

"Data Bytes per Sectors" defines Block Length (200h or 800h).

"Motor off Delay" defines time for spinning down operation. X'FF' is to does not stop motor forever.

"Medium Rotation Rate" defines revolutions per minute.

Table 4.58 Changeable values in flexible disk page

Bit Byte	7	6	5	4	3	2	1	0
2-3	0000h							
4	00h							
5	00h							
6-7	00h							
8-9	0000h							
10-19	0000h							
20	00h							
21-27	00h							
28-29	0000h							
30-31	00h							

Table 4.59 Default values in flexible disk page

Bit Byte	7	6	5	4	3	2	1	0
2-3	3E80h							
4	40h							
5	20h							
6-7	In case of 640 Mbytes and 1.3 Gbytes media = 800h Others or Not Ready = 200h							
8-9	Number of LBA for media / (40h $\times$ 20h) In case of Not Ready = the value of the maximum capacity media among the supported 512 sectors media							
10-19	00h							
20	FFh							
21-27	00h							
28-29	154Fh							
30-31	00h							

4.6.5.4 Caching page

Table 4.60 Caching page

Bit Byte	7	6	5	4	3	2	1	0
0	PS	0	Page Code (08h)					
1	Page Length (0Ah)							
2	Reserved					WCE	Reserved	RCD
3-19	Reserved							

When the WCE (Write Cache Enable) bit is 0, the write cache function for the WRITE (10), WRITE (12), or WRITE AND VERIFY command is disabled. When the bit of WCE is 1, the write cache function is enabled.

When the RCD (Read Cache Disable) bit is 0, the read ahead cache function for the READ (10) command is enabled. When the bit of RCD is 1, the read ahead cache function is disabled.

The caching page can be saved.

Table 4.61 Changeable values in the caching page

Bit Byte	7	6	5	4	3	2	1	0
2	0	0	0	0	0	1	0	1
3-11	00h							

Table 4.62 Default values for the caching page

Bit Byte	7	6	5	4	3	2	1	0
2	0	0	0	0	0	1	0	0
3-19	00h							

4.6.5.5 Removable Block Access Capabilities Page

Table 4.63 Removable Block Access Capabilities Page

Bit Byte	7	6	5	4	3	2	1	0
0	0	0	Page Code (1Bh)					
1	Page Length (0Ah)							
2	SFLP	SRFP	Reserved					
3	NCD	SML	Reserved			TLUN		
4-11	Reserved							

The System Floppy Type (SFLP) bit indicates that the current device is a system floppy disk.

The Supports Reporting progress of Format (SRFP) bit indicates that format progress status is reported by the REQUEST SENSE command, when the FORMAT UNIT command with the IMMED bit set to 1 is issued.

The Non CD Optical device (NCD) bit indicates that the current device is a non-CD optical disk device.

The Single/Multiple LUN supported (SML) bit indicates that a CD device and a non-CD optional disk device use the same LUN.

The Total LUN supported (TLUN) bit indicates the number of LUNs to support.

Removable Block Access Capabilities Page cannot be saved.

Table 4.64 Removable Block Access Capabilities variable

Bit Byte	7	6	5	4	3	2	1	0
2	0	0	000000b					
3	0	0	000b			000b		
4-11	00h							

Table 4.65 Removable Block Access Capabilities Page default value

Bit Byte	7	6	5	4	3	2	1	0
2	0	1	000000b					
3	1	0	000b			001b		
4-11	00h							

4.6.5.6 Timer & Protect Page

Table 4.66 Timer & Protect Page

Bit Byte	7	6	5	4	3	2	1	0
0	PS	0	Page Code (1Ch)					
1	Page Length (06h)							
2	Reserved							
3	Reserved				Inactivity Time Multiplier			
4	Reserved						DISP	SWPP
5-7	Reserved							

Inactivity Time Multiplier defines the minimum period beginning from when an access command ends until entry to standby mode. For the relationship between the specified value and period, see Table 4.67, "Inactivity Time Multiplier values."

When a value in a range of 1h to 9h is specified, Ah is assumed and the command responds with Recovered Error.

Table 4.67 Inactivity Timer Multiplier values

Inactivity Time Multiplier	Minimum period beginning from when access command ends until entry to standby mode
0h	Infinite
1h	125 ms
2h	250 ms
3h	500 ms
4h	1 s
5h	2 s
6h	4 s
7h	8 s
8h	16 s
9h	32 s
Ah	1 min
Bh	2 min
Ch	4 min
Dh	8 min
Eh	16 min
Fh	32 min

When the Disable Media Access until Power cycle (DISP) bit is 1, the command responds with Not Ready to any command from the host until power-off or hardware reset. The ODD does not support the DISP function.

When the Software Write Protect until Power-down (SWPP) bit is 1, the write-protect state is entered.

The DISP and SWPP bit values cannot be saved. The ODD does not support the SWPP function.

Timer & Protect Page can be saved.

Table 4.68 Timer & Protect Page variable

Bit Byte	7	6	5	4	3	2	1	0
2	00h							
3	0h				Fh			
4	000000b						0	0
5-7	00h							

Table 4.69 Timer & Protect Page default value

Bit Byte	7	6	5	4	3	2	1	0
2	00h							
3	0h				Fh			
4	000000b						0	0
5-7	00h							

4.6.6 MODE SENSE (10) command

Table 4.70 MODE SENSE (10) command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (5Ah)							
1	Logical Unit Number			Reserved	DBD	Reserved		
2	PC		Page Code					
3-6	Reserved							
7-8	Allocation Length							
9-11	Reserved							

This command transfers the mode parameter list to the host. Table 4.72 shows the mode parameter list format.

When the Disable Block Descriptors (DBD) bit is 1, the block descriptor is not returned. When the DBD bit is 0, the block descriptor is returned.

Allocation Length indicates the number of bytes of the mode parameter to transfer. When Allocation Length is 0, the command ends normally without transferring any data.

Page Control (PC) defines the type of the page descriptor to transmit.

Table 4.71 Page Control field

Bit 7	Bit 6	Parameter type
0	0	Current value
0	1	Changeable value
1	0	Default value
1	1	Save value

Page Code defines the page descriptor to transfer. When 3Fh is specified, all page descriptors are transferred. For the supported page descriptors, see Table 4.46, "Mode Parameters."

Mode pages are transferred in ascending order by page code, except for the drive operation mode page (00h). The drive operation mode page (00h) is transferred last.

Table 4.72 Mode Parameter List

Bit Byte	7	6	5	4	3	2	1	0
0-7	Mode Parameter Header							
0-n	Page Descriptor(s)							

The mode parameter list consists of a mode parameter header and page descriptor. Table 4.73 shows the mode parameter header format.

Table 4.73 Mode Parameter Header

Bit Byte	7	6	5	4	3	2	1	0
0-1	Mode Data Length							
2	Medium Type Code							
3	WP	Reserved						
4-7	Reserved							

Medium Type Code returns the following values:

- 03h for normal FRAM (MO) media

- 07h for overwrite FRAM media

- 01h for FROM media

- 05h for PROM media

- 03h for other media and in Not Ready state

The Write Protect (WP) bit indicates the state of the cartridge write protect key. When this bit is 1, the medium is write-protected.

Mode Data Length indicates the byte length of the mode data to be transferred successively.

Block Descriptor Length indicates the byte length of the block descriptor to transfer.

Table 4.74 lists the block descriptor.

Table 4.75 lists the page descriptor.

Table 4.74 Page Descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	PS	0	Page Code					
1	Page Length (n-1)							
2-n	Mode Parameters							

When PS is 1, saving to a flash ROM is possible. For details on Mode Parameter, see the section on the Mode Select command.

4.6.7 MODE SENSE (6) command

Table 4.76 MODE SENSE (6) command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Ah)							
1	Logical Unit Number			Reserved	DBD	Reserved		
2	PC		Page Code					
3	Reserved							
4	Allocation Length							
5-11	Reserved							

This command transfers the mode parameter list to the host. Table 4.77 shows the mode parameter list format.

The Disable Block Descriptor (DBD) bit is ignored.

Page Control (PC) is ignored.

When Page Code is not 3Fh, an error occurs.

Table 4.77 Mode parameter list

Bit Byte	7	6	5	4	3	2	1	0
0-3	Mode Parameter Header							

The mode parameter list consists of a mode parameter header and page descriptor. Because the page descriptor has no supported page, it always consists of only a header. Table 4.78 shows the mode parameter header format.

Table 4.78 Mode parameter header

Bit Byte	7	6	5	4	3	2	1	0
0	Mode data Length							
1	Medium Type Code							
2	WP	Reserved						
3	Block Descriptor Length							

4.6.8 PREVENT/ALLOW MEDIUM REMOVAL command

Table 4.79 PREVENT/ALLOW MEDIUM REMOVAL command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Eh)							
1	Logical Unit Number			Reserved				
2-3	Reserved							
4	Reserved							Prevent
5-11	Reserved							

The PREVENT/ALLOW MEDIUM REMOVAL command allows or inhibits media ejection on the device.

A value of 0 in the Prevent bit allows ejection and a value of 1 disables ejection.

The power-on default value is Enabled.

If there is any data not written yet in the write cache, the ODD completes writing on media, then allows ejection.

Hard reset resets the prevent state to allow ejection.

Table 4.80 Response to Prevent/Allow/Eject

Operation	Status at operation	When no media is loaded	When media is loaded
Prevent = 0	Enabled	No error	No error
	Inhibited	No error	No error
Prevent = 1	Enabled	No error	No error. Media ejection is inhibited.
	Inhibited	No error	No error
Eject	Enabled	No error	No error: Eject the cartridge
(Ejection with START/STOP UNIT command)	Inhibited	Error: SENSE KEY 5 ASC/ASCQ 5302	Error: SENSE KEY 5 ASC/ASCQ 5302
Eject	Enabled	The state remains unchanged.	Eject the cartridge
(Ejection with the Eject switch)	Inhibited	The state remains unchanged.	The state remains unchanged. Media ejection is still inhibited.

4.6.9 READ (10) command

Table 4.81 READ (10) command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (28h)							
1	Logical Unit Number			Reserved				
2-5	Logical Block Address							
6	Reserved							
7-8	Transfer Length							
9-11	Reserved							

The READ (10) command reads data for the specified number of blocks from the specified logical block address and transfers it.

Logical Block Address specifies the head logical block address used to start reading.

Transfer Length specifies the number of blocks to be read and transferred.

When Transfer Length is 0, the command does not carry out data transfer. It simply ends normally without reading any data.

4.6.10 READ (12) command

Table 4.82 READ command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (A8h)							
1	Logical Unit Number			Reserved				
2-5	Logical Block Address							
6-9	Transfer Length							
10-11	Reserved							

This command reads data for the specified number of blocks beginning from the specified logical block address and transfers the data.

Logical Block Address indicates the first logical block address from which reading starts.

Transfer Length indicates the number of blocks to transfer and read.

When 0 is specified as Transfer Length, data is not transferred. The command ends normally without executing Read processing.

4.6.11 READ CAPACITY command

Table 4.83 READ CAPACITY command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (25h)							
1	Logical Unit Number			Reserved				
2-7	Reserved							
8	Reserved							PMI
9-11	Reserved							

The READ CAPACITY command transfers data on the media capacity to the host.

Table 4.84 lists the data transferred if the Partial Medium Indicator (PMI) bit is 0.

Table 4.84 READ CAPACITY data (PMI=0)

Bit Byte	7	6	5	4	3	2	1	0
0-3	Last Logical Block Address							
4-7	Block Length in Bytes							

Last Logical Block Address indicates the LBA of the last accessible block.

Block Length in Bytes indicates the number of bytes per block.

When the Partial Medium Indicator (PMI) bit is 1, the data to be transferred depends on the type of media. Tables 4.85 and 4.86 list the data transferred for two types of media.

Table 4.85 READ CAPACITY data (PMI=1, MO media, FROM medium)

Bit Byte	7	6	5	4	3	2	1	0
0-3	Last Logical Block Address							
4-7	Block Length in Bytes							

Table 4.86 READ CAPACITY data (PMI=1, PROM medium)

Bit Byte	7	6	5	4	3	2	1	0
0-3	Last Logical Block Address for M0 area							
4-7	Block Length in Bytes							

4.6.12 READ FORMAT CAPACITIES command

Table 4.87 READ FORMAT CAPACITIES command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (23h)							
1	Logical Unit Number			Reserved				
2-6	Reserved							
7-8	Allocation Length							
9-11	Reserved							

The READ FORMAT CAPACITIES command transfers data on the capacity of media currently loaded to the host. If no media is loaded, this command returns the maximum capacity value of supported media to the host.

Table 4.88 READ FORMAT CAPACITIES data format

Bit Byte	7	6	5	4	3	2	1	0
	Capacity List Header							
	Current / Maximum Capacity Descriptor							

Table 4.89 Capacity list header

Bit Byte	7	6	5	4	3	2	1	0
0-2	Reserved							
3	Capacity List Length (8h)							

Capacity List Length indicates the length of the capacity descriptor in bytes.

Table 4.90 Current/Maximum capacity descriptor

Bit Byte	7	6	5	4	3	2	1	0
0-3	Number of Blocks							
4	Reserved						Descriptor Code	
5-7	Block Length							

Number of Blocks indicates the number of addressable blocks.

Descriptor Code indicates the type of descriptor to be reported to the host.

Block Length indicates the length of the block in bytes.

Table 4.91 Descriptor code definition

Descriptor Code	Descriptor Type
00b	Unformatted media (Other fields are ineffective.)
01b	Unformatted media (Maximum format capacity)
10b	Formatted media (Current media capacity)
11b	No media loaded (Maximum format capacity)

4.6.13 READ DEFECT DATA command

Table 4.92 READ DEFECT DATA command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (37h)							
1	Logical Unit Number			Reserved				
2	Reserved			Plist	Glist	Defect List Format		
3-6	Reserved							
7-8	Allocation Length							
9-11	Reserved							

The READ DEFECT DATA command transfers media defect data to the host.

When Plist is 1, the command transfers header and PDL. When Glist is 1, this command transfers header and SDL. When both Plist and Glist are 0, it transfers the header. When both Plist and Glist are 1, the command transfers PDL and SDL. PDL and SDL are arranged in an ascending order.

Table 4.93 lists the supported defect list format. If any other format is specified, the command assumes that the format listed in Table 4.93 is specified, and reports Recovered Error.

Table 4.93 Defect List Format

Defect List	Data format
Format	
101	Physical sector address format

Table 4.94 summarizes the defect list header. Table 4.95 lists the defect descriptors.

Table 4.94 Defect List Header

Bit / Byte	7	6	5	4	3	2	1	0
0	00h							
1	0	0	0	Plist	Glist	Defect List Format		
2-3	Defect List length							
4-n	Defect Descriptor(s)							

Table 4.95 Defect Descriptor

Byte	Defect Descriptor
0-2	Defect block track address
3	00h
4-7	Defect block sector address

4.6.14 READ LONG command

Table 4.96 READ LONG command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (3Eh)							
1	Logical Unit Number			Reserved				
2-5	Logical Block Address							
6	Reserved							
7-8	Byte Transfer Length							
9-11	Reserved							

The READ LONG command reads data in the data, CRC, and ECC sections from the specified logical block address.

The transfer byte length must be a multiple of 600 (258h) bytes for 512 byte media and a multiple of 2380 (94Ch) bytes for 2048 byte media.

4.6.15 RECEIVE DIAGNOSTIC RESULTS command

Table 4.97 RECEIVE DIAGNOSTIC RESULTS command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Ch)							
1	Logical Unit Number			Reserved				
2	Reserved							
3-4	Allocation Length							
5-11	Reserved							

The RECEIVE DIAGNOSTIC RESULTS command transfers the diagnostic results indicated by the SEND DIAGNOSTIC command to the host. The RECEIVE DIAGNOSTC RESULT command must be issued following the SEND DIAGNOSTIC command. If not issued continuously or if there is no data to be transferred, the command transfers no data and ends normally.

4.6.16 REQUEST SENSE command

Table 4.98 REQUEST SENSE command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (03h)							
1	Logical Unit Number			Reserved				
2-3	Reserved							
4	Allocation Length							
5-11	Reserved							

The REQUEST SENSE command transfers sense data to the host. Sense data indicates detailed error information on the command whose error was reported previously. If no error command was reported, SENSE KEY indicates NO SENSE.

When issuing the REQUEST SENSE command to detect the device status, first issue the TEST UNIT READY command, then issue REQUEST SENSE.

Allocation Length indicates the length of sense data to be transferred in bytes. If Allocation Length is 0, the command transfers no data and ends normally.

When the ODD detects a CRC error involving the Ultra DMA transfer during the data transfer using this command, it returns the CHECK CONDITION. (The Sense Key of the Error register indicates ABORTED COMMAND.)

The original sense data at the CRC error occurrence is reported normally using the REQUEST SENSE command. Otherwise, it will be reported when another command is received.

The sense data format is shown in Table 4.99.

Table 4.99 Request sense data

Bit Byte	7	6	5	4	3	2	1	0
0	Valid	Error Code (70h or 71h)						
1	Reserved (00h)							
2	Reserved (0h)				Sense Key			
3-6	Information							
7	Additional Sense Length (18h)							
8-11	Command-Specific Information							
12	Additional Sense Code							
13	Additional Sense Code Qualifier							
14	Reserved (00h)							
15-17	Sense-key specific							
18-31	Additional Sense Bytes							

When the Valid bit is 1, the information field (bytes 3 to 6) is effective.

Error Code indicates the sense data format and type. See Table 4.100.

Table 4.100 Error code

Error Code	Report timing
70h (Current error)	Reported for a normal error.
71h(Deferred error)	Reported when an error occurs in the command that accesses the write cache when the write cache is enabled. If this sense data is reported, the command that reported the Check Condition status is not executed.

Sense Key outlines the error. The definition of Sense Key is listed in Table 4.101.

Table 4.101 Sense Key code

Sense Key	Abbreviation	Definition
0h	NO SENSE	Indicates there is no sense key to be reported. NO SENSE is set when a command ends normally.
1h	RECOVERED ERROR	Indicates that recovery ends successfully or that the command ends normally using the internal default value even if invalid data is detected in command parameters. (Not reported when the PER bit is 0.)
2h	NOT READY	Indicates that access with an access command cannot be executed.
3h	MEDIUM ERROR	Indicates that an unrecoverable error is detected due to media failure.
4h	HARDWARE ERROR	Indicates that an unrecoverable error is detected due to hardware failure.
5h	ILLEGAL REQUEST	Indicates that command packets or command parameters contains invalid data. Media data remains unchanged.
6h	UNIT ATTENTION	Indicates that reset, power-on, or media exchange is caused.
7h	DATA PROTECT	Indicates that media is write-protected with the Write Protect key or the device is softwre-write-protected.
8h	BLANK CHECK	Indicates that a blank sector is detected. Not used
9h-Ah	Reserved	Not used
Bh	ABORTED COMMAND	Indicates that the command is interrupted.
Ch-Fh	Reserved	Not used

The information indicates LBA of an error block. If an error occurs in multiple blocks, the LBA of the first block is indicated.

Command-Specific Information indicates the logical track address of the block indicated in Information (or logical block address).   The track address format is shown in Table 4.102.

Table 4.102 Logical block address format

Byte	Description
8-9	Logical track address
10	00h
11	Logical sector address

Additional Sense Code (ASC)/Additional Sense Code Qualifier (ASCQ) indicates detailed error information. The definition of ASC/ASCQ is shown in Table 4.103.

Table 4.103 ASC/ASCQ list (1/2)

Sense Key	ASC	ASCQ	Error description
2	04	00	LOGICAL UNIT NOT READY, CAUSE NOT REPORTABLE
2	04	04	LOGICAL UNIT NOT READY, FORMAT IN PROGRESS
3	09	00	TRACK FOLLOWING ERROR
4	08	03	LOGICAL UNIT COMMUNICATION CRC ERROR
3	09	01	TRACKING SERVO ERROR
3	0C	00	WRITE ERROR
3	0C	02	WRITE ERROR/AUTO REALLOCATION FAILED
3	10	00	ID CRC ERROR
3	11	00	UNRECOVERED READ ERROR
3	15	02	POSITIONING ERROR DETECTED BY READ OF MEDIUM
1	17	06	RECOVERED DATA WITHOUT ECC/DATA AUTO REALLOCATED
1	18	00	RECOVERED DATA WITH ERROR CORRECTION & RETRIES APPLIED
1	19	00	DEFECT LIST ERROR
3	19	01	DEFECT LIST NOT AVAILABLE
3	19	02	DEFECT LIST ERROR IN PRIMARY LIST
3	19	03	DEFECT LIST ERROR IN SECONDARY LIST
1	1C	00	DEFECT LIST NOT FOUND
5	20	00	INVALID COMMAND OPERATION CODE
5	21	00	LOGICAL BLOCK ADDRESS OUT RANGE
5	24	00	INVALID FIELD IN COMMAND PACKET
5	25	00	LOGICAL UNIT NOT SUPPORTED
5	26	00	INVALID FIELD IN PARAMETER LIST
7	27	00	WRITE PROTECTED
6	28	00	NOT READY TO READY TRANSITION, MEDIUM MAY HAVE CHANGED
6	29	00	POWER ON, RESET, DEVICE RESET OCCURRED

Table 4.103 ASC/ASCQ list (2/2)

Sense Key	ASC	ASCQ	Error description
3	30	00	INCOMPATIBLE MEDIUM INSTALLED
3	30	01	CANNOT READ MEDIUM/UNKNOWN FORMAT
3	31	00	MEDIUM FORMAT CORRUPTED
3	31	01	FORMAT COMMAND FAILED
3	32	00	NO DEFECT SPARE LOCATION AVAILABLE
3	32	01	DEFECT LIST UPDATE FAILURE
1	37	00	ROUNDED PARAMETER
2	3A	00	MEDIUM NOT PRESENT
4	40	NN	DIAGNOSTIC FAILURE ON COMPONENT NN
4	44	00	INTERNAL TARGET FAILURE
4	4A	00	COMMAND PHASE ERROR
4	4B	00	DATA PHASE ERROR
B	4E	00	OVERLAPPED COMMAND ATTEMPTED
4	53	00	MEDIA LOAD OR EJECT FAILED
5	53	02	MEDIUM REMOVAL PREVENTED
2/4	83	00	THERMAL ERROR

The Sense-Key Specific field format is shown in Table 4.104. Format Progress Indication Bytes is effective only when Sense key is NOT READY and the SKSV bit is 1. Otherwise, the field is set with 00h. This field is defined for the FORMAT UNIT command having the Immed bit of 1.

Table 4.104 Format Progress Indication Bytes

Bit Byte	7	6	5	4	3	2	1	0
15	SKSV	Reserved						
16-17	Progress Indication							

Progress Indication indicates the formatting completion rate when the denominator is 65536 (10000h).

Additional Sense Bytes indicates the detailed error code. For repairs, Additional Sense Bytes is recommended to be defined.

4.6.17 SEND DIAGNOSTIC command

Table 4.105 SEND DIAGNOSTIC command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Dh)							
1	Logical Unit Number			Reserved		SelfTest	Reserved	Reserved
2	Reserved							
3-4	Parameter List Length							
5-11	Reserved							

The SEND DIAGNOSTIC command instructs diagnostic operation from the host.

When the Self-Test bit is 1, the command executes diagnostics on the data buffer. If an error occurs, the device responds with Check Condition.

Parameter List Length specifies the data length of diagnostic parameters to be transferred.

The functions and specifications of diagnostic parameters are not open.

4.6.18 SEEK command

Table 4.106 SEEK command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Bh)							
1	Logical Unit Number			Reserved				
2-5	Logical Block Address							
6-11	Reserved							

The SEEK command positions the head on the track at the specified logical block address.

Logical Block Address specifies the logical block address at which the head is positioned.

4.6.19 START/STOP UNIT command

Table 4.107 START/STOP UNIT command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (1Bh)							
1	Logical Unit Number			Reserved				IMMED
2-3	Reserved							
4	Reserved						LoEj	Start
5-11	Reserved							

The START/STOP UNIT command ejects media or starts and stops rotating the disk.

When the IMMED (Immediate) bit is 1, command completion is reported before processing is completed.

Processing for other values is listed in Table 4.108.

Table 4.108 START/STOP/EJECT processing

LoEj	Start	Processing
0	0	Stops disk rotation.
0	1	Starts disk rotation and checks the format type of media.
1	0	Ejects media if possible.
1	1	Ends abnormally (ILLEGAL REQUEST).

4.6.20 SYNCHRONIZE CACHE command

Table 4.109 SYNCHRONIZE CACHE command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (35h)							
1	Logical Unit Number			Reserved			IMMED	Reserved
2-5	Logical Block Address							
6	Reserved							
7-8	Number of Blocks							
9-11	Reserved							

The SYNCHRONIZE CACHE command writes cache memory data not written yet in the data buffer to media.

The IMMED (Immediate) bit is not supported. When the IMMED bit is 1, the command responds with Check Condition.

The command writes all data not written yet in the cache memory of the data buffer to media, regardless of the value set in Logical Block Address and Number of Blocks. The command does not check the value of Logical Block Address and Number of Blocks.

4.6.21 TEST UNIT READY command

Table 4.110 TEST UNIT READY command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (00h)							
1	Logical Unit Number			Reserved				
2-11	Reserved							

The TEST UNIT READY command checks if the device is ready for test and reports the device status to the host.

If the ODD can end normally for appropriate access commands, the command responds with the Good status. Otherwise, the command responds with Check Condition to the host.

4.6.22 VERIFY command

Table 4.111 VERIFY command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Fh)							
1	Logical Unit Number			Reserved			ByteChk	Reserved
2-5	Logical Block Address							
6	Reserved							
7-8	Verification Length							
9-11	Reserved							

The VERIFY command verifies for the specified number of blocks from the specified logical block address.

Logical Block Address specifies the head logical block address from which verification starts.

Verification Length specifies the number of blocks to be verified and transferred.

When Verification Length is 0, the command verifies no block and ends normally.

The ByteChk bit indicates data compare execution. However, since the ByteChk is not supported, it must be set to 0. If a value 1 is specified, the command ends with Check Condition.

4.6.23 WRITE (10) command

Table 4.112 WRITE (10) command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Ah)							
1	Logical Unit Number			Reserved				
2-5	Logical Block Address							
6	Reserved							
7-8	Transfer Length							
9-11	Reserved							

The WRITE (10) command receives and writes data for the specified number of blocks from the specified logical block address.

Logical Block Address specifies the head logical block address used to start writing.

Transfer Length specifies the number of blocks to be transferred and written.

When Transfer Length is 0, the command does not carry out data transfer. It simply ends normally without writing any data.

4.6.24 Write (12) command

Table 4.113 Write (12) command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (AAh)							
1	Logical Unit Number			Reserved				
2-5	Logical Block Address							
6-9	Transfer Length							
10-11	Reserved							

The Write (12) command receives data for the specified number of blocks and, starting from the specified logical block address, writes the data.

Logical Block Address indicates the beginning logical block address where writing starts.

Transfer Length indicates the number of blocks to transfer and write.

When Transfer Length is 0, the command does not transfer data. The command simply ends normally without writing any data.

4.6.25 WRITE AND VERIFY command

Table 4.114 WRITE AND VERIFY command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (2Eh)							
1	Logical Unit Number			Reserved			ByteChk	Reserved
2-5	Logical Block Address							
6	Reserved							
7-8	Transfer Length							
9-11	Reserved							

The WRITE AND VERIFY command receives and writes data for the specified number of blocks from the specified logical block address.

Logical Block Address specifies the head logical block address used to start writing.

Transfer Length specifies the number of blocks to be transferred and written.

The ByteChk bit indicates data compare execution. However, since the ByteChk is not supported, it must be set to 0. If a value 1 is specified, the command ends with Check Condition.

When Transfer Length is 0, the command does not carry out data transfer. It simply ends normally without writing any data.

4.6.26 WRITE BUFFER command

Table 4.115 WRITE BUFFER command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (3Bh)							
1	Logical Unit Number			Reserved		Mode		
2	Reserved	Reserved	TNFY	Reserved	Code-ID			
3-5	Buffer Offset							
6-8	Allocation Length							
9-11	Reserved							

The WRITE BUFFER command downloads the firmware to the flash ROM.

Mode must be set to 5. Otherwise, the command responds with Check Condition.

If TNFY is 0 and Allocation Length is not 0, the command transfers data to be written on the flash ROM to the data buffer. The WRITE BUFFER command checks for validity of transfer data, then writes it on the flash ROM.

If TNFY is 0 and Allocation Length is 0, the command checks propriety of data on the data buffer and writes on the flash ROM.

When TNFY is 1, the command transfers data to be written on the flash ROM into the data buffer.

Code-ID indicates the type of code to be downloaded.

Allocation Length indicates the length of data to be transferred in bytes.

Buffer Offset indicates the offset value for data to be transferred.

If write operation to the flash ROM ends abnormally, the command responds with Check Condition.

IMPORTANT

If power failure or interface cable disconnection occurs during downloading, flash ROM data may not be assured.

Valid download data is Fujitsu distributed data only.

Table 4.116 Code-ID

Code-ID	Micro-code type	Data file length
0h	Main Code	78040h
1h-Fh	Reserved	-

Downloading procedure

Example 1: When a 78,040h-byte download file is transferred at one time

Step 1: Transfer the 78,040h-byte download file to the device by issuing the command with 78,040h specified as Allocation Length, 0h as Buffer Offset, 5 as Mode, and 0 as TNFY. Make sure that the command ends normally.

Example 2: When a 78,040h-byte download file is transferred in units having a maximum size of 32 kilobytes

Step 1: Transfer data stored from 0h until 3Fh in the download file to the device by issuing the command with 40h specified as Allocation Length, 0h as Buffer Offset, 5 as Mode, and 1 as TNFY.

Step 2: Transfer data stored from 40h until 803Fh in the download file to the device by issuing the command with 8,000h specified as Allocation Length, 40h as Buffer Offset, 5 as Mode, and 1 as TNFY.

Step 3: Transfer data stored from 8,040h to 1,003Fh in the download file to the device by issuing the command with 8,000h specified for Allocation Length, 8,040h for Buffer Offset, 5 for Mode, and 1 for TNFY.

Step 4: Transfer the remaining data in the download file by issuing the command with the Buffer Offset value changed as described above.

Step 5: Issue the command with 0h specified as Allocation Length, 0h as Buffer Offset, 5 as Mode, and 0 as TNFY. Make sure that the command ends normally.

4.6.27 WRITE LONG command

Table 4.117 WRITE LONG command

Bit Byte	7	6	5	4	3	2	1	0
0	Operation Code (3Fh)							
1	Logical Unit Number			Reserved				
2-5	Logial Block Address							
6	Reserved							
7-8	Byte Transfer Length							
9-11	Reserved							

The WRITE LONG command writes data in the data, CRC, and ECC sections to the specified logical block address.

The transfer byte length must be a multiple of 600 (258h) bytes for 512 byte media and a multiple of 2380 (94Ch) bytes for 2048 byte media.

4.7 Timing

4.7.1 Register/PIO data transfer timing
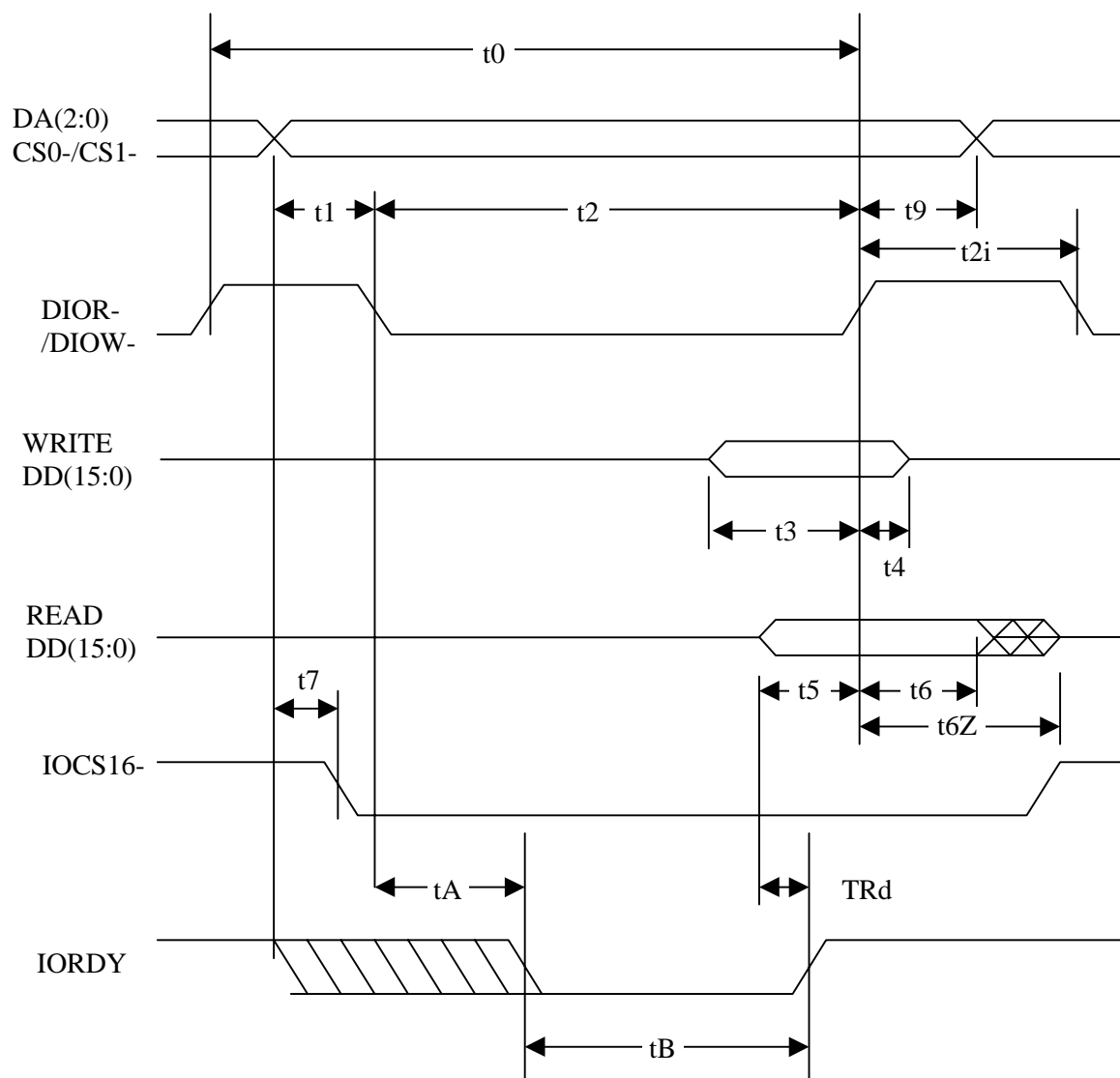
Figure 4.2 Register/PIO data transfer

Table 4.118 Register/PIO data transfer timing parameters

Symbol	Timing parameter	min (Units: ns)	max (Units: ns)	Condition
t0	Cycle time	120	-	At mode 4, no wait
t1	DIOR-/DIOW- setup time	25	-	
t2	DIOR-/DIOW- pulse width	70	-	
t2i	DIOR-/DIOW- recovery time	25	-	
t3	DIOW- data setup time	20	-	
t4	DIOW- data hold time	10	-	
t5	DIOR- data setup time	20	-	
t6	DIOR- data hold time	5	-	
t6Z	DIOR- data High –Z time	-	30	
t7	From address decided to IOCS16- asserted	-	30	
t8	From address decided to IOCS16- released	-	30	
t9	DIOR-DIOW- to address valid hold time	10	-	
tA	IORDY setup time	-	35	PIO flow control transfer mode
tB	IORDY pulse width	-	1250	PIO flow control transfer mode
tRd	Read data valid to IORDY active	0	-	

4.7.2 Multiword DMA data transfer timing
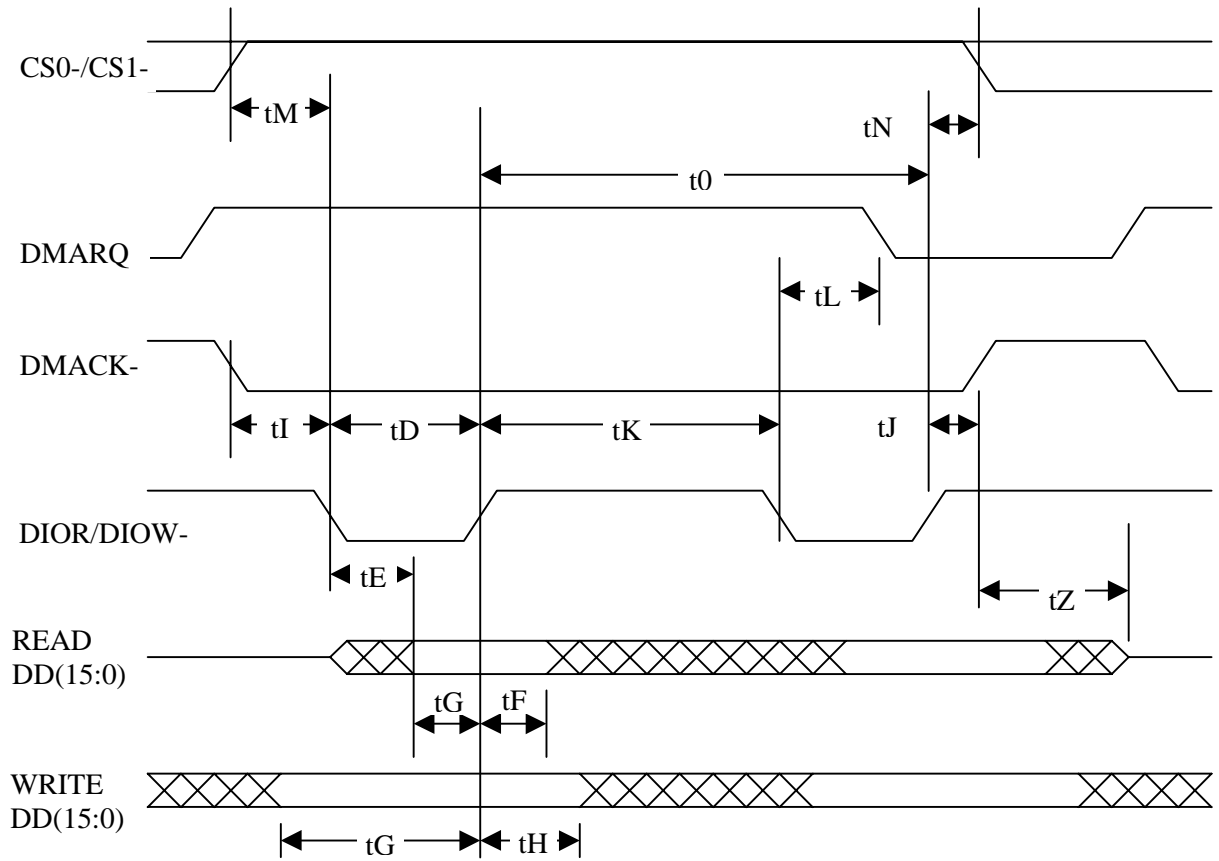
Figure 4.3 Multiword DMA data transfer

Table 4.119 Multiword DMA data transfer timing parameters

Symbol	Timing parameter	min (Units: ns)	max (Units: ns)	Condition
t0	Cycle time	120	-	Mode 2
tD	DIOR-/DIOW- pulse width	70	-	
tE	DIOR- data access time	-	50	
tF	DIOR- data hold time	5	-	
tG	DIOR-/DIOW- data setup time	20	-	
tH	DIOW- data hold time	10	-	
tI	DMACK- to DIOR/DIOW- setup time	0	-	
tJ	DIOR-/DIOW to DMACK- hold time	5	-	
tK	DIOR-/DIOW negated pulse width	25	-	
tL	DIOR-/DIOW to DMARQ- delay time	-	35	
tM	CS (1:0) to DIOR /DIOW valid time	25	-	
tN	CS (1:0) hold time	10	-	
tZ	DMACK- to tristate time	-	25	

4.7.3 Ultra DMA data in transfer (initialization timing)
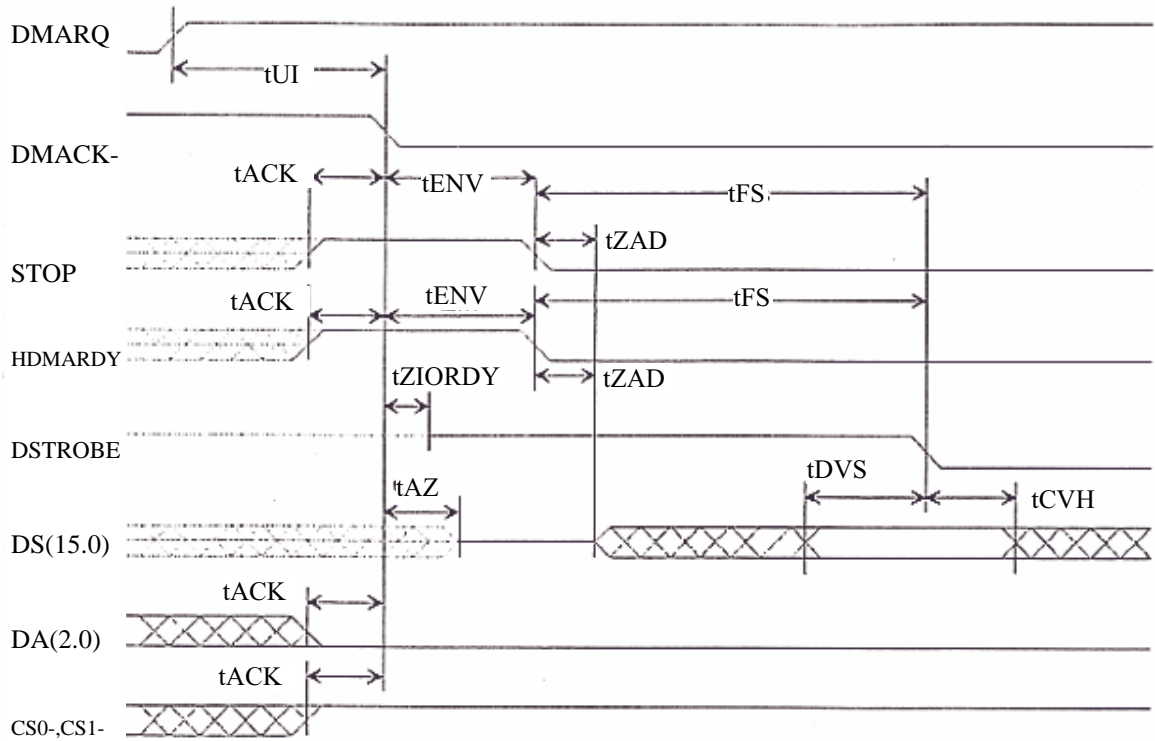
Figure 4.4 Ultra DMA data in transfer (initialization timing)

4.7.4 Ultra DMA data in transfer (continuous transfer timing)
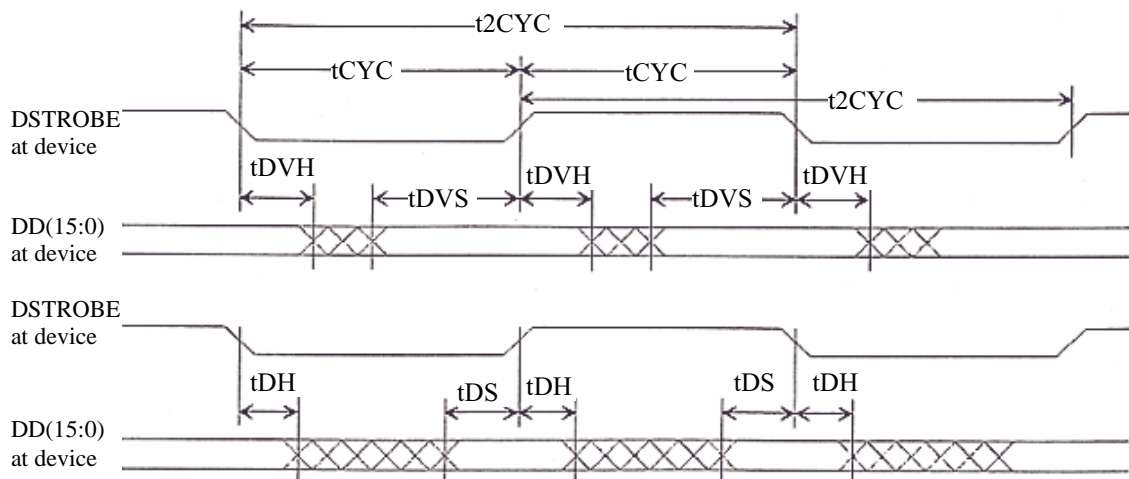
Figure 4.5 Ultra DMA data in transfer (continuous transfer timing)

4.7.5 Ultra DMA data in transfer (host stop timing)
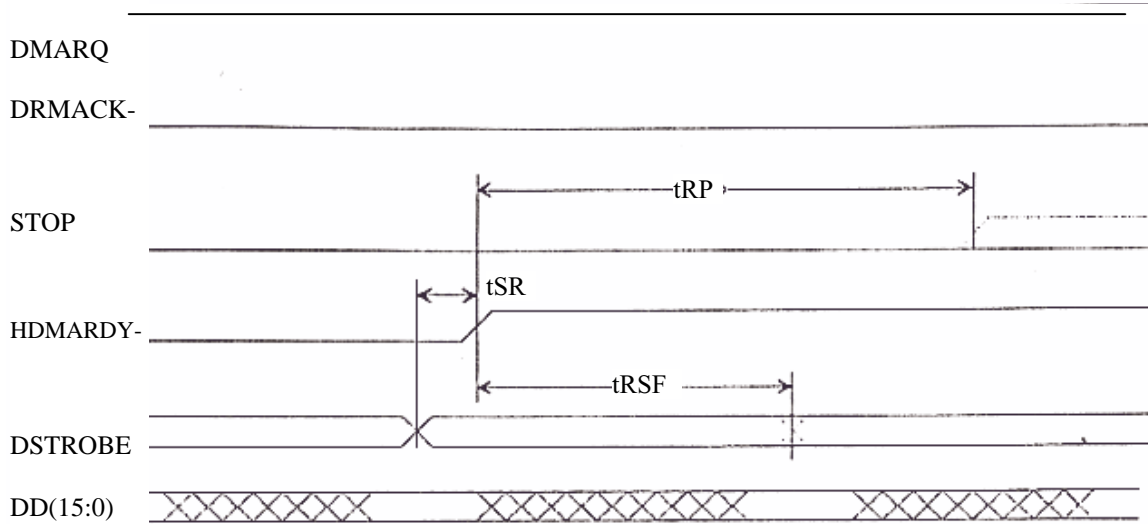
Figure 4.6 Ultra DMA data in transfer (host stop timing)

4.7.6 Ultra DMA data in transfer (device end timing)
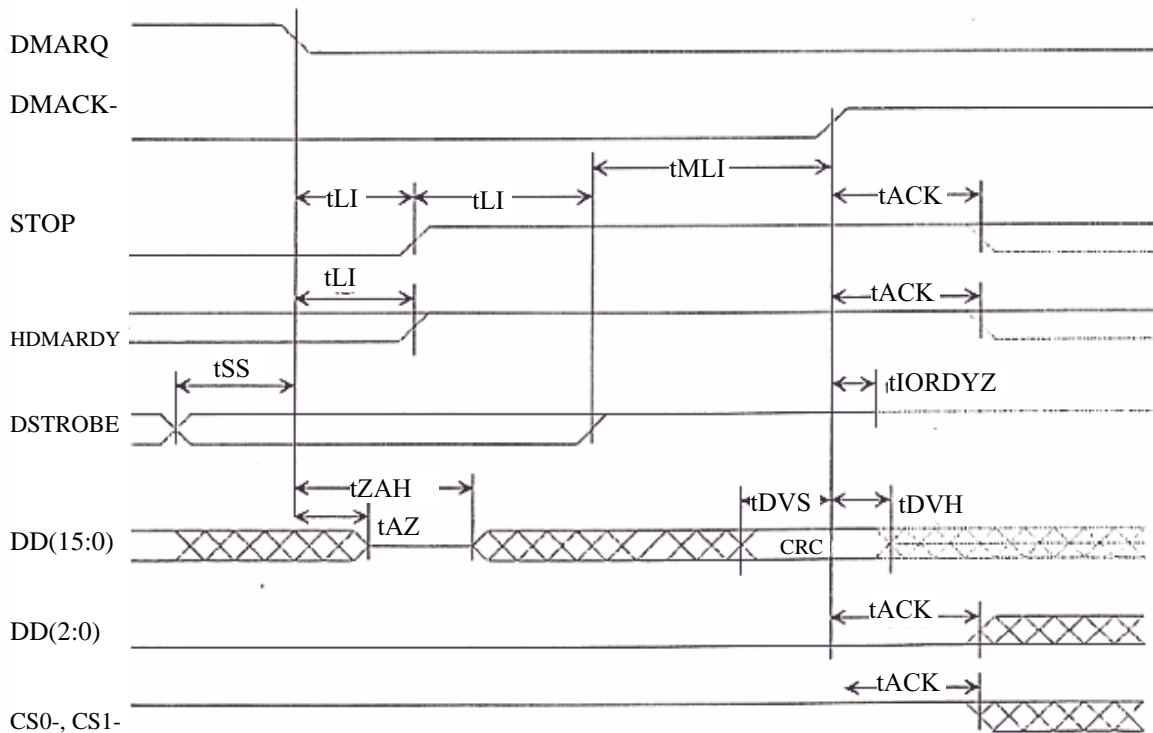
Figure 4.7 Ultra DMA data in transfer (device end timing)

4.7.7 Ultra DMA data in transfer (host end timing)
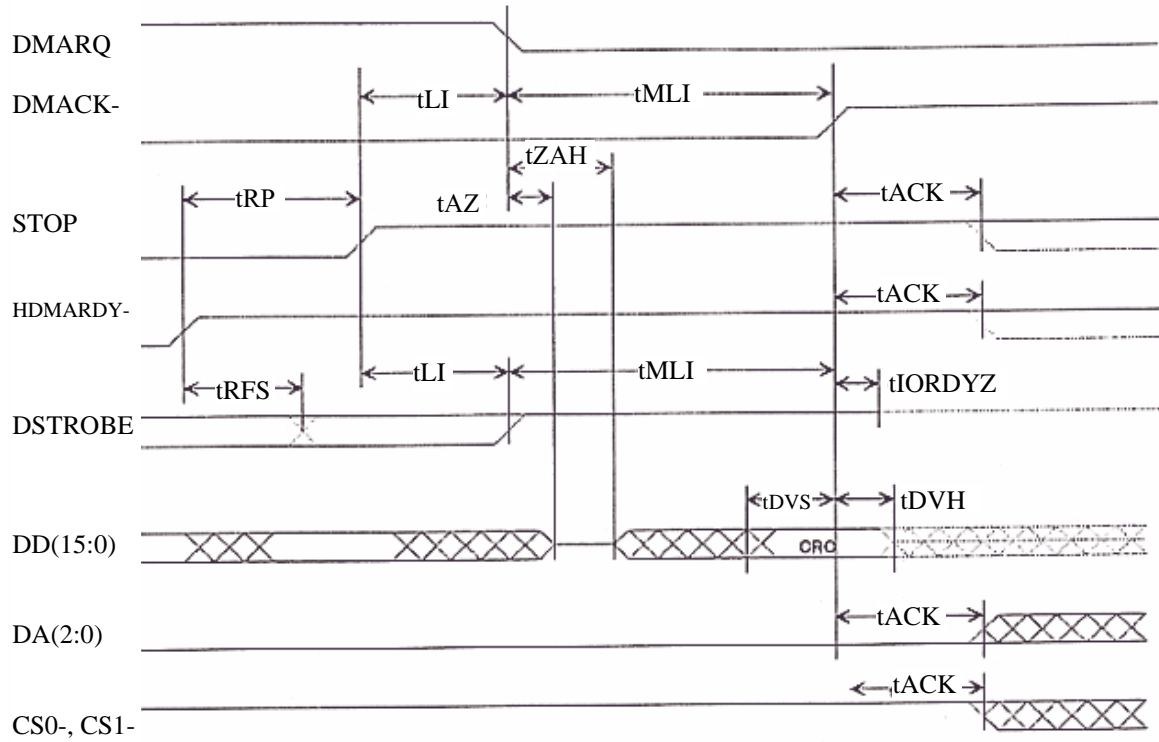
Figure 4.8 Ultra DMA data in transfer (host end timing)

4.7.8 Ultra DMA data out transfer (initialization timing)
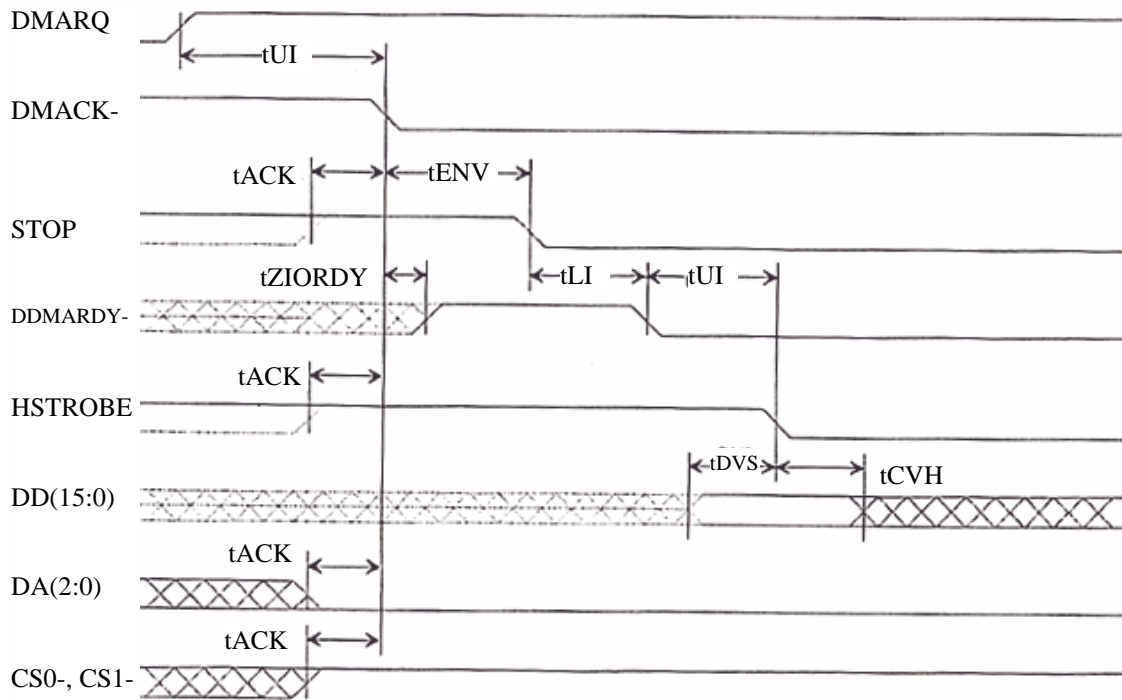
Figure 4.9 Ultra DMA data out transfer (initialization timing)

4.7.9 Ultra DMA data out transfer (continuous transfer timing)
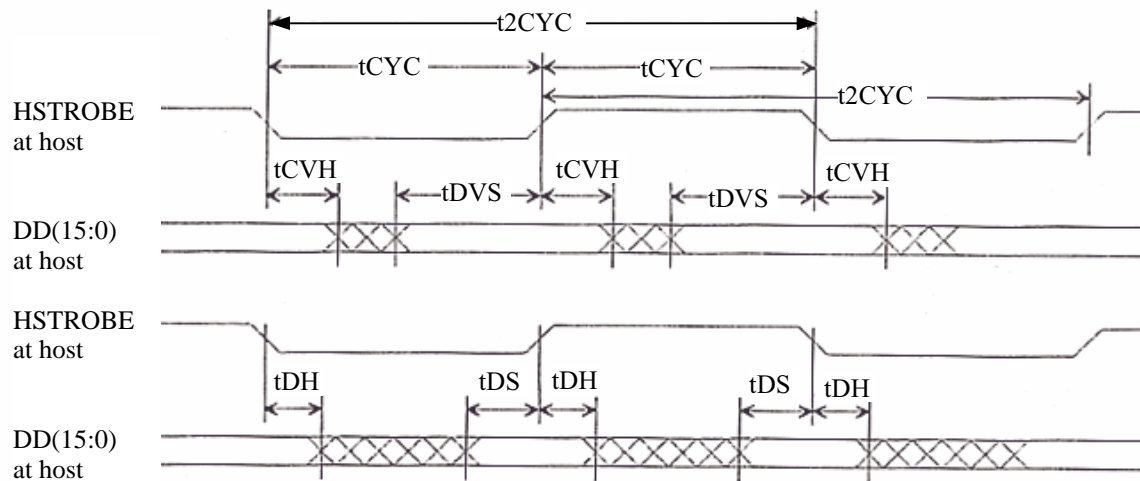
Figure 4.10 Ultra DMA data out transfer (continuous transfer timing)

4.7.10 Ultra DMA data out transfer (device stop timing)
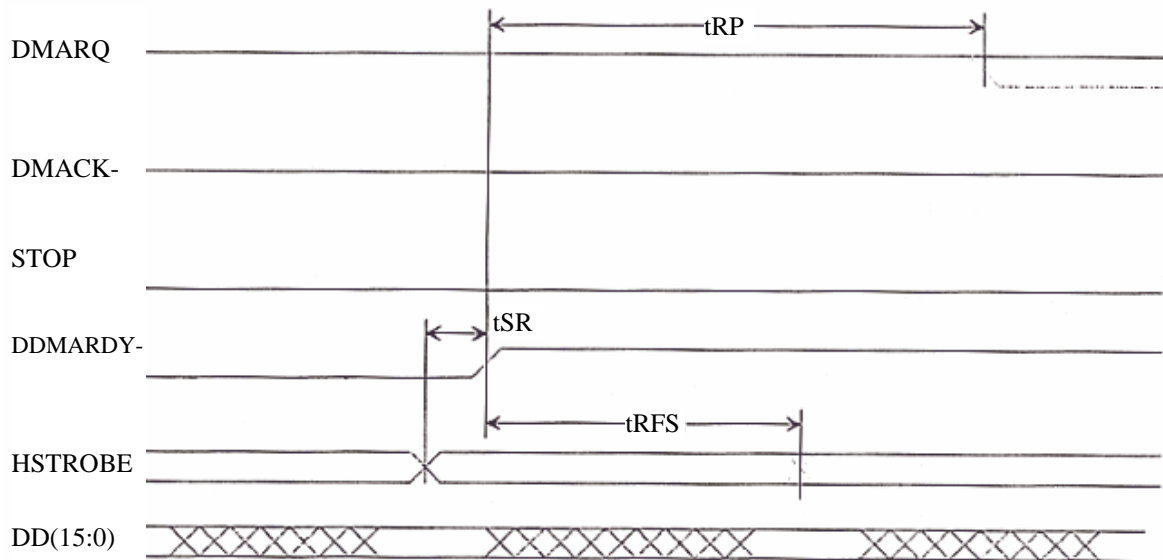
Figure 4.11 Ultra DMA data out transfer (device stop timing)

4.7.11 Ultra DMA data out transfer (host suspend timing)
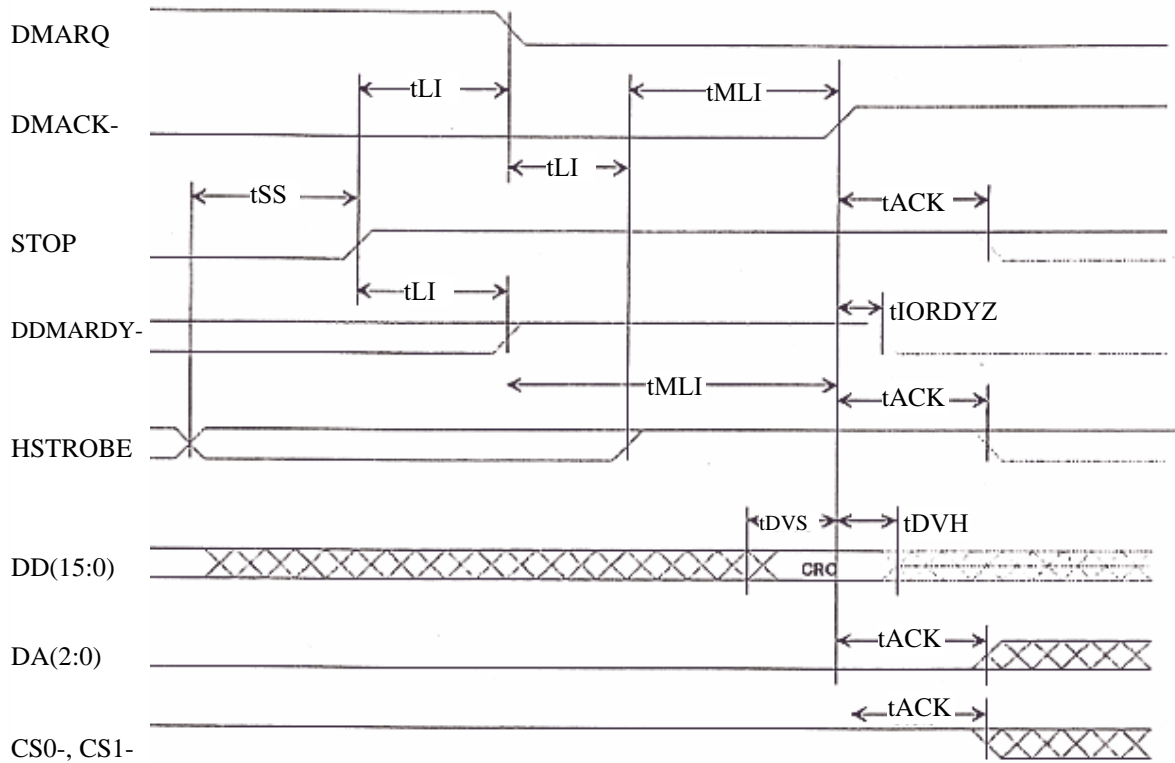
Figure 4.12 Ultra DMA data out transfer (host suspend timing)

4.7.12 Ultra DMA data out transfer (device end timing)
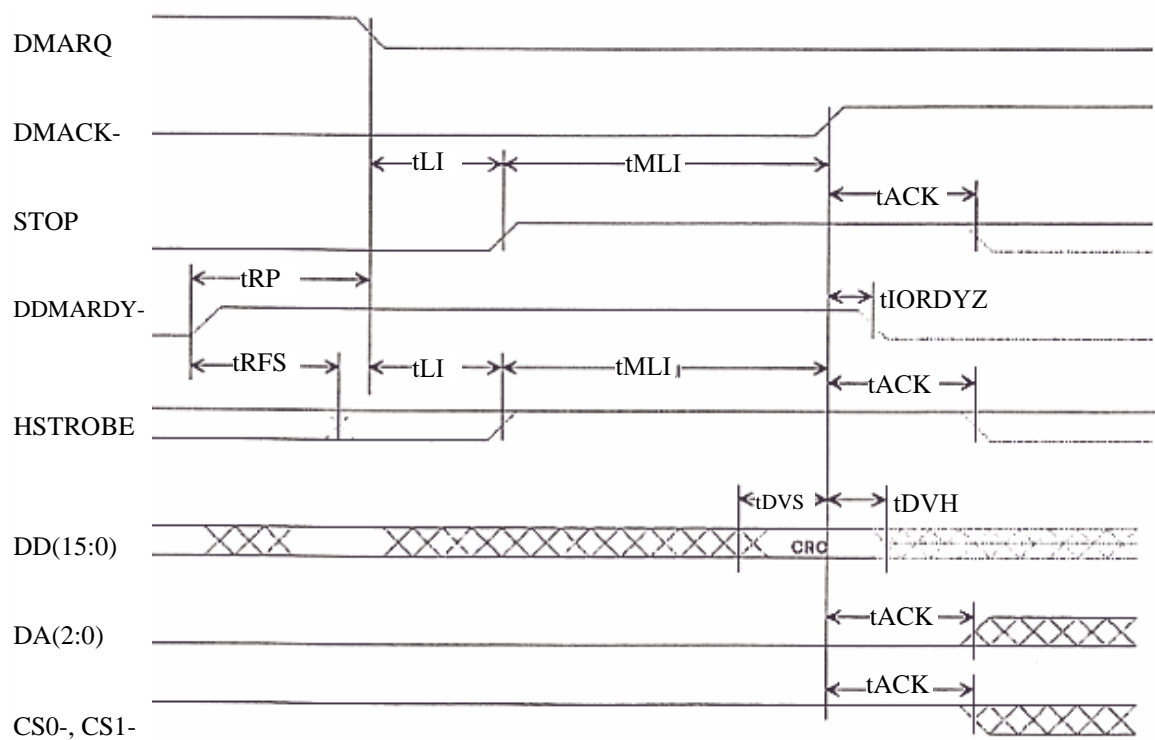
Figure 4.13 Ultra DMA data out transfer (device end timing)

Table 4.120 Ultra DMA data out transfer parameter

Symbol	Timing parameter	min (Units: ns)	max (Units: ns)	Condition
t2CYCTYP	Average 2-cycle time	120	-	Mode 2
tCYC	Cycle time (for non-target clock and at clock change)	54	-	
t2CYC	2-cycle time (at clock change)	115	-	
tDS	Data setup time on receiving side	7	-	
tDH	Data hold time on receiving side	5	-	
tDVS	Data enabled setup time on sending side	30	-	
tDVH	Data enabled hold time	6	-	
tFS	First strobe time	0	170	
tLI	Restricted interlock time	0	150	
tMLI	Minimum interlock time	20	-	
tUI	Non-restricted interlock time	0	-	
tAZ	Driver Maximum release time	-	10	
tZAH	Output delay time	20	-	
tZAD	Driver Assert and negate time	0	-	
tENV	Envelope time	20	70	
tSR	STROBE to DMARDY time	-	20	
tRSF	Ready to the last STROBE time	-	60	
tRP	Ready to stop time	100	-	
tIORDYZ	Maximum IORDY release time	-	20	
tIORDDY	STROBE operation minimum time	0	-	
tACK	DMACK- setup and hold time	20	-	
tSS	STROBE edge to DMARQ negate and assert time	50	-	

4.7.13 Power-on and Reset Timing
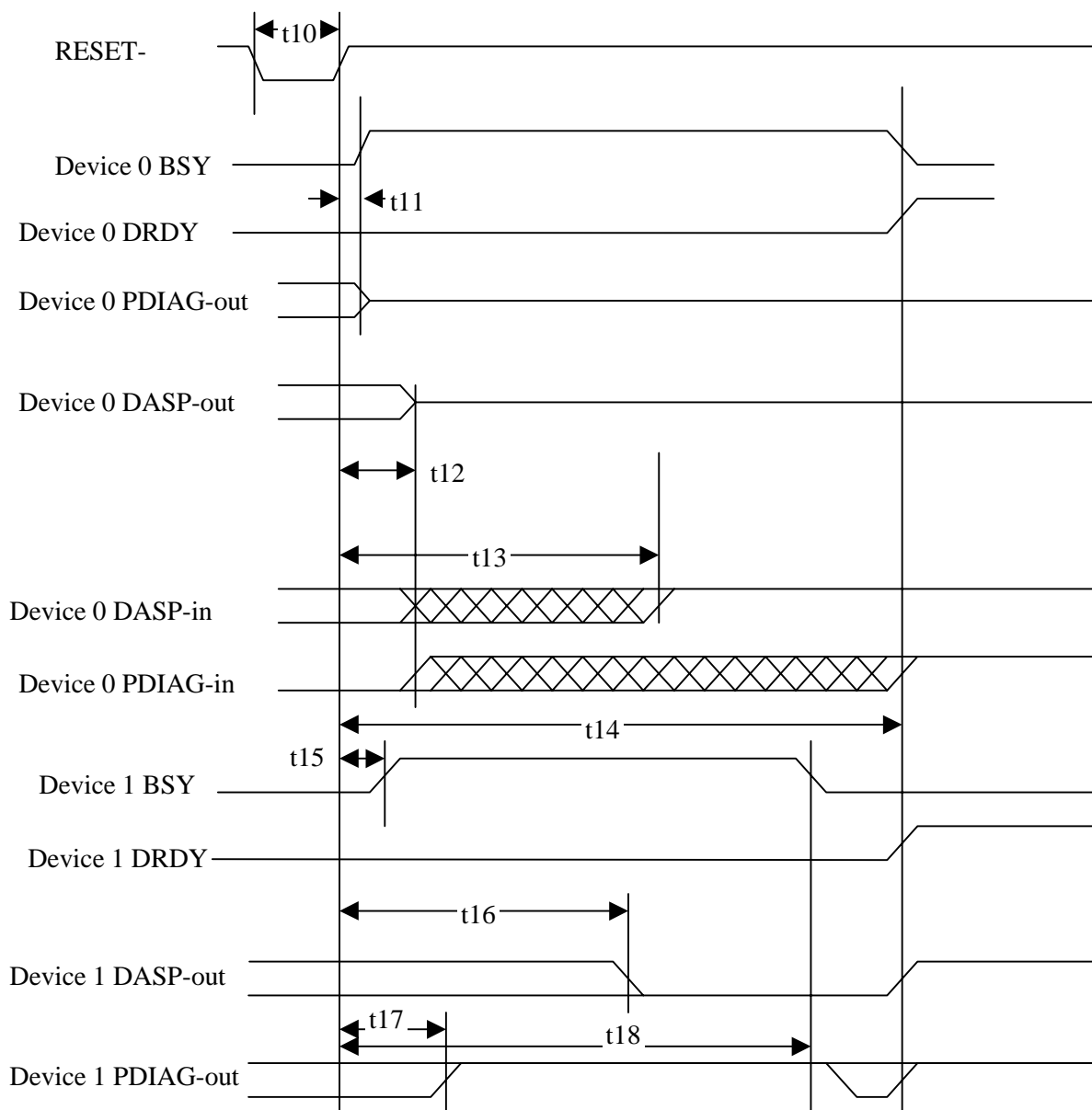
*1   Device 0 sets the BSY bit to 0 when device 1 is not connected.

*2   Device 0 uses DASP- to indicate that it is in operation when device 1 is not connected.

*3   DASP- is used to indicate that the device is in operation.

Figure 4.14 Power-on and reset timing

Table 4.121 Power-on and reset timing

Symbol	Timing parameter	min	max
t10	RESET- pulse width	25 µs	-
t11	Device 0 RESET- negation to BSY bit set to one, release PDIAG -	-	400 ns
t12	Device 0 release DASP-	-	1 ms
t13	Device 0 sample time of DASP-	1 ms	450 ms
t14	Device 0 sample time of PDIAG-	1 ms	31 s
t15	Device 1 RESET- negation to BSY bit set to one	-	400 ns
t16	Device 1 assert DASP-	-	400 ms
t17	Device 1 negate PDIAG - if asserted	-	1 ms
t18	Device 1 assert PDIAG-	-	30 s

CHAPTER 5 Operation and Cleaning

This chapter describes how to operate and clean the optical disk drive and an optical disk cartridge.

5.1 Operation of Optical Disk Drive

The optical disk drive has automatic load and eject functions. All of the operator must do about the drive is to insert an optical disk cartridge and push the eject button. This section explains loading and ejecting an optical disk cartridge, assuming that the drive is mounted horizontally. You can operate the drive in the same manner even when it is mounted vertically.

Figure 5.1 shows the front view of the optical disk drive. The following sections explain the names and functions of parts that a user should know for operation as well as methods of loading and ejecting an optical disk cartridge.

5.1.1 Appearance of optical disk drive

2) Eject button/BUSY LED

3) Manual eject hole
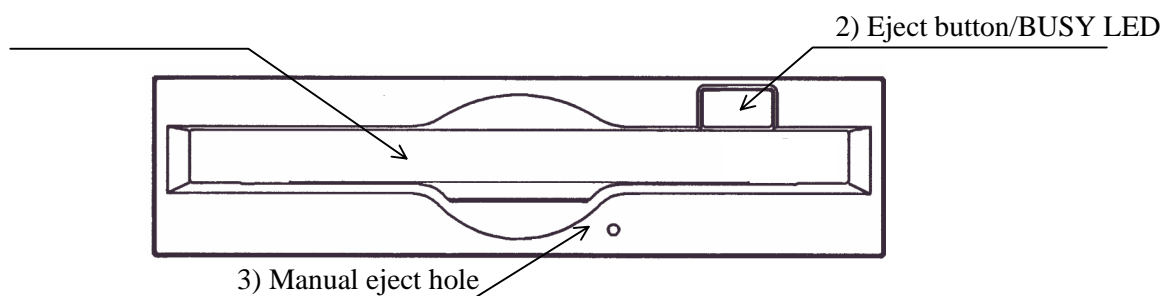
Figure 5.1 Optical disk drive front view (with panel)

The following explains the parts and functions of the optical disk drive (the following numbers correspond to those in Figures 5.1):

1) Disk insertion slot

Insert and eject an optical disk cartridge into and out of this slot.

2) Eject button & BUSY LED (indicator lamp)

On this optical disk drive, the eject button serves also as the BUSY LED (indicator lamp). Eject an optical disk cartridge by pressing this button, which also goes on in green during seeking and during erasing, writing or reading of data. When ejection is disabled by an ATAPI command, an optical disk cartridge cannot be taken out.

3) Manual eject hole

Use this hole to eject an optical disk cartridge manually at power-off.

5.1.2 Precautions

To maintain the performance and reliability of the drive and to prevent data from being damaged, observe the following instructions:

- Do not eject an optical disk cartridge while the drive is in the Busy state.

  Particularly, do not manually eject the cartridge by force.

- Be extra careful not to insert the wrong media such as a floppy disk or foreign matter, which causes a malfunction of the drive.

5.1.3 Inserting an optical disk cartridge

Insert an optical disk cartridge as follows (see Figure 5.2):

(1) While the drive is powered on:

1) Make sure that there is no other optical disk cartridge in the drive.

2) Hold an optical disk cartridge with the printed shutter surface facing upward.

3) Press the opening section of the cartridge against the disk insertion slot.

4) Hold the center of the rear half of the cartridge to insert the cartridge straight into the slot until the cartridge is lowered to the bottom (a little inside the operator panel).

The cartridge starts to be loaded when it has been inserted. The BUSY LED indicator lamp goes on immediately and goes off in a few seconds, indicating the completion of loading.

Notes:

1. Insert a cartridge as far as it will go until the BUSY LED indicator lamp goes on.

2. A cartridge may not be sufficiently inserted if you press only the left or right edge of the rear half of the cartridge. Be sure to push the central part straight into the slot as far as it will go.

3. If the BUSY LED indicator lamp does not go on after a cartridge is inserted, press the eject/BUSY LED button once to eject the cartridge and insert it again.

4. Do not forcibly insert a cartridge if you have any difficulty inserting it. If you do, the drive may be damaged. In such a case, be sure to remove the cartridge once and check the insertion orientation and the face and back of the cartridge before inserting it again.

(2) While the drive is powered off:

1) Make sure that there is no other optical disk cartridge in the drive.

2) Hold an optical disk cartridge with the printed shutter surface facing upward.

3) Press the opening section of the cartridge against the disk insertion slot.

4) Hold the center of the rear half of the cartridge to insert the cartridge straight into the slot until the cartridge is lowered to the bottom (a little inside the operator panel).

The cartridge remains where it has been inserted. If you power on the drive, the BUSY LED indicator lamp goes on.

Notes:

1. If the BUSY LED indicator lamp does not go on when the power is turned on, press the eject button to eject the cartridge and then insert it again until the lamp goes on.

2. A cartridge may not be sufficiently inserted if you press only the left or right edge of the rear half of the cartridge. Be sure to push the central part straight into the slot as far as it will go.

3. Do not forcibly insert a cartridge if you have any difficulty inserting it. If you do, the drive may be damaged. In such a case, be sure to remove the cartridge once and check the insertion orientation and the face and back of the cartridge before inserting it again.
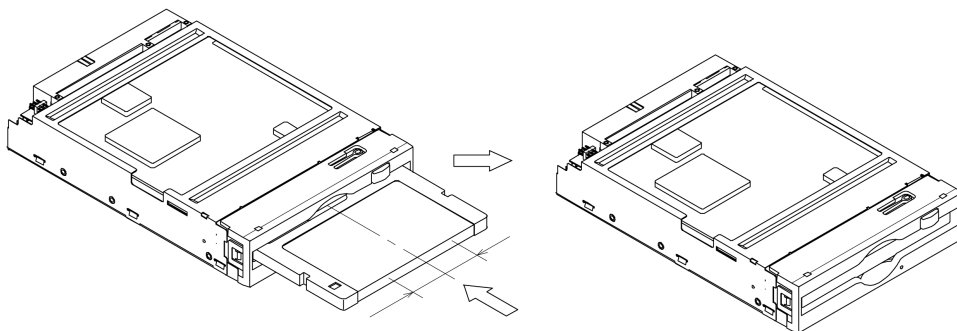
Push on the back of the cartridge somewhere within the area extending 20 mm from left of center to 20mm from right of center, up to the location shown on the right.

Figure 5.2 Inserting an optical disk cartridge

IMPORTANT

If you insert an optical disk cartridge with the printed shutter facing upward by pressing on the rear of cartridge at the left edge, you may hear an audible click but the drive may not become READY. In such a case, press the cartridge further by pressing on the back of the cartridge from the center (somewhere near the notched section of the panel front) until the LED indication lamp goes on. If this happens, the cartridge has been normally inserted.

5.1.4 Removing an optical disk cartridge

Remove an optical disk cartridge as described below.

(1) While the drive is powered on:

1) Press the eject switch to remove an optical disk cartridge (see Figure 5.3).

Notes:

1. No optical disk cartridge can be removed if the ATAPI command inhibits ejection.

2. Remove an optical disk cartridge after it is completely ejected.

3. Be careful not to let a cartridge drop out of the drive when it is ejected. This may happen depending on the ambient environment and the cartridge's condition even if the drive installation conditions are met.

(2) While the drive is powered off:

While the drive is powered off, you cannot remove an optical disk cartridge by pressing the eject switch.

To remove a cartridge in such a case, insert an accessory eject jig or a pin about 1 mm in diameter into the manual eject hole (see Figure 5.1) and push on it.

Notes:

1. NEVER eject a cartridge while the BUSY LED lamp is on. The data may be destroyed or the drive may be damaged.

2. Note that a cartridge may drop out of the drive when it is ejected.

3. Do not carry the optical disk drive around while a cartridge is loaded in it.

Press the eject switch
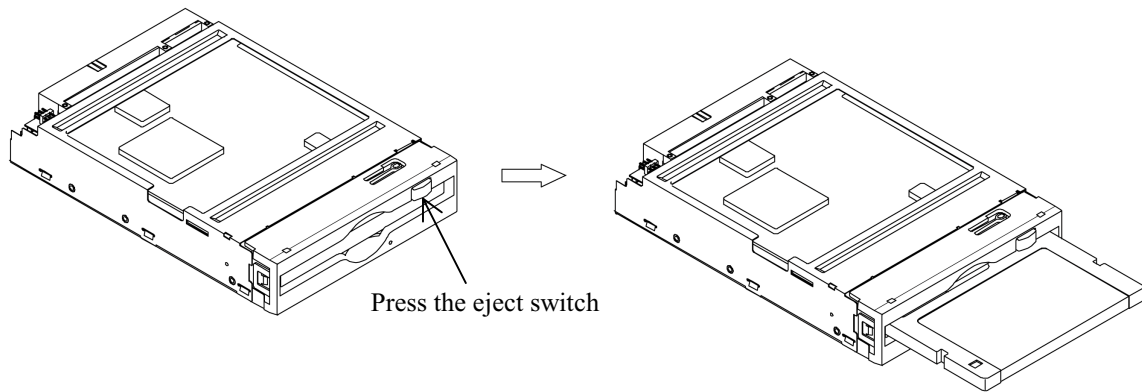
Figure 5.3 Removing an optical disk cartridge

5.2 Cleaning of Optical Disk Drive

The drive performance may deteriorate if dust, particle or cigarette smoke deposits accumulate on the lens actuator of the drive. Clean the lens actuator periodically using following head cleaner (*1).

*1   How often the lens actuator should be cleaned varies depending on the environment in which the optical disk drive has been installed. Usually, clean the lens actuator once every three months.

Table 5.1   Head cleaner

Product name	Product number	Order number
Head cleaner	0240470	CA90002-C980

Clean the lens actuator using the head cleaner as follows:

1)   Power on the optical disk drive.

2)   Insert the head cleaner.

3)   When the head cleaner is automatically loaded, the optical head positioner moves back and forth to cause the head cleaner's cleaning brush to clean the object lens.

4)   When the cleaning is finished, the head cleaner is automatically ejected.

Note: The cleaning time is around 15 seconds.

⚠CAUTION

Device Damage:
Be sure to use the dedicated head cleaner shown above.

IMPORTANT

Check the state of the cleaning brush by opening the shutter of the head cleaner. If the tips of the brush bristles are spread out, the lens cannot be completely cleaned. In such a case, use a new head cleaner.

5.3 Operation of Optical Disk Cartridge

5.3.1 Appearance

Figure 5.4 shows the appearance of an optical disk cartridge. It also shows the names of components of an optical disk cartridge that you should be familiar with for operation and cleaning.

See Section 2.3.2, "Appearance" for the functions of these components.

(a) Shutter closed

(2) Shutter

(1) Cartridge case

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(3) Write protect tab

(b) Shutter open

(4) Disk

(5) Hub

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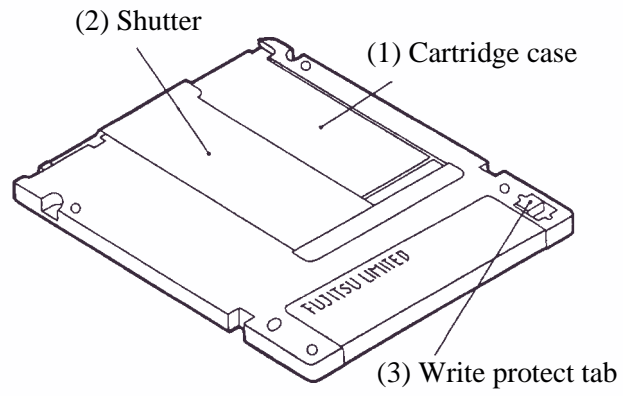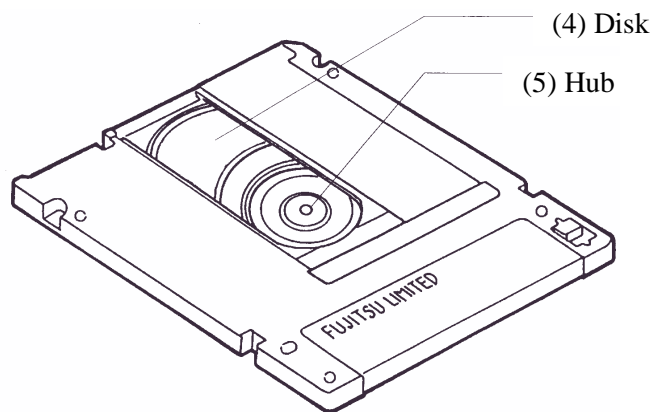
Figure 5.4 Appearance of optical disk cartridge

5.3.2 Write protect tab

Move the write protect tab to enable or disable writing to an optical disk cartridge. Use a fingernail or something similar to move the write protect tab (it must be completely moved to one end because there is some play in the middle).

Figure 5.5 shows where the write protect tab is located on a optical disk cartridge and how the write protect tab should be moved (see the Write Enabled and Write Disabled indications printed on the label).

Write protect tab

Tab moved to this end

Write enabled

Tab moved to this end

Write disabled
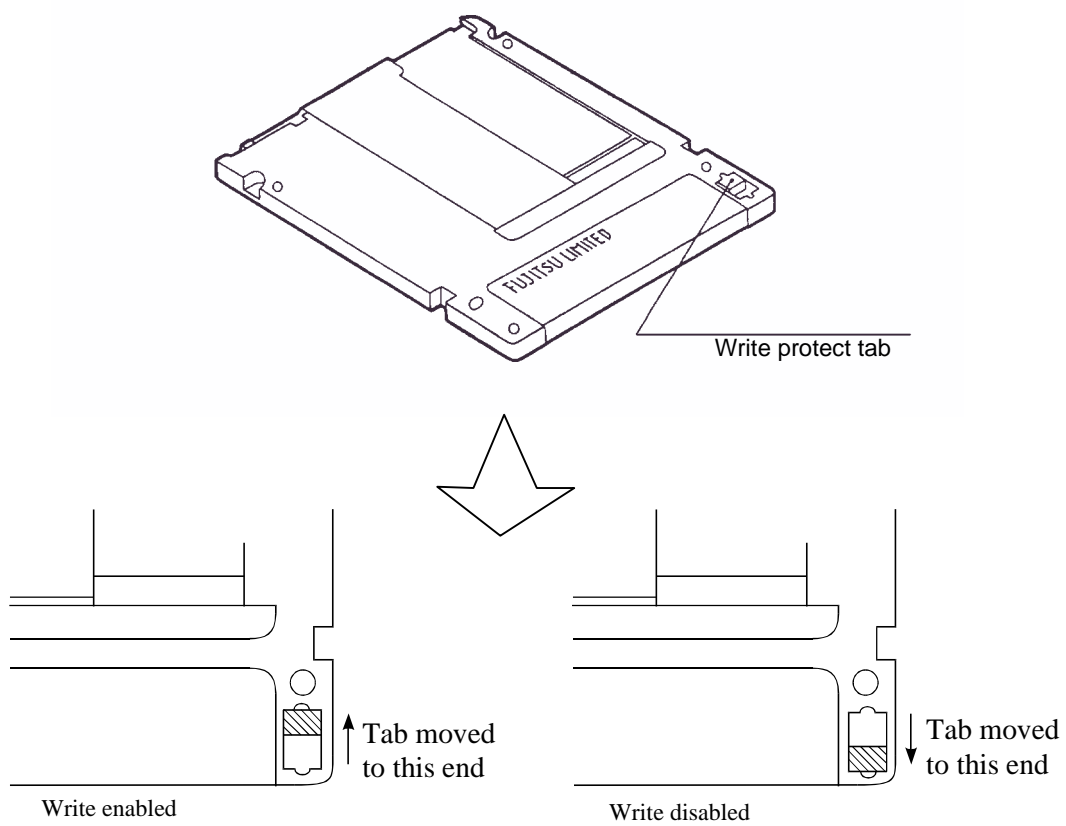
Note: The write protect tab should be at each of the shaded portions.

Figure 5.5 Write protect tab

5.3.3 Precautions

To maintain the performance and reliability of an optical disk cartridge, keep the following points in mind when using, storing, or transporting an optical disk cartridge:

(1) Using a cartridge

- Do not use a cartridge in an environment where it is exposed to direct sunlight or sharp temperature changes, or high temperature or humidity.

- Do not press hard, drop, or otherwise apply excessive shock or vibration to a cartridge case or shutter.

- Do not use a cartridge in an environment filled with dust, particle, or cigarette smoke.

- Do not open the shutter or touch the surface of a disk with bare fingers.

(2) Storing a cartridge

- Do not place a heavy object on a cartridge.

- Do not store a cartridge in an environment where it is exposed to direct sunlight or sharp temperature changes, or high temperature or humidity.

- Do not store a cartridge in an environment filled with dust, particle, or cigarette smoke.

(3) Transporting a cartridge

- Transport a cartridge sealed in a nylon bag or the equivalent, to protect it from moisture during transportation.

- Put a cartridge in a solid container and cover the cartridge with appropriate cushioning materials to protect it from damage during transportation.

5.4 Cleaning the Optical Disk Cartridge

You must periodically clean an optical disk cartridge because the accumulation of dust, particle, or cigarette smoke deposits on the disk lowers the performance of the cartridge. How often the cartridge should be cleaned varies depending on the environment in which the optical disk drive has been installed. Usually, clean the cartridge once every 300 hours of operation or once in two to three months.

5.4.1 Cleaning tool for optical disk cartridge

Use the following cleaning kit to clean an optical disk cartridge.

(1) Cleaning kit

This cleaning kit is for a 3.5-inch optical disk cartridge only. Read the attached instruction manual and use the cleaning kit correctly. Table 5.2 shows the specifications of the cleaning kit.

Table 5.2   Cleaning kit

Product name	Product number	Order number
Cleaning kit	0632440	CA90003-0702

Table 5.3 shows the packing list of the cleaning kit.

Table 5.3   Packing list for cleaning kit

Name	Quantity
Setting case	1
Cleaning cloth	5 pieces (70mm × 70mm)
Cleaning solution	1 bottle (20ml)

The following refill kit is available for the cleaning solution and cloth.

- Product number 0632450

- Order number CA90002-D901

⚠CAUTION

Disk damage: To clean a disk, use the cleaning solution and cleaning cloth specified in Table 5.2.

If a cleaning solution or cleaning cloth other than the one specified is used, the surface of a disk may be damaged.

(2) Precautions on use and storage of cleaning kit

Keep the following in mind when using or storing the cleaning kit:

- Tighten the cap after using the cleaning solution.

- Do not insert a floppy disk or stack floppy disks in the setting case because a magnet is used at the disk revolving knob of the setting case.

- Do not use or store the cleaning kit in an environment where it is exposed to direct sunlight or near a flame.

- Keep the cleaning kit out of the reach of children.

⚠CAUTION

Disk damage: Do not use this cleaning kit on a floppy disk or an optical disk cartridge to be used on other optical disk drives.

5.4.2 Cleaning of optical disk cartridge

Clean an optical disk cartridge as follows:

⚠CAUTION

Disk damage: Clean a cartridge in a dust-free environment. Fujitsu recommends wearing disposable gloves during cleaning so that no fingerprints are left on a disk.

1) Slide the cartridge shutter until it is completely open (see Figure 5.6).
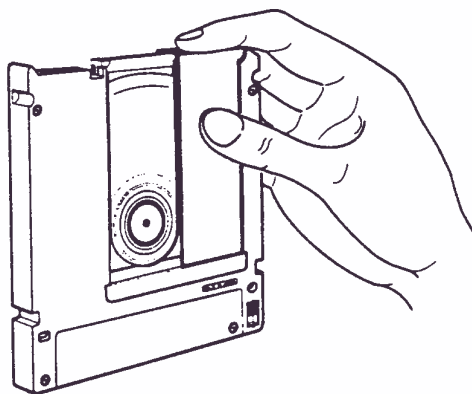
Figure 5.6 Opening a shutter

2) Set the cartridge with the printed shutter surface facing downward and with the shutter completely open, into the shutter stopper of the setting case as shown in Figure 5.7.
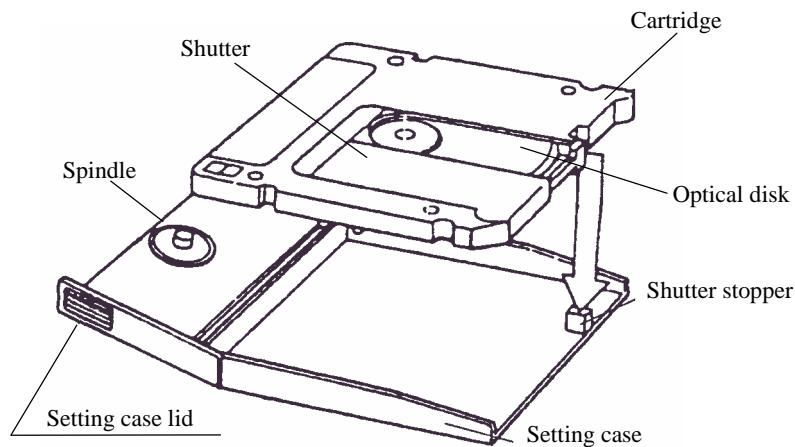
Figure 5.7 Setting an optical disk cartridge into the setting case

⚠CAUTION

Disk damage: Do not press hard or apply excessive shock to an optical disk cartridge case while setting it in the setting case.

3) Place the setting case cover over the cartridge while inserting the disk revolving knob pin into the center hub of the cartridge (see Figure 5.8).
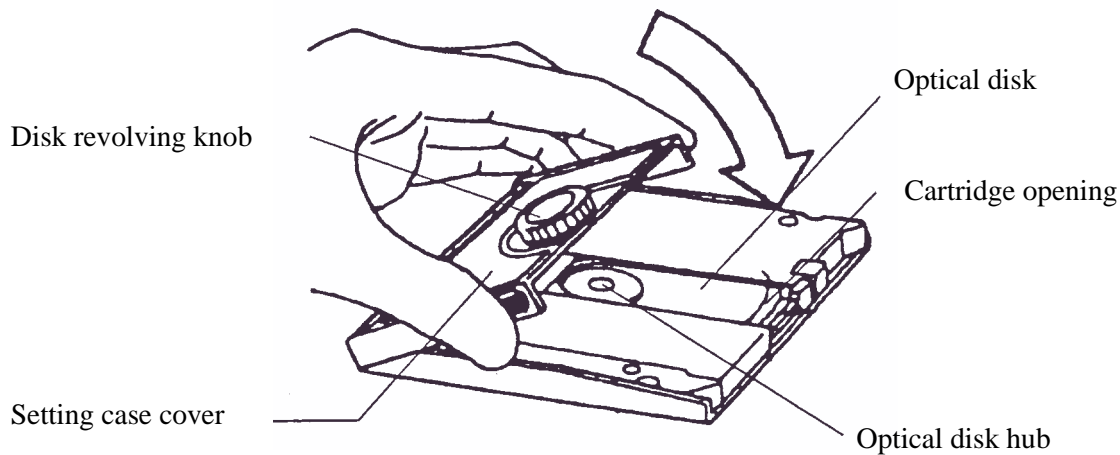
Figure 5.8 Placing the setting case cover

4) When wiping the disk, remove from the disk surface any fragments that may damage it.

5) Moisten the accessory cleaning cloth with a few drops of the cleaning solution.

⚠CAUTION

Eye inflammation: If the cleaning solution gets into your eyes, immediately wash the solution away with water.

6) Gently wipe the disk surface, going from the center to the edge of the disk.

7) After wiping, turn the disk-revolving knob and then wipe the next section in the same manner (see Figure 5.9).
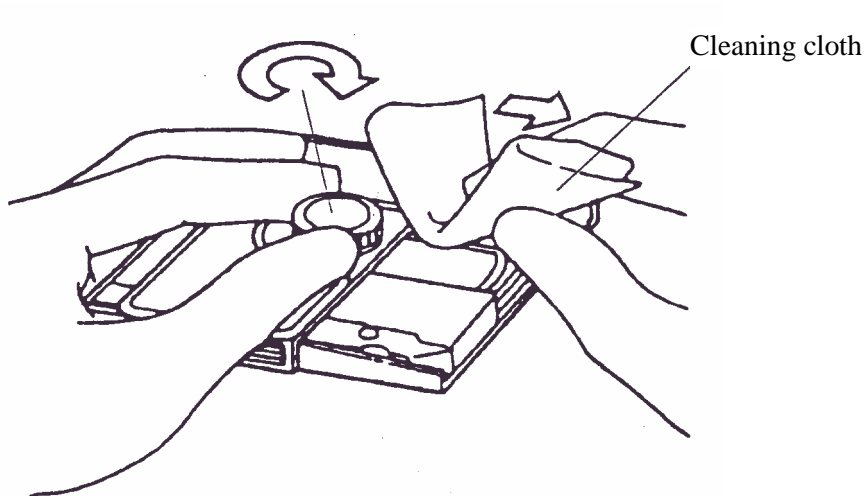
Cleaning cloth

Figure 5.9 Cleaning of disk surface

8) Wipe off any excess cleaning solution remaining on the disk surface, using a new portion of the cleaning cloth (where no cleaning solution is absorbed).

CHAPTER 6 Diagnostics and Maintenance

> 6.1   Diagnostics
>
> 6.2   Maintenance Information

This chapter provides diagnostics and maintenance information.

6.1 Diagnostics

Table 6.1 lists test items during diagnostics.

The optical disk drive has a self-diagnostics function. This function can check the normality of basic operations of the drive.

To check the generation operations including the operations of the interface with the host system, provide a test program that can run in the host system (see Section 6.1.3).

Table 6.1   Diagnostics function

Description of diagnostics	Diagnostics item
Initial self-diagnostics	Basic operations (hardware function test)
Diagnostic command	Basic operations
Test program	General operations

6.1.1 Initial self-diagnostics

When the power is turned on, the optical disk drive executes initial self-diagnostics. The initial self-diagnostics tests basic hardware operations.

The hardware function test checks the normality of the basic operations of the controller. This test includes the normality check of the ROM that stores microcodes, microprocessor (MPU) peripheral circuit test, memory (RAM) test, and data buffer test.

The LED on the drive front panel blinks if an error is detected during initial self-diagnostics.

6.1.2 Diagnostic command

The host system issues the EXECUTIVE DEVICE DIAGNOSTIC command to cause the ODD to execute self-diagnostics.

See the description on the EXECUTIVE DEVICE DIAGNOSTIC command for more information.

6.1.3 Test program

To check the operations of the interface with the host system and the general operations in an environment that simulates an actual operation status, provide a test program that can run in the host system.

The configuration and function of the test program depend on the requirements of the user system.

To comprehensively test the functions of the optical disk drive, the Fujitsu recommends that the test program include the following test items:

(1) Random/sequential read test

Use the READ or VERIFY command to test the positioning (seek) and read operations in both random access mode and sequential access mode.

(2) Write/read test

Using a disk whose data may be erased, execute write/read test based on arbitrary data patterns.

6.2 Maintenance Information

6.2.1 Maintenance requirements

(1) Preventive maintenance

No preventive maintenance is required.

(2) Service life

This drive will not require overhaul within the first five years of installation if it is used in an appropriate environment and handled as recommended.

(3) Service system and repair

Fujitsu provides a service system and repair facility for its optical disk drives. Submit to your Fujitsu representative information required to replace or repair a drive. Normally, the information includes:

a) Optical disk drive model, product number (P/N), revision number, serial number (S/N), and date of manufacture

b)   Failure status

−   Date of failure

−   System configuration

−   Environment conditions (temperature, humidity, supply voltage, etc.)

c)   Failure history

d)   Failure description

−   Description of failure

−   Issued commands and specified parameters

−   Sense data

−   Other error analysis information

⚠CAUTION

Data loss: For a repair request, you normally do not need to
include any optical disk cartridge with an optical disk drive.
However, you do need to include a cartridge if errors keep occurring
with a specific cartridge. In such a case, be sure to save data stored
in the cartridge before sending it in. Fujitsu shall bear no
responsibility for any data lost during service or repair.

See Section 5.3.3, "Precautions" for information on packing and handling a drive
when you send it to Fujitsu.

6.2.2 Revision number

The revision number of an optical disk drive is represented with an alphabetic
character followed by a single-digit number. The revision number is shown on a
revision label attached to the drive. For example, Figure 6.1 shows the format of a
revision label.
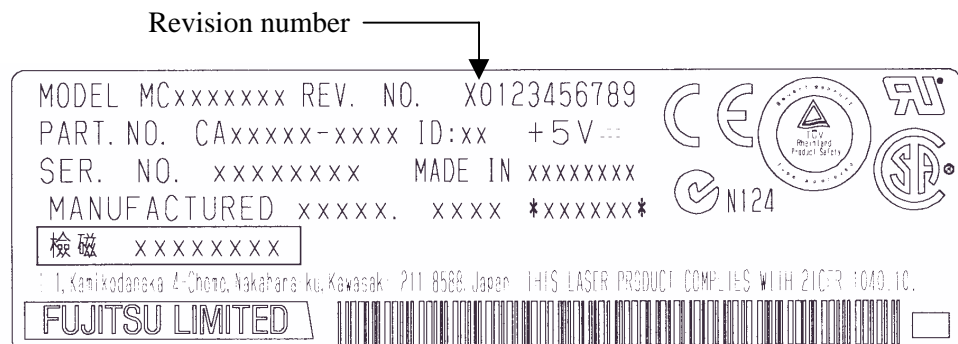
Figure 6.1 Revision label

(1) Indication of revision number at shipment

> The revision number indicated on the drive at the time of shipment is indicated by marking (crossing out) the numbers up to the pertinent number using double lines (=) in the line of the pertinent alphabetic character (see Figure 6.2).

(2) Change of revision number in the field

> To change the revision number in the field because of parts replacement or modification, indicate the new revision number by circling the number in the line of the pertinent alphabetic character (see Figure 6.2).
>
> If a revision number is changed after shipment, Fujitsu issues "Revision Number Change Request/Notice" to indicate the new revision number. The user must update the revision label as described above after applying the change.
>
> Indication of revision number at shipment
>
>   REV.NO. A 0̶ 1̶ 2̶ 3 4 5 6 7 8 9   Revision A2
>
> Change of revision number in field
>
>   REV.NO. A 0̶ 1 2 ③ 4 5 6 7 8 9   Revision A3
>
> Note: "A" in Revision Number is impressed.

Figure 6.2 Revision number indication

Glossary

Axial acceleration

Acceleration in the recording layer along the line perpendicular to the disk reference surface at a specified rotation speed. Axial acceleration is detected by optical means.

Axial displacement

A displacement at a point in the recording layer in a direction perpendicular to the disk reference surface from its standard position. The standard position in the recording layer is detected optically using the thickness and refraction rate of the protective layer, based on the disk reference surface.

Case

A cover of an optical disk. The case protects the disk from being damaged during handling and also allows the operator to replace disks easily. The case also provides for a label, write protection tab, automatic handling support, and media identification hole.

CDB (Command Descriptor Block)

A series of data describing input-output commands. The CDB is sent from the initiator to the target.

Clamp area

A disk ring area on which the clamp mechanism applies a clamp force.

Command

An input-output instruction to the target. Described as CDB.

Control track

A track used to store media parameters and format information required to record and read data to or from an optical disk.

Defect management

In real time processing mode, defect management refers to an automatic program used to change the power, focus, tracking of reading and recording if an error is detected and used to decide whether numerous error sectors should be discarded. In batch mode, defect management refers to a guideline used to re-record or save data in a disk.

Disk reference surface

An ideal flat ring surface of an ideal spindle that comes into contact with the clamp area on a disk. The disk reference surface is perpendicular to the rotation axis.

Error correction code

An error correction code designed to correct specific errors in data.

Error detection and correction

A series of methods used to add a redundant code to data in the existing format and then record data. In read mode, the decoder removes a redundant code and detects and corrects errors using the redundant information.

Interleaving section

A process that physically arranges data units so that data resists burst errors.

LUN (Logical Unit Number)

A device address used to identify a logical unit.

Recording layer

A disk layer in which data should be recorded during manufacturing or recording.

Recording power

An incidence power specified on the incidence surface and used to form marks.

Sense code

A single-byte code set in sense data. This information is used to identify the type of error detected.

Sense data

Information generated by the target to report detailed error information if a command end status contains any error information.

Sense key

A 4-bit code set in sense data. This information is used to classify the type of error detected.

Spindle

A disk drive component that comes into contact with a disk and a hub.

Status

> Single-byte information reported from the target to the initiator at the end of execution of each command. The status indicates the end status of a command.

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Acronyms and Abbreviations

A

AC	Alternating current
ACK	Acknowledge
ALPC	Automatic laser power control
AM	Address mark
ANSI	American National Standards Institute
ARRE	Automatic read reallocation enabled
ASC	Additional sense code
ASCII	American Standard Code forInformation Interchange
ASCQ	Additional sense code qualifier
ATN	Attention
AWG	American Wire Gauge
AWRE	Automatic write reallocationenabled

B

BCV	Buffer control valid
BPV	Bit pointer valid
BSY	Busy
BytChk	Byte check

C

C/D	Control/data
CDB	Command descriptor block
CDRH	Center for Devices and Radiological Health
CRC	Cyclic redundancy code
CSA	Canadian Standards Association

D

DB	Data bus
DBD	Disable block descriptor
DBP	Data bus parity
DC	Direct current
DCRT	Disable certification
DDS	Disk definition sector
DMA	Defect management area
DPO	Disable page out
DPRY	Disable primary
DSP	Digital signal prosessor

E

EBC	Enable blank check
EBP	Erase by-pass
ECC	Error correcting code
EN	European Norm
EVPD	Enable vital product data

F

FG	Frame ground
FIFO	First in first out
FmtData	Format data
FOV	Format options valid
FRU	Field replaceable unit

G

GND	Ground

I

I/O	Input/output
IC	Integrated circuit
ID	Identifier
IDD	Intelligent disk drive
IEC	International Electrotechnical Commission
Immed	Immediate
IP	Initialize pattern
ISO	International Standardization Organization

L

LD	Laser diode
LED	Light emitting diode
LoEj	Load eject
LSB	Least significant byte
LUN	Logical unit number

M

MPU	Microprocessor unit
MSB	Most significant byte
MSG	Message
MTBF	Mean time between failures
MTTR	Mean time to repair

N

N.C.	No connection

O

ODD	Optical disk drive
ODF	Offset detection flag
OEM	Original equipment manufacturer

P

PA	Postamble
P/N	Part number
PC	Page control
PCA	Printed circuit assembly
PCF	Page control field
PCR	Parameter code reset
PDL	Primary defect list
PEP	Phase encoded part
PF	Page format
PLL	Phase-locked loop
PMI	Partial medium indicator
PPC	Parameter pointer control
PWM	Pulse width modulation

R

RAM	Random-access memory
RelAdr	Relative addressing
REQ	Request
RH	Relative humidity
ROM	Read only memory
rpm	revolutions per minute
RST	Reset
RSV	Reserved

S

S/N	Serial number
SB	Spare band
SCT	Sector
SDL	Secondary defect list
SDTR	Synchronous data transfer request
SEL	Select
SFP	Standard formatted part
SG	Signal groun
SKSV	Sense key specific valid
SM	Sector mark
SNSKEY	Sense key
SP	Save page
SP	Save parameter
STPF	Stop format
SYNC	Synchronization mark

T

TTL	Transister-transister-logic
Typ	Typical

U

UB	User band
UL	Underwriters Laboratories Incorporated

V

VCM	Voice coil motor
VDE	Verband Deutscher Elektrotechniker
VFO	Variable frequency oscillator
VLD	Valid
VPD	Vital product data
VU	Vendor unique

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