# MCE3130AP, MCE3064AP, MCF3064AP

# OPTICAL DISK DRIVES

# PRODUCT MANUAL

FUJITSU

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# PREFACE

This manual describes the MCE3130AP, MCE3064AP and MCF3064AP 90mm(3.5-inch) optical disk drives.

This manual explains the specifications of the above optical disk drive (ODD) and function of the ATAPI that interfaces to the user's system.

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 on the organization of manuals related to the optical disk drives and the scope of this manual.  Use the other manuals shown in "Manual Organization" as well as this manual if necessary.

This manual is organized as follows:

**Chapter 1        GENERAL DESCRIPTION**

This chapter introduces the MCE3130AP, MCE3064AP and MCF3064AP optical disk drives and describes their standard features, system configuration, and drive configuration.

**Chapter 2        SPECIFICATIONS**

This chapter describes the specifications of the MCE3130AP, MCE3064AP and MCF3064AP optical disk drives, ATAPI function specifications, and optical disk cartridge specifications.

**Chapter 3        INSTALLATION REQUIREMENTS**

This chapter describes basic installation requirements (environment, mounting, power supply, and connection) for the MCE3130AP, MCE3064AP and MCF3064AP optical disk drives.

**Chapter 4        HOST INTERFACE**

This chapter describes host interface of the MCE3130AP, MCE3064AP and MCF3064AP optical disk drives.

**Chapter 5        OPERATION AND CLEANING**

This chapter describes the operation and cleaning of the MCE3130AP, MCE3064AP and MCF3064AP optical disk drives, outlines optical disk cartridges, and describes how to clean the cartridges.

**Chapter 6        DIAGNOSIS AND MAINTENANCE**

This chapter describes the self-diagnostic functions and maintenance of the MCE3130AP, MCE3064AP and MCF3064AP optical disk drives.

**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 *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 procedure 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)

**⚠CAUTION**

*Before moving the drive, remove the optical disk cartridge to avoid head or disk damage*

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

# DISCLAIMER

Failure of the MCE3130AP, MCE3064AP and MCF3064AP optical disk drives are defined as a failure requiring adjustment, repair, or replacement. Fujitsu is not responsible for failure due to misuse, operation outside the specified environment conditions, power line trouble, controller problems, cable failure, or other failure not caused by the optical disk drive itself.

# Important Alert Items

**Important Alert Messages**

The important alert messages in this manual are as follows:

| | 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 procedure correctly. |
|---|---|
| **⚠CAUTION** | |

| Task | Alert message | Page |
|---|---|---|
| Operation | *Low temperature burns*<br>*The surface temperatures of some ICs on the printed circuit board unit in the optical disk drive exceed 55°C while operating.  Be careful of low tenperature burns.* | 3-1 |
| Installation | *Device damage*<br><br>*1) Shock or vibration applied to the drive that exceeds the values defined in the standard damage the drive.  Use care when unpacking.*<br><br>*2) Do not leave the drive in dirty or contaminated environments.*<br><br>*3) Since static discharge may destroy the CMOS devices in the drive, pay attention to the following points after unpacking:*<br><br>*• Use an antistatic mat and wrist strap when handling the drive.*<br><br>*• Hold the mounting frame when handling the drive.  Do not touch the PCA except when setting the switches.*<br><br>*4) When handling the drive, hold both sides of the mounting frame. When touching other than both sides of the mounting frame, avoid putting force.*<br><br>*5) Do not forcibly push up the end of the header pin of the printed circuit board unit when handling or setting the drive.* | 3-17 |

| Task | Alert message | Page |
|---|---|---|
| Installation | *Device Damage*<br>*Be sure to turn on the power supply before inserting your cartridge for the first time. It releases the device from transport protection and enables you to insert the cartridge.*<br>*The device may be damaged if you insert the cartridge without releasing the protection. From the next time, you don't need to turn on the power supply beforehand.*<br><br>*Before moving the drive, remove the optical disk cartridge. 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 and reading the data may fail.* | 3-18 |
| | *1) Make sure that the system power is off.* | 3-20 |
| | *2) Do not connect or disconnect any cable when the power is on.* | |
| | *Device Damage*<br>*Before demounting the optical disk drive, turn off the system power. Do not remove screws securing the cables and drive when the power is on.* | 3-22 |
| Cleaning cartridge | *Device Damage*<br>*Be sure to use the dedicated head cleaner described above.* | 5-6 |
| | *Damage for disk medium*<br>*Use the cleaning solution and cleaning cloth specified in Table 5.2. If other than the specified items is used, disk media surface may be damaged.* | 5-10 |
| | *Damage for date medium*<br>*Do not use this cleaning kit for the floppy disk or the optical disk cartridge used for other optical disk drive.* | |
| | *Damage for disk medium*<br>*Clean the cartridge at clean place. Put a disposable groves at cleaning so that the fingerprint does not put on the disk media (recommendation).* | 5-11 |
| | *Damage for disk medium*<br>*At setting the cartridge to the setting case, do not apply the heavy shock and push hardly.* | 5-12 |
| | *Eye inflammation*<br>*In case of contact with eyes, immediately flush eyes with water.* | |
| Maintenance and Repair | *Data loss*<br>*In case of regular repair, the optical disk cartridge should not be attached except where the cartridge causes the error. And before having the drive repaired, save the data in the cartridge. Fujitsu is not responsible for data last during maintenance or repair.* | 6-3 |

| | |
|---|---|
| MCE3130AP, MCE3064AP and MCF3064AP OPTICAL DISK DRIVE PRODUCT MANUAL<br><br>(C156-E142)<br><This manual> | • GENERAL DESCRIPTION<br>• SPECIFICATIONS<br>• INSTALLATION REQUIREMENTS<br>• HOST INTERFACE<br>• OPERATION AND CLEANING<br>• DIAGNOSIS AND MAINTENANCE |
| MCE3130AP, MCE3064AP and MCF3064AP OPTICAL DISK DRIVE MAINTENANCE MANUAL | • MAINTENANCE AND DIAGNOSIS<br>• FAULT ANALYSIS<br>• REMOVAL AND REPLACEMENT PROCEDURES<br>• PRINCIPLES OF OPERATION<br>• CLEANING |

# REFERENCED STANDARDS

| Item | Number | Name | Organization |
|------|--------|------|--------------|
| 1 | X3T13/1321D Revision 2 | AT Attachment with Packet Interface-5 (ATA/ATAPI-5) | American National Standards Institute (ANSI) |
| 2 | SFF-8070I Revision 1.2 | ATAPI Removable Rewritable Media | Small Form Factor Committee (SFF) |
| 3 | ISO/IEC 10090 | 90 mm optical disk cartridges, rewritable and read only, for data interchange | ISO/IEC |
| 4 | ISO/IEC 13963 | Data interchange on 90 mm optical disk cartridges,<br>– Capacity: 230 megabytes per cartridge | ISO/IEC |
| 5 | ISO/IEC 15041 | Data interchange on 90 mm optical disk cartridges,<br>– Capacity: 640 megabytes per cartridge | ISO/IEC JTC1* |
| 6 | Cherry Book Version 1.0 | GIGAMO 1.3 GB 90 mm Magneto-Optical Disk System | FUJITSU LIMITED SONY CORPORATION |

*Note: ISO = International Organization for Standardization
IEC = International Electrical Commission
JTC1 = Joint Technical Committee 1

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# CHAPTER 1    GENERAL DESCRIPTION

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| **1.1    Features** |
| **1.2    Drive Configuration** |
| **1.3    System Configuration** |

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

The MCE3130AP, MCE3064AP, MCF3064AP (hereafter optical disk drives) is disk that maintain the compatibility and intend high speed as the succeed drive of the MCE3130AP, MCE3064AP, MCF3064AP.

The MCE3130AP, MCE3064AP, MCF3064AP is high-performance, 90mm(3.5-inch) commutative rewritable optical disk drive which incorporates an ATAPI controller.

The interface connecting the MCE3130AP, MCE3064AP, MCF3064AP drives to the host system complies with the ATA/ATAPI-4.

The flexibility and expandability through ATAPI I/F, the high performance of the MCE3130AP, MCE3064AP, MCF3064AP optical disk drives, and the drive's commands set enable the user to construct high-reliability, high-performance disk subsystems with advanced functions and large-scale storage.


## 1.1    Features

This section describes the following drive features:

- Performance
- Reliability
- Maintainability/operability
- Adaptability
- Interface

### 1.1.1 Performance

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

The ATAPI controller can be directly connected to the system EIDE bus. The controller meets the specifications of the standard 25.4 mm height 90mm(3.5-inch) fixed disk drive form factor.

(2) High-speed data transfer

The speed of the MCE3130AP disk medium is 3,214 rpm when a 1.3 GB disk medium is used. When other media are used, the speed is 4,558 revolutions per minute.
The speed of the MCE3064AP disk medium is 3600 revolutions per minute.
In the disk unit, high-speed data transfers at rates of 3.46 to 5.92 MB/s (1.3 GB) are realized. The data transfer rate on the EIDE bus is 16.6 MB/s in PIO mode 4 and 16.6 MB/s in Multi-word DMA Mode 2.
The EIDE bus high-speed data transfer capacity can be used effectively through the optical disk unit's large capacity data buffer (with read-ahead cache).

(3) High-speed mean seek time

This drive features a linear voice-coil motor for high-speed head positioning. The average seek time is the average of 1,000 random seeks and is 23 ms. (However, this does not include command overhead or address check.)

(4) Compatible with international standards (media interchangeability)

90mm(3.5 inch) type 1.3 GB format optical disks as well as ISO standards compatible 128 MB, 230 MB, 540 MB and 640 MB format optical disk media can be used in the MCE3130AP Optical Disk Unit.
ISO standards compatible 128 MB, 230 MB, 540 MB and 640 MB format optical disks can be used in the MCE3064AP and MCF3064AP optical disk units.

(5) Direct-overwrite medium support

The drive can use an optic modulation direct-overwrite disk that does not read an erase operation; 230-MB disk, 540-MB disk with the ISO standard.

(6) Dust resistance

The optical disk drive needs class 5 millions or less of the dust particles.

(7) Lower power consumption

The power consumption of the MCE3130AP optical disk drive is 5.5 W and that of the MCE3064AP, and MCF3064AF optical disk drives is 5.3 W. (These power consumption values are typical values during read and write operation.) These drives do not use a fan.
The minimum power consumption is 0.65 W during power save.

(8)     Automatic spindle stop function

If access is not made within a certain time, this function stops disk rotation to minimize dust accumulation on the disk.  This function can be set that time by the MODE SELECT command.

## 1.1.2  Reliability

(1)     Mean time between failure (MTBF)

This drive features a 120,000 hour MTBF.

(2)     Error recovery

For the error depending on the optical disk drive, recovery process is made by a suitable retry. This drive features Reed-Solomon error correction (ECC) to assure error-free operation.

(3)     Automatic allocation of alternate data blocks

This drive features a function which automatically allocates alternate data blocks to defective data blocks detected while data is being read from or written to an optical disk.

## 1.1.3  Maintainability/operability

(1)     Diagnostic function

This drive has a diagnostic function to check optical disk drive operations.  The diagnostic 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 handled, maintained, and cleaned as recommended.

(3)     Mean time to repair (MTTR)

The MTTR is 30 minutes or less, if repaired by a specialized maintenance staff member.

## 1.1.4  Adaptability

(1)     Wide operating environment

An LSI circuits reduce power consumption to 5.3 W (read/write).  This drive features a wide operating environment (5 to 45°C, general office environment).  Dust particles are class 5 millions or less.

(2)        Low noise and low vibration

This drive operates quietly 26 dB or less (A character) even during seek operations and will not degrade the office environment.  Rubber vibration isolators support the drive and minimize vibration.  (Low noise and low vibration features are available except while an MO cartridge is being ejected.)

(3)        Vibration resistance (shock resistance)

Rubber vibration isolators protect the drive against external shock or vibration.

(4)        Safety standards

- UL1950 (U.S.A., safety)
- CDRH class 1 (U.S.A., laser)
- CSA C22.2 No. 950 (Canada, safety)
- EN60950 (Europe, safety)
- EN60825  Class 1 (Europe, laser)

(5)        Various radio wave standards

This optical disk device is installed in a host system, and meets the following standards:

- EN55022 class B, EN55024 (European wave standards)
- AS/NZS3548 class B (Australian wave standards)
- CNS13438 (Taiwanese radio interference standard, except MCE3023AP)

### 1.1.5    Interface

(1)        ATA/ATAPI-4

This drive supports the basic ATA/ATAPI-4 specifications.

ATAPI commands enable operation using logical block addresses that are independent of the physical attributes of the drive, enabling software flexibility in terms of system expansion.

Supports PIO Mode 4 and Multi-word DMA Mode 2.

(2)        Continuous block processing

Logical block addresses are used for data block addressing.  Without consideration of the physical attributes of track boundaries, the initiator can access data by specifying a block number in logically continuous data space.

(3)     Data buffer

1,844 KB buffer is used to transfer data between the EIDE bus and disk.  Since data is stored in this buffer, the host can execute input-output processing effectively by using the high-speed data transfer capability of the EIDE bus without regard to the 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 data is transferred from the buffer without another disk access.


(5)     Write cache feature

When the host system issues the write command to the optical disk drive, a command complete is usually responded after completion of the write and verify operations.  By using the write cache feature, a command complete is responded after completion of the data transfer to the data buffer without waiting the completion of the write and verify operations then the write and verify operations are made asynchronously with the interface operation.  Therefore, the apparent write command processing time measured at the host system is reduced and the I/O performance of the host system is improved.

The write cache feature is enabled or disabled by MODE SELECT command.


## IMPORTANT

*When the write cache feature is enabled, a write error is reported at the completion status of next command.  At a system so that the host retries the command, a retry process may be failed.*


(6)     Defective block slipping

When a disk is initialized, logical data blocks are reallocated in a physical sequence by slipping defective data blocks.  This enables high-speed continuous data block processing without rotational delay due to defective data blocks.


(7)     Device driver software (1.3 GB optical disk media)

The optical disk drive requires more extended processing time than conventional optical device drives because of higher density.  Consequently, a processing time timeout when using the OS can occur and this requires special device driver software.

## 1.2 Drive Configuration

### 1.2.1 Drive model

Figures 1.1 and 1.2 show the outer view.
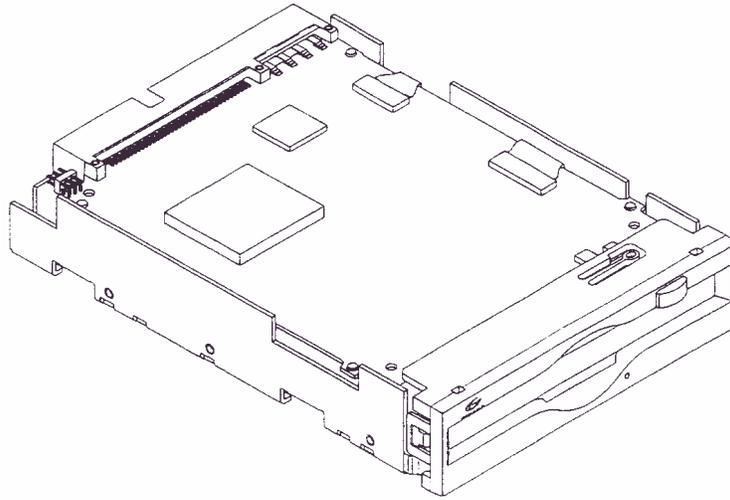


**Figure 1.1    Outer view (with panel)**
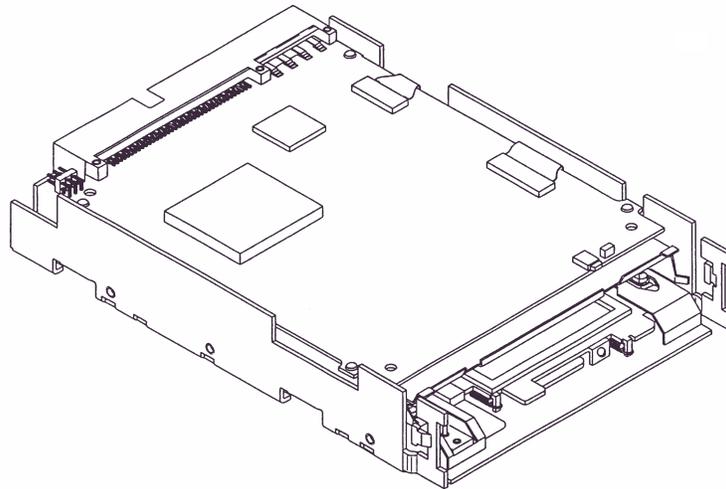


**Figure 1.2    Outer view (without panel)**

### 1.2.2 Configuration

Figure 1.3 shows the drive configuration.

The drive consists of mechanical sections, a fixed optics section, actuator, and a control circuit section.  The mechanical sections include the spindle motor, actuator section, bias magnet, and the cartridge folder vertical motion mechanism.

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

The control circuit sections include the drive control circuit section and ATAPI controller section.
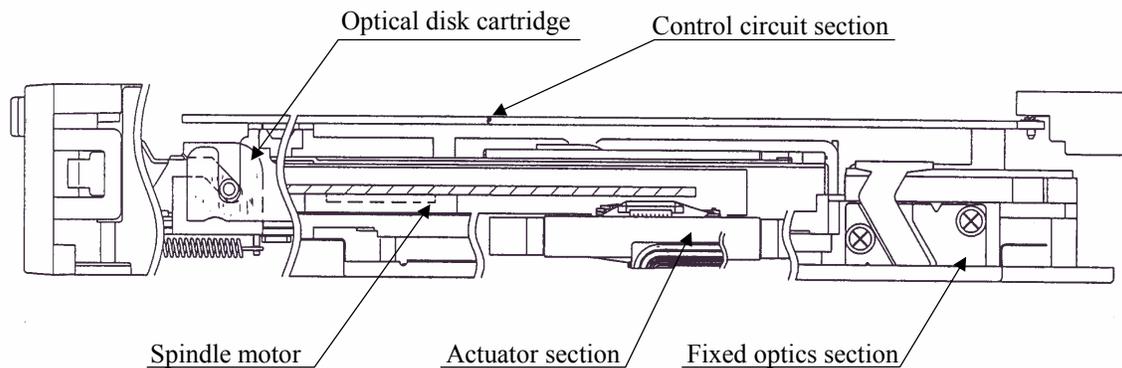


**Figure 1.3    Optical disk drive configuration**

### 1.2.3 Mechanical sections

(1)    Optical disk cartridge load/eject

The system includes a cartridge mechanism which lowers the optical disk cartridge and mounts (loads) it on the spindle motor automatically when the optical disk cartridge is fully inserted in the optical disk drive's disk slot, and a mechanism which automatically ejects the cartridge when the Eject button on the front panel is pressed.

(2)    Spindle motor

Optical disk cartridge hubs are linked through magnetic clamps to minimize slippage between the spindle motor shaft and disk.  The spindle motor is the direct drive type which rotates the disk at the same speed as the spindle motor shaft.  A DC brushless spindle motor is used.  The spindle motor rotates at 4,558 rpm $\pm$ 0.1%.

(3)    Actuator section

The positioner moves (seeks) a head actuator radically across the disk surface.

The positioner is driven by a linear voice coil motor.  A pulse-width modulation (PWM) is adopted as a driving system and realizes low power consumption and high-speed access.

(4)    Separate optical sections

The optical head section is separated in such a way that the fixed optics section is separated from the moving optics section to minimize seek time and positioning error.  (See Subsection 1.2.4 for the fixed optical section.)  This reduces the weight of the moving parts.

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

The fixed optics section includes a laser diode for recording and playback, and transmits one laser beam to the head actuator.


(5)    Panel

The central part of the panel is hollowed out deeply to provide pushing finger space for inserting the cartridge, thereby facilitating the insertion.

The panel is also simply designed by making the eject button and LED light emitting part integral with each other.


## 1.2.4    Control circuit section

Figure 1.4 is the block diagram of the control circuit section.
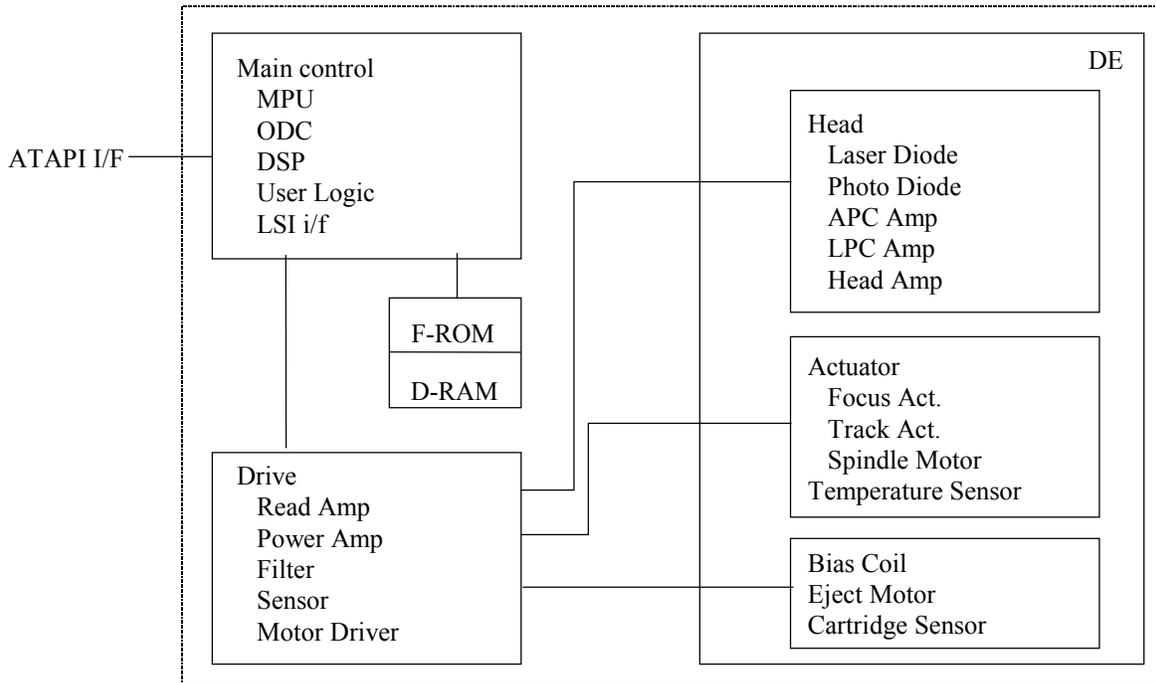


**Figure 1.4    Control circuit section block diagram**

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

(1)    ATAPI controller circuit section

The ATAPI controller circuit's reliability is improved by large-scale integrated circuit technology. The high-speed microprocessor (MPU) handles ATAPI interface control and drive control such as drive read-and-write control and single-beam control.

(2)    Drive circuit section

The drive circuit section consists of the following circuits:

- Laser diode control circuit
- Signal reproduction circuit
- Servo/seek control circuit
- Rotation control circuit
- Drive miscellaneous control circuit

The DSP (digital signal processor) is used for the servo/seek control circuit to reduce the circuit amount, therefore this circuit is a simple configuration.

The drive circuit section executes operations such as seek, erase, record, and playback while the MPU controls the focus-tracking of the beam.

## 1.3    System Configuration

Figures 1.5 and 1.6 show the PC AT interface system configuration.  The interface can be directly connected to the 40-pin AT-compatible EIDE interface.
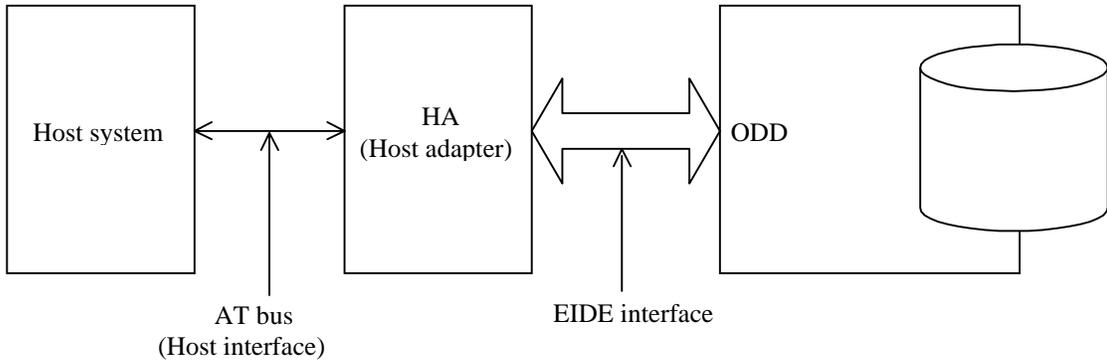


**Figure 1.5     System configuration with one optical disk drive**
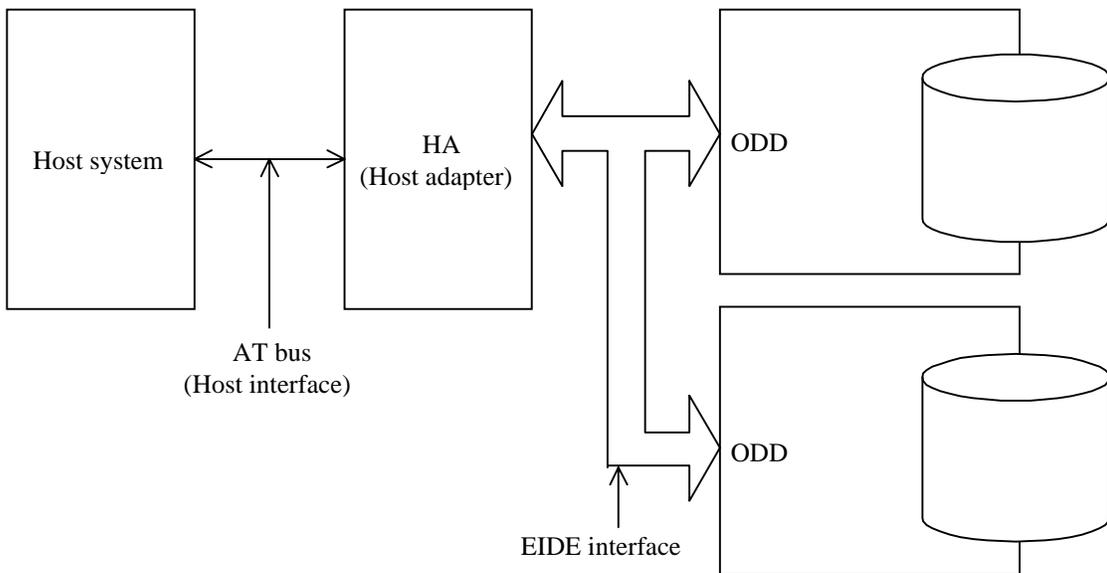


**Figure 1.6     System configuration with two optical disk drives**

## IMPORTANT

The PC AT interface will not meet the specification if two optical disk drives not conforming to the ATA are connected.

The host adapter (HA) consists of an address decoder, driver, and receiver.  ATA stands for AT Attachment.  This drive supports the ATA interface.

# CHAPTER 2    SPECIFICATIONS

> **2.1    Optical Disk Drive Specifications**
>
> **2.2    Optical Disk Cartridge Specifications**
>
> **2.3    Defect Management**

This chapter contains the specifications of the optical disk drive, and the optical disk cartridge.

## 2.1    Optical Disk Drive Specifications

### 2.1.1    Model and product number

Table 2.1 lists the model and order number.

**Table 2.1    Model and order number (1 of 2)**

| Model Name | Order No. | Panel | Panel Color | Mounting Screws |
|---|---|---|---|---|
| MCE3130AP | CA05696-B501 CA05696-B531 | with panel | Light gray (2.5Y 7.2/0.4) | Metric screws (M3) |
| | CA05696-B631 | with panel | Light gray (2.5Y 7.2/0.4) | Inch screws (32 UNC) |
| | CA05696-B701 CA05696-B731 | without panel | – – – | Metric screws (M3) |
| | CA05696-B831 | without panel | – – – | Inch screws (32 UNC) |
| MCE3064AP | CA01747-B501 CA01747-B531 | with panel | Light gray (2.5Y 7.2/0.4) | Metric screws (M3) |
| | CA01747-B631 | with panel | Light gray (2.5Y 7.2/0.4) | Inch screws (32 UNC) |
| | CA01747-B701 CA01747-B731 | without panel | – – – | Metric screws (M3) |
| | CA01747-B831 | without panel | – – – | Inch screws (32 UNC) |

**Table 2.1 Model and order number (2 of 2)**

| Model Name | Order No. | Panel | Panel Color | Mounting Screws |
|---|---|---|---|---|
| MCF3064AP | CA05437-B501<br>CA05437-B531 | with panel | Light gray (2.5Y 7.2/0.4) | Metric screws (M3) |
| | CA05437-B631 | with panel | Light gray (2.5Y 7.2/0.4) | Inch screws (32 UNC) |
| | CA05437-B701<br>CA05437-B731 | without panel | – – – | Metric screws (M3) |
| | CA05437-B831 | without panel | – – – | Inch screws (32 UNC) |

**Note:** The panel colors (2.5Y 7.2/0.4) are indicated in Munsell symbols. (JIS Z8721)

## 2.1.2 Drive specifications

Table 2.2 lists MCE3130AP, MCE3064AP, MCF3064AP drives specifications

### Table 2.2 Specifications (1 of 4)

[MCE3130AP]

| Item | | Specifications | | | | |
|---|---|---|---|---|---|---|
| Optical disk cartridge | | 128 MB media | 230 MB media | 540 MB media | 640 MB media | 1.3 GB media |
| Total capacity | Unformatted | 181 MB | 325 MB | 819 MB | 818 MB | 1.683 GB |
| | Formatted | 128 MB | 230 MB | 538 MB | 643 MB | 1.283 GB |
| Capacity/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/sector | Unformatted | 725 bytes | | 778 bytes | 2,584 bytes | 2,631 bytes |
| | Formatted | 512 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 | | | 17 | |
| Data transfer rate | | 1.37 MB/s (max.) 0.32 MB/s continuous writing (execution) 0.97 MB/s continuous reading (execution) | 1.65 to 2.65 MB/s (max.) 0.39 to 0.62 MB/s continuous writing (execution) 1.16 to 1.86 MB/s continuous reading (execution) | 2.95 to 4.96 MB/s (max.) 0.64 to 1.08 MB/s continuous writing (execution) 1.92 to 3.26 MB/s continuous reading (execution) | 2.94 to 4.90 MB/s (max.) 0.77 to 1.29 MB/s continuous writing (execution) 2.33 to 3.88 MB/s continuous reading (execution) | 3.46 to 5.92 MB/s (max.) 0.88 to 1.50 MB/s continuous writing (execution) 2.63 to 4.50 MB/s continuous reading (execution) |
| Random seek time (*2) | | 23 ms (typ) | | | | |
| Average latency | | 6.6 ms | | | | 9.3 ms |
| Rotational speed | | 4,558 rpm ±0.1% | | | | 3,214 rpm ±0.1% |
| Heads | | One-head on the positioner | | | | |
| Positioner type | | Linear voice coil motor | | | | |
| Servo tracking method | | ISO continuous servo method | | | | |
| 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 (ATA/ATAPI-4 standard) | | | | |
| Data Transfer Modes | | PIO Mode 4 and Multi-word DMA Mode 2 | | | | |
| Data transfer rate | | PIO Mode 4          16.6 MB/s  Multi-word DMA Mode 2     16.6 MB/s | | | | |
| Data buffer | | 1,844 KB | | | | |
| Error correction (*5) | | Correctable up to 8-byte/interleave Bit error rate: $10^{-12}$ less | | | | |

Table 2.2    Specifications (2 of 4)

[MCE3064AP]

| Item | | Specifications | | | |
|---|---|---|---|---|---|
| Optical disk cartridge | | 128 MB media | 230 MB media | 540 MB media | 640 MB media |
| Total capacity | Unformatted | 181 MB | 325 MB | 819 MB | 818 MB |
| | Formatted | 128 MB | 230 MB | 538 MB | 643 MB |
| Capacity/track | Unformatted | 18,100 bytes | 18,100 bytes (logical track capacity) | 19,450 bytes (logical track capacity) | 43,928 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) |
| Capacity/sector | Unformatted | 725 bytes | | 778 bytes | 2,584 bytes |
| | Formatted | 512 bytes | | 512 bytes | 2048 byte |
| Number of user tracks/side  (*1) | | 10,000 | 17,940 | 42,042 | 18,480 |
| Number of alternate sectors/side | | ≤1,024 | ≤1,025 | ≤2,250 | ≤2,244 |
| Number of sectors/track | | 25 | | 25 | 17 |
| Data transfer rate | | 1.37 MB/s (max.) 0.32 MB/s continuous writing (execution) 0.97 MB/s continuous reading (execution) | 1.65 to 2.65 MB/s (max.) 0.39 to 0.62 MB/s continuous writing (execution) 1.16 to 1.86 MB/s continuous reading (execution) | 2.95 to 4.96 MB/s (max.) 0.64 to 1.08 MB/s continuous writing (execution) 1.92 to 3.26 MB/s continuous reading (execution) | 2.94 to 4.90 MB/s (max.) 0.77 to 1.29 MB/s continuous writing (execution) 2.33 to 3.88 MB/s continuous reading (execution) |
| Random seek time  (*2) | | 23 ms (typ) | | | |
| Average latency | | 6.6 ms | | | |
| Rotational speed | | 4,558 rpm ±0.1% | | | |
| Heads | | One-head on the positioner | | | |
| Positioner type | | Linear voice coil motor | | | |
| Servo tracking method | | ISO continuous servo method | | | |
| 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 | |
| Loading time (*3) | | 7 sec. (typ) | | | |
| Unloading time (*4) | | 4 sec. (typ) | | | |
| Load/unload life | | 20,000 | | | |
| Host interface | | ATAPI (ATA/ATAPI-4 standard) | | | |
| Data Transfer Modes | | PIO Mode 4 and Multi-word DMA Mode 2 | | | |
| Data transfer rate | | PIO Mode 4            16.6 MB/s Multi-word DMA Mode 2    16.6 MB/s | | | |
| Data buffer | | 1,844 KB | | | |
| Error correction  (*5) | | Correctable up to 8-byte/interleave Bit error rate: $10^{-12}$ less | | | |

**Table 2.2    Specifications (3 of 4)**

[MCF3064AP]

| Item | | Specifications | | | |
|---|---|---|---|---|---|
| Optical disk cartridge | | 128 MB media | 230 MB media | 540 MB media | 640 MB media |
| Total capacity | Unformatted | 181 MB | 325 MB | 819 MB | 818 MB |
| | Formatted | 128 MB | 230 MB | 538 MB | 643 MB |
| Capacity/track | Unformatted | 18,100 bytes | 18,100 bytes (logical track capacity) | 19,450 bytes (logical track capacity) | 43,928 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) |
| Capacity/sector | Unformatted | 725 bytes | | 778 bytes | 2,584 bytes |
| | Formatted | 512 bytes | | 512 bytes | 2,048 bytes |
| Number of user tracks/side  (*1) | | 10,000 | 17,940 | 42,042 | 18,480 |
| Number of alternate sectors/side | | ≤1,024 | ≤1,025 | ≤2,250 | ≤2,244 |
| Number of sectors/track | | 25 | | 25 | 17 |
| Data transfer rate | | 1.09 MB/s (max.) 0.256 MB/s continuous writing (execution) 0.768 MB/s continuous reading (execution) | 1.3 to 2.1 MB/s (max.) 0.31 to 0.49 MB/s continuous writing (execution) 0.92 to 1.47 MB/s continuous reading (execution) | 2.33 to 3.92 MB/s (max.) 0.51 to 0.86 MB/s continuous writing (execution) 1.52 to 2.58 MB/s continuous reading (execution) | 2.32 to 3.87 MB/s (max.) 0.61 to 1.02 MB/s continuous writing (execution) 1.84 to 3.07 MB/s continuous reading (execution) |
| Random seek time  (*2) | | 23 ms (typ) | | | |
| Average latency | | 8.3 ms | | | |
| Rotational speed | | 3,600 rpm ±0.1% | | | |
| Heads | | One-head on the positioner | | | |
| Positioner type | | Linear voice coil motor | | | |
| Servo tracking method | | ISO continuous servo method | | | |
| 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 | |
| Loading time (*3) | | 7 sec. (typ) | | | |
| Unloading time (*4) | | 4 sec. (typ) | | | |
| Load/unload life | | 20,000 | | | |
| Host interface | | ATAPI (ATA/ATAPI-4 standard) | | | |
| Data Transfer Modes | | PIO Mode 4 and Multi-word DMA Mode 2 | | | |
| Data transfer rate | | PIO Mode 4                    16.6 MB/s Multi-word DMA Mode 2      16.6 MB/s | | | |
| Data buffer | | 1,844 KB | | | |
| Error correction  (*5) | | Correctable up to 8-byte/interleave Bit error rate: $10^{-12}$ less | | | |

**Table 2.2    Specifications (4 of 4)**

*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 seek and does not include command overhead nor track address recognition time.  Furthermore, it may reach a maximum of 35 ms depending on the quality of media and drive installation environment.

*3  Loading time is the time from when the optical disk cartridge is inserted to when the optical disk drive is ready.

*4  Unloading time is the time from when the eject button is pressed or the eject command is issued to when the optical disk cartridge  is ejected.

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

### 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%,  1.1 A (2.5 A Max.) (*1) <br> Ripple requirement 100mV P-P (DC-1 MHz) | |
| Power consumption | | MCE3130AP | MCE3064AP, MCF3064AP |
| | Ready | 3.9 W (typical) (*2) | 3.9 W (typical) (*2) |
| | Random seek, read/ or write | 5.5 W (typical) (*2) | 5.3 W (typical) (*2) |
| | Power save mode <br> Pre-idle mode <br> Idle mode <br> Standby mode <br> Sleep mode | 3.40 W (typical) (*2) <br> 2.00 W (typical) (*2) <br> 0.65 W (typical) (*2) <br> 0.65 W (typical) (*2) | 3.40 W (typical) (*2) <br> 2.00 W (typical) (*2) <br> 0.65 W (typical) (*2) <br> 0.65 W (typical) (*2) |
| Dimensions (W×D×H) | With panel | 101.6×150.0×25.4 mm | |
| | Without panel | 101.6×148.4×25.4 mm | |
| Weight | | 480 g (with panel) | |
| Environmental requirements | Operating | Temperature:          5 to 45°C (*3) <br>                         (gradient 15°C /h or less) <br> Relative humidity:  10 to 85% (Noncondensing) <br> Max. wet bulb temperature:    29°C or lower | |
| | Idle | Temperature:          0 to 50°C <br> Relative humidity:  10 to 85% (Noncondensing) <br> Max. wet bulb temperature:    36°C or lower | |
| | Transport | Temperature:    –40 to 60°C (24 hours or less) <br> Temperature:    –20 to 60°C (24 hours or more) <br> Relative humidity:  5 to 90% (Noncondensing) <br> Max. wet bulb temperature:    41°C or lower <br> Requirement:  Packing conditions specified by Fujitsu | |
| Installation | Tilt angle | –5° to +10° (*3) | |
| Vibration/ shock | Operating | 3.92 $m/s^2$ (0.4 G [5 to 500 Hz, sine sweep]) <br> Shock 19.6 $m/s^2$ (2 G [10ms, half-sine pulse]) | |
| | Idle <br> No cartridge, power ON | 9.8 $m/s^2$ (1.0 G [5 to 500 Hz, sine sweep]) <br> 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]) <br> Requirement:  Packing conditions specified by Fujitsu | |

**Table 2.3 Environmental and power requirements (2 of 2)**

| | Item | Specification |
|---|---|---|
| Altitude | Operating | 3,000 m (10,000 ft) or less |
| | Idle | 12,000 m (40,000 ft) or less |
| Ambient for purity | Air flow | Unused (*4) |
| | Air purity | General office environment or better (dust perticles: Class 5 millions or less) |

**Note:**

1.   Current limiter value for +5 VDC power:  5 A or less

2.   Specifications under transporting condition are under the packaging specified by Fujitsu.

3.   A voltage drop may occur depending on the used power supply or power cable.

*1 At random seek or read/write.  Excluding pulse waveform under 500 μs or less.
*2 It demonstrates a power of 5.3 W in an installation environment of a temperature of 25°C, voltage of 5 V.
*3 The efficiency is specified in an environment of a temperature of 25°C and 0° horizontal level placement.
*4 For details, refer to section 3.1.3 'Air Flow'

## 2.1.4  Error rate

Data blocks to be accessed are 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 cartridge 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. Failure due to disk errors is not included.

Conditions
- Power-on time: 200 hours/month or less
- LD-on time: 20% or less of power-on time
- Environment Temp.: 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 power is applied.

2) Device failures indicate that devices require repair, readjustment, or replacement. Failure due to external factors such as minor defects during device handling, operation outside environmental specifications, power failure, host system errors, and interface cable errors are not included.

(2) Service Life

Under appropriate handling and operation, disk cleaning and optical head cleaning, overhaul of the drive is not required for the first five years.

(3) Data security at power failure

Except for the data of the block to which write operation is in progress, all data on the disk is secure from power failure. This does not apply if power failure occurs during disk initialization (formatting) or defect processing (alternate block allocation).

## 2.2    Optical Disk Cartridge Specifications

### 2.2.1    Recommended optical disk cartridge specifications

Specifications comply with the ISO/IEC 10090 standard for 128 MB disk, ISO/IEC 13963 standard for 230 MB disk, and ISO/IEC 15041 standard for 540 MB disk, and 640 MB disk.  The following three disk types comply with the specifications.

Table 2.4 shows the specifications of the optical disk cartridge recommended for this optical disk drive.  The use of another disk cartridge may lower drive performance.

**Table 2.4    Recommended optical disk cartridge specifications**

| Model | Order number |
|---|---|
| Optical disk cartridge (128 MB) | CA90002-C010 |
| Optical disk cartridge (230 MB) | CA90002-C011 |
| Optical disk cartridge (540 MB) | CA90002-C012 |
| Optical disk cartridge (640 MB) | CA90002-C013 |
| Optical disk cartridge (1.3 GB) | CA90002-C015 |
| Overwrite optical disk cartridge (230 MB) | CA90002-C041 |
| Overwrite optical disk cartridge (540 MB) | CA90002-C042 |
| Overwrite optical disk cartridge (640 MB) | CA90002-C043 |

### 2.2.2 Optical disk cartridge

Figure 2.1 shows an optical disk cartridge. The figure below shows the cartridge with its shutter open.

- Shutter closed
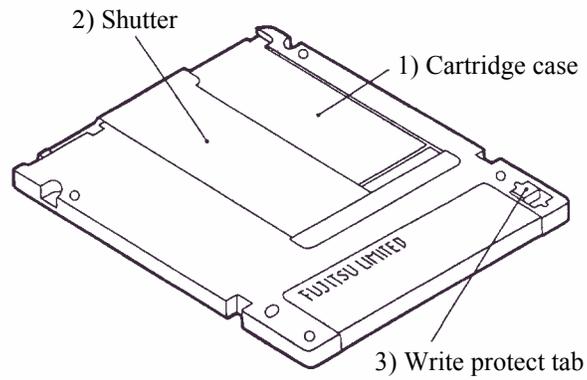


- Shutter open
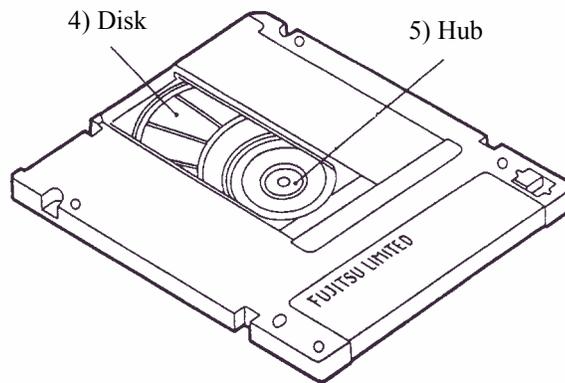


**Figure 2.1     Optical disk cartridge**

The following explains the components of the optical disk drive shown in Figure 2.1:

1)  Cartridge case

    Covers the disk to protect it from damage when handled and facilitates disk replacement. The cartridge case is labeled and has a write protect tab.

2)  Shutter

    Protects the disk against dust.  When the cartridge is inserted into the optical disk drive, the shutter (metallic door) is opened.

3)  Write protect tab

    The write protect tab selects whether write is enabled or disabled.

4)  Disk

    Holds information which can be read by an optical beam.

5)  Hub

    The hub is placed at the center of the disk and is linked to the spindle of the drive.  The hub is used for radial centering and axial positioning.

### 2.2.3 Disk specifications

(1) 128 MB disk

The ISO/IEC10090 defines 128 MB disk specification.

(2) 230 MB disk

The ISO/IEC13963 defines 230 MB disk specification.

(3) 540 MB/640 MB disk

The ISO/IEC15041 defines 540 MB/640 MB disk specification.

(4) 1.3 GB disk

The Cherry Book version 1.0 defines 1.3 GB disk specification.

Table 2.5 lists disk specifications.

**Table 2.5　Disk specifications**

| Item | | Specification |
|---|---|---|
| Reliability | Read cycle | >$10^8$ |
| | Erase/write/read cycle | >$10^6$ |
| | Load/unload cycle | 2,5000 |
| | Archival life (according to acceleration test results) | >10 years (*1) |
| | Shelf life (according to 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 is the period in which recorded information can be read.
*2　Shelf life is the period in which information to be recorded can be written.
*3　Maximum wet bulb temperature = 29°C.

**Note:**

Non-recommended disks must be checked for compatibility.

## 2.3 Defect Management

### 2.3.1 Defect management schematic diagram

Defective sectors on the disk shall be replaced by good sectors according to the defect management scheme as follows: Defective sectors found during surface certification are handled by a sector slipping algorithm. Defective sectors found after initialization are handled by a linear replacement algorithm.

Figure 2.2 shows the algorithms for alternate processing.
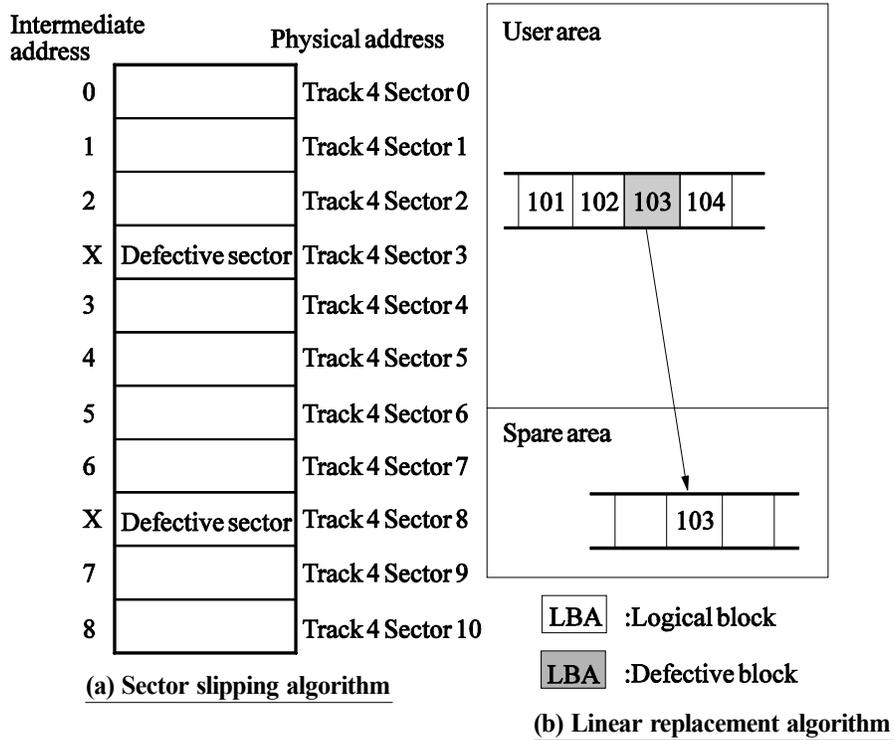


**Figure 2.2    Algorithms for alternate processing**

The user area is divided into several groups during media initialization. Each group contains data sectors and spare sectors. Spare sectors are used as replacements for defective data sectors. Media initialization can include a certification of the user area.

Figure 2.3 shows an example of alternate processing.

Logical block address    Intermediate address    Physical address
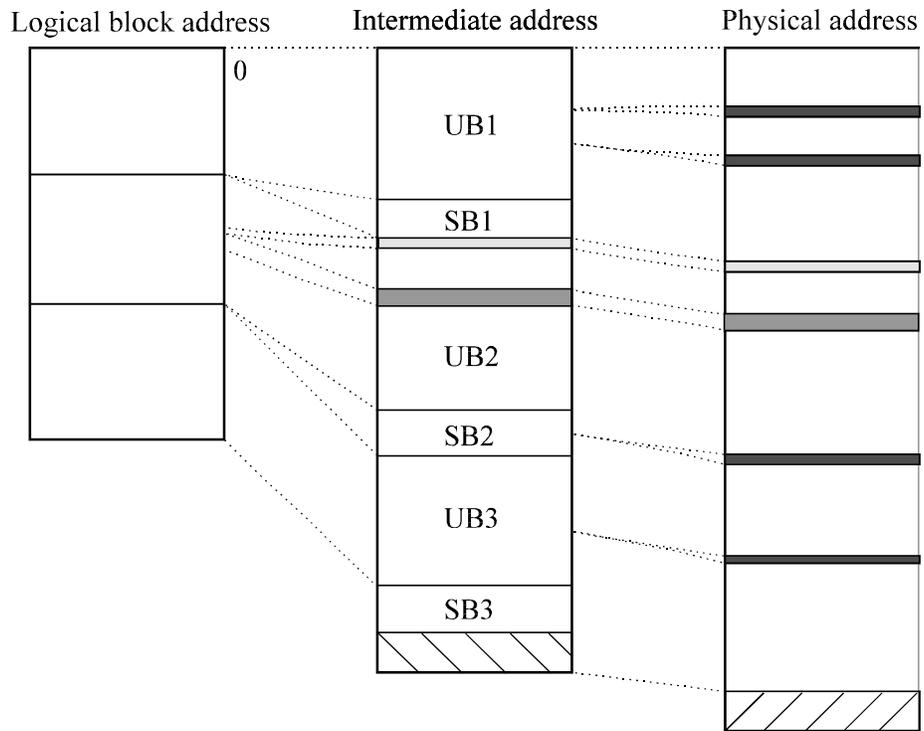
SB: Spare band
UB: User band

▭ Sector resigned by the linear replacement algorithm

▬ Defective sector detected
by the linear replacement algorithm

▬ Defective sector detected by the sector slipping algorithm

▨ Slipping area
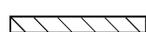
▨ Unused area

**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 environment in which these drives are installed must comply with the ambient environmental requirements defined in Subsection 2.1.3.

### 3.1.1　Temperature measurement point

When a drive is operating, the ambient temperature measured 3 cm from the base surface of the optical disk drive and the PCA unit surface must satisfy the environmental requirements specified in Subsection 2.1.3.  For the temperature of each surface during operation, the contact temperature at each measurement point shown in Figure 3.1 must satisfy the requirements specified in Subsection 3.1.2.

**⚠CAUTION**

*Low temperature burns*
*The surface temperatures of some ICs on the printed circuit board unit*
*in the optical disk drive exceed 55°C while operating.  Be careful of*
*low tenperature burns.*

(a) Inside optical disk cartridge



Operating of inner
partition wall

Tip of thermocouple

Hole for inserting thermocouple

(b) IC (controller, read map)
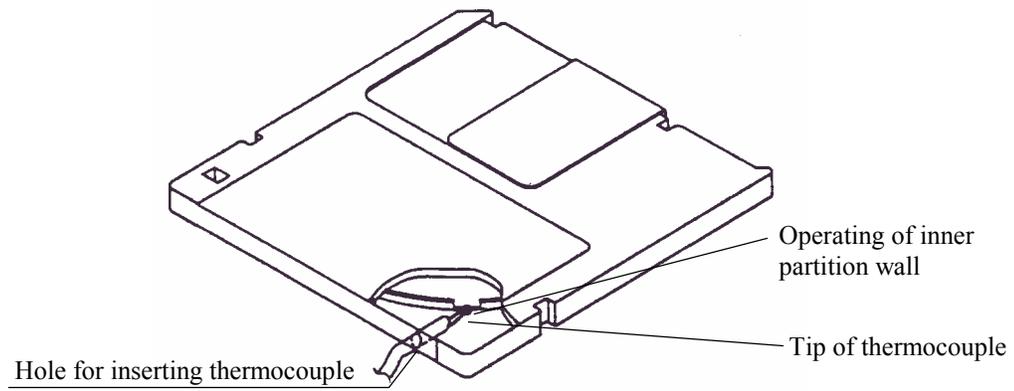


IC (controller)

IC (read amp)
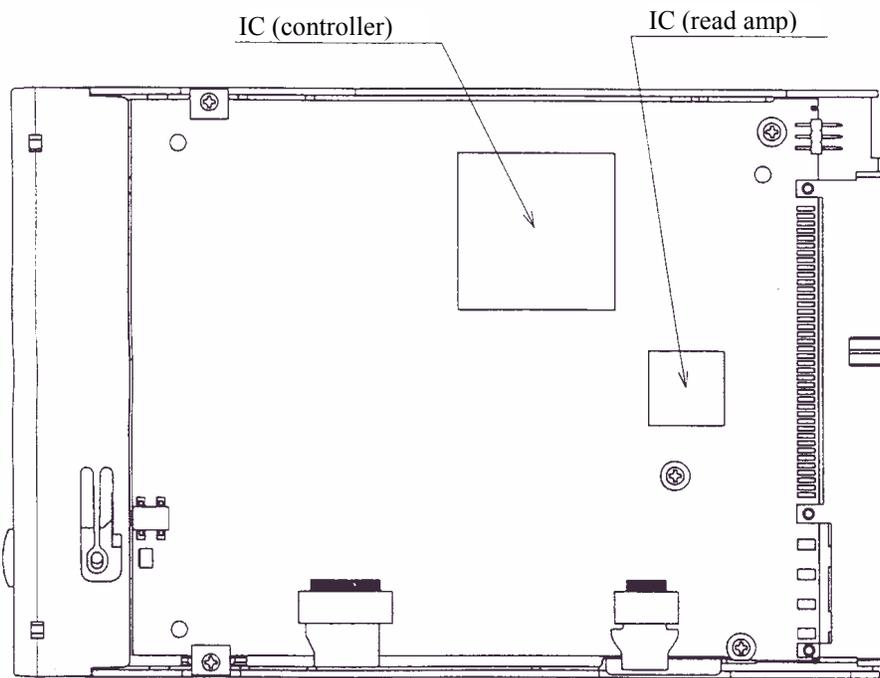
**Figure 3.1    Surface temperature measurement points**

### 3.1.2 Temperature requirements and measuring method

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

**Table 3.1    Temperature requirements at measurement points**

| Measurement point | Maximum surface temperature |
|---|---|
| Cartridge inside | 55°C (*) |
| IC (controller) surface | 95 °C |
| IC (read amp.) surface | 85 °C |

Note: *  60°C for the optical disk cartridge (1.3 GB excluded) manufactured by Fujitsu.

Following procedure is for temperature measurement of inside cartridge.

1) Make a hole for the thermocouple as shown in Figure 3.1.

2) Disassemble the cartridge disk.

3) Cut off a part of the partition wall for the optical media as shown in Figure 3.1.  (Cut off width: 5 to 10 mm)

4) Fix the tip of the thermocouple to the cut portion of partition wall with an adhesive agent.

5) Pass the thermocouple through the hole at the cartridge case and assemble the cartridge disk. When there is a gap between the hole and the thermocouple, fill the gap with the adhesive agent.

**Note:**

The surface of the cartridge shown in Figure 3.1 has been cut away to make the elements inside the case clearly visible.  In reality the surface is not cut away.

If the external environment temperature is higher than the specified value, the device will automatically take an interval to respond to command, and then take protective action to respond to the temperature increase.

### 3.1.3    Air flow

It is recommended that this optical disk drive be installed in a fanless cabinet. However, if the power supply is incorporated into the same cabinet, it is necessary that it satisfy the "Temperature Conditions" in 3.1.2 and that the air flow rate being drawn in by the device) at the cartridge loading slot be 0.02 m$^3$/min, 0.3 m/s or lower.  Furthermore, if there is a system fan in a system where this drive is being installed, the same conditions must be met.

**Note:**

Air flow temperature is 40°C and below.

### 3.1.4 Temperature rise under several conditions

**Table 3.2 Temperature at each measuring point (Reference)**

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

| Measurement point | Ready | Random seek | Criteria |
|---|---|---|---|
| Inside cartridge | 49°C | 54°C | 55°C |
| IC (controller) surface | 50°C | 70°C | 95°C |
| IC (read amp.) surface | 48°C | 70°C | 85°C |
| Thermal sensor | 47°C | 55°C | — |

**Notes:**

1. The above data are data measured in a constant temperature chamber in which the temperature surrounding the equipment was kept at 45°C. They are not the same as the data obtained from measurements using the exclusive box in which the equipment is normally used.

2. When using the box, the ambient temperature around the equipment will differ depending on the air circulation conditions of the box, and the temperature rise inside the cartridge will differ because of this, so please exercise caution.

### 3.1.5 Air purity

Air purity in the device environment is expressed by the number of dust particles per unit area and must be class 5 millions (equivalent to 0.15 mg/m$^3$) or less.  (Class 500 millions:  500 millions dust particles of 0.5 μm dia. or larger per cubic foot)

## 3.2 Mounting Requirements

### 3.2.1 External dimensions

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



Unit: mm

Note: The height length is 25.4 ± 0.8 besides the panel size.

**Figure 3.2　Dimensions**
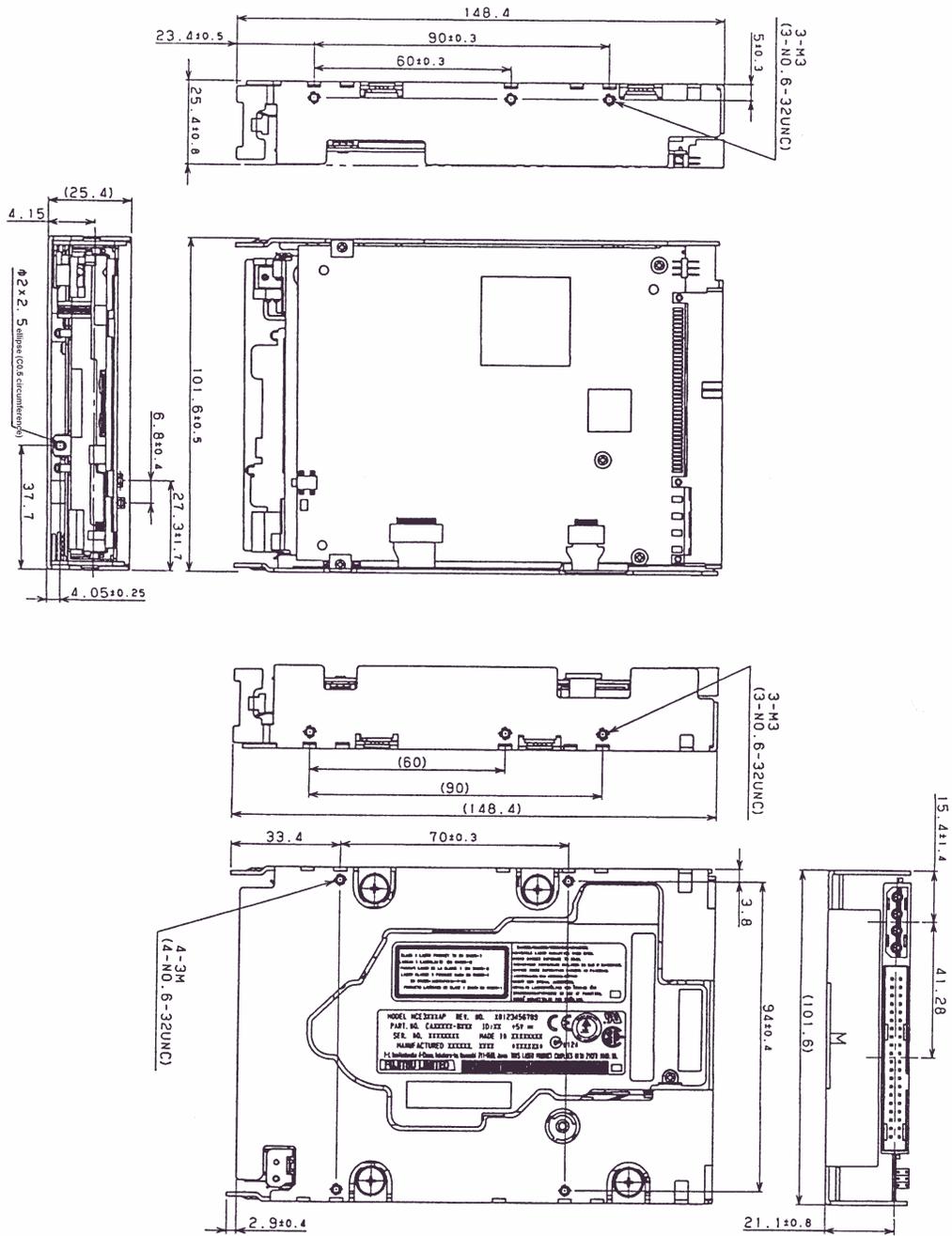
Unit: mm

Note: Those enclosed in parentheses are inch screws.

**Figure 3.3     Dimensions (without panel)**

### 3.2.2 Installation direction

Figure 3.4 shows the permissible installation directions for this drive. The mounting angle tolerance must be within −5° to 10° from the horizontal. (−) shows that the insertion faces below.
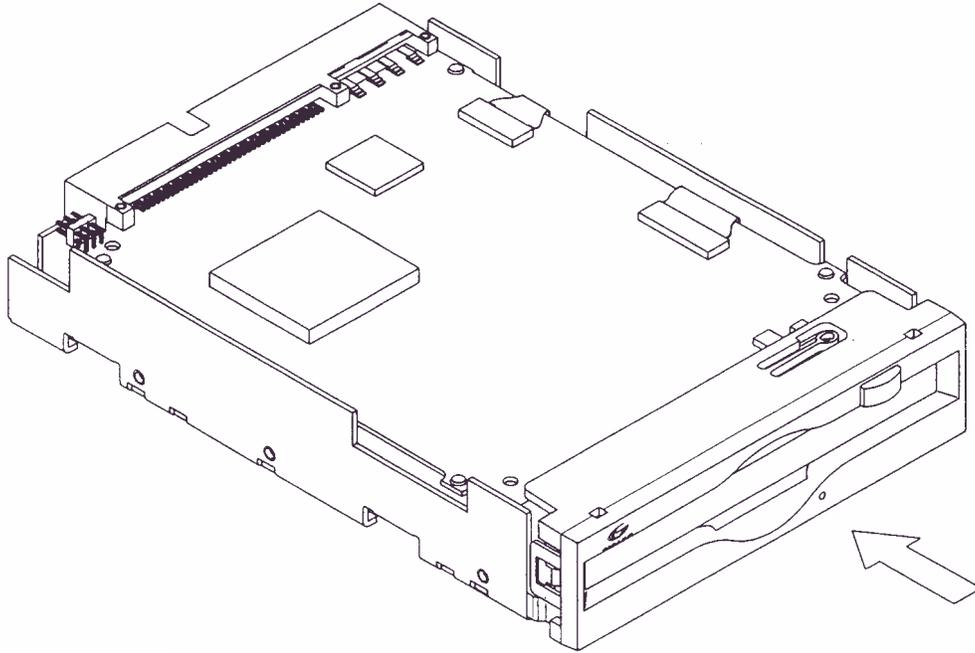


- Horizontal
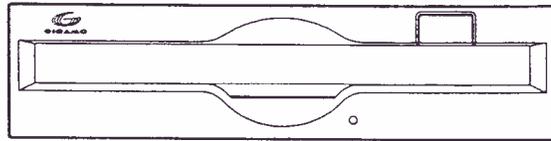


- Vertical
  (Two orientations)
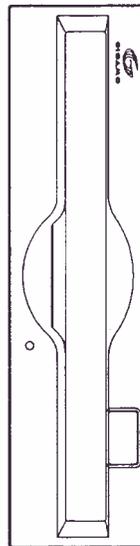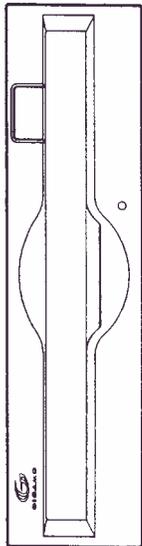


**Figure 3.4    Installation directions**

### 3.2.3    Centers of gravity

Figure 3.5 shows the centers of gravity of the drive.



Unit:  mm
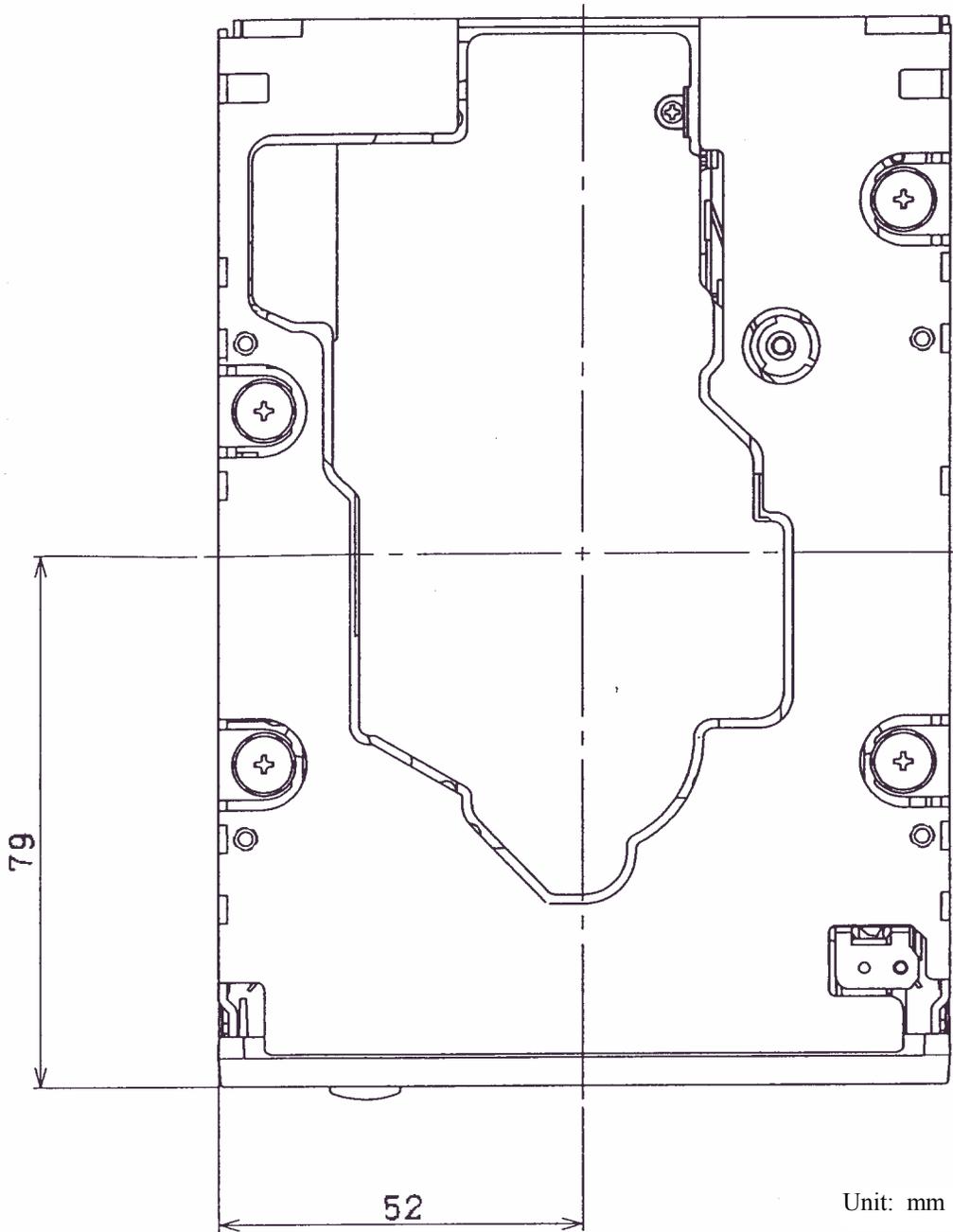
**Figure 3.5      Centers of gravity**

### 3.2.4    Notes on mounting

(1)    Mounting frame structure and clearance

    a)    For vibration resistance and heat dissipation, this optical disk drive uses an embossed structure as shown in Figure 3.6, as well as a frame which has a construction similar to other frames which perform the same function.

    b)    As shown in Figure 3.6, the inward projection of the mounting screw from the outer surface of the drive frame must not exceed 3 mm.

    c)    The clearance between the external surface of the drive frame and the user's frame structure must be at least 1.5 mm.

    d)    The clearance between the top and bottom surfaces and the user's frame structure must be at least 1.5 mm.

    e)    When mounting the optical disk drive, the screw tightening torque should be 0.4 to 0.45Nm (4 to 4.6kgcm).

    f)    When the optical disk drive (with panel) is mounted in a locker, there should be no deformation of the mounting fittings provided and the optical disk drive's panel should not be deformed. If the drive is used with the panel deformed, ejection of the cartridge will be faulty. Check if the door will close from any position whatever when the optical disk drive is installed.



If  a side surface mounted.

If  a buttom surface mounted.
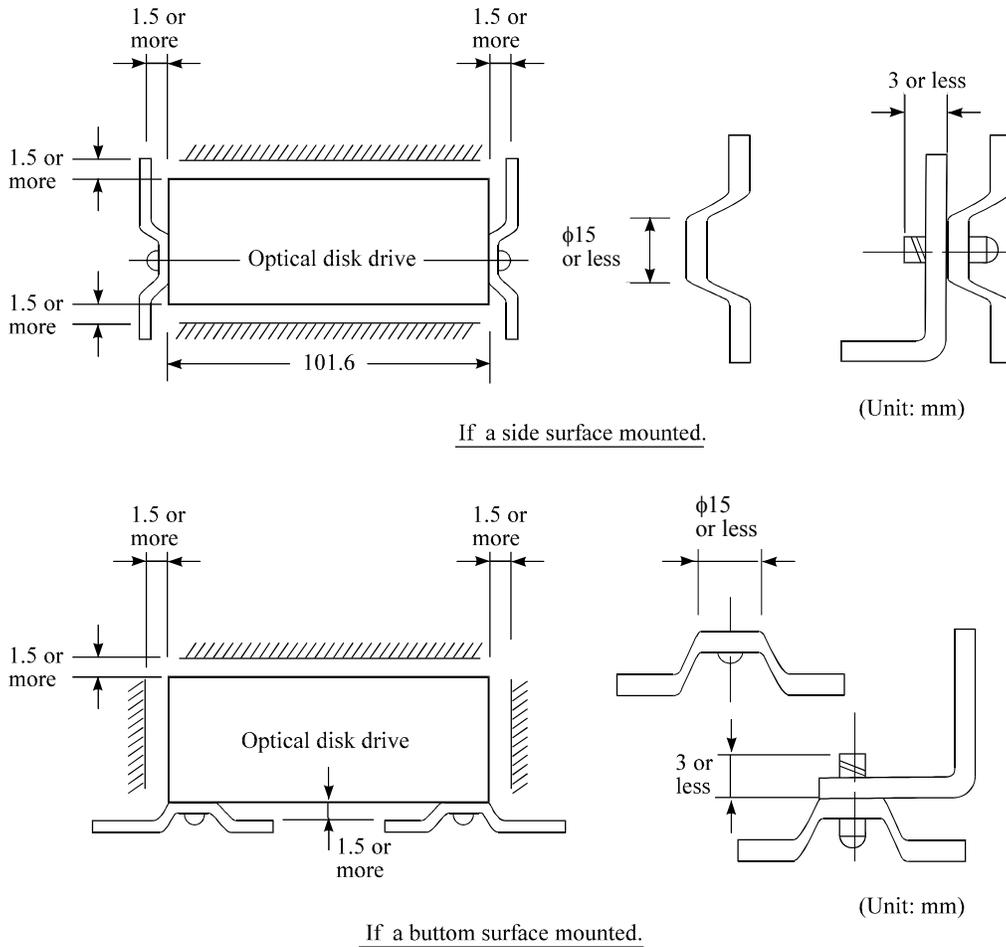
**Figure 3.6    Mounting frame structure**

(2)    Panel function processing

When installed in a cabinet, do not change the panel formal.  The processing is installation status and the disk insertion door can be closed from any locations.

(3)    Service clearance

Figure 3.7 shows locations which must be accessed for installation and maintenance.  Be sure to leave sufficient service clearance.

P side
●   Cable connection



R side
●     Mounting screw hole

Q side
●    Mounting screw hole
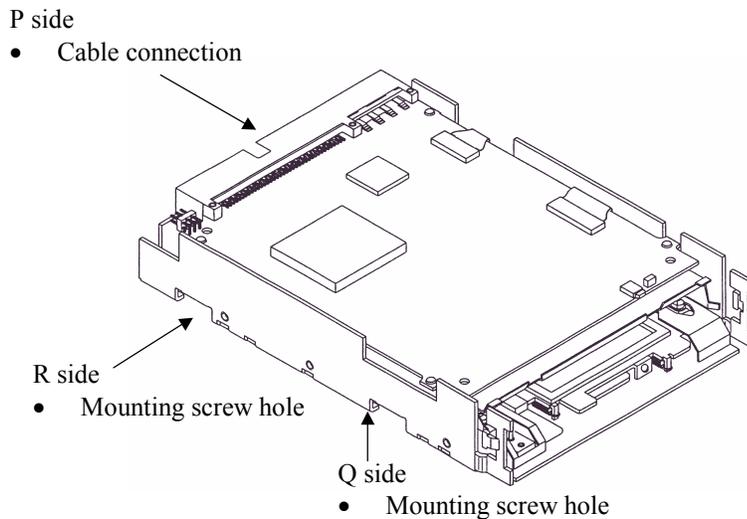
**Figure 3.7    Service clearance**

(4)    External magnetic fields

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

(5)    Leak magnetic field

The VCM drive magnetic circuit may leak the magnetic field (Maximum 25 Gauss at distance of 4 mm from the drive).

## IMPORTANT

*Do not place a device 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

The optical disk drive should be grounded to the signal ground (SG) of the power supply of the system.  This SG line should be supplied with the system.

The Frame Ground is shorted in the optical disk drive by a metal strip attached to the vibration isolation rubber between the frame (FG) and the base (SG).


## IMPORTANT

*When mounting the optical disk drive in the Device Bay 120mm (5 inch) of the PC chassis, there are two ways of choosing frames the metal frame and the plastic (nonconductive material) frame.*
*When using a plastic frame, there is not a short circuit between FG of PC and FG of the optical disk drive.  As a result, the static electricity tolerance decreases compared with metal frame.*
*It is recommended to use a metal frame to enhance the static electricity prevention.*


**3.3    Power Supply Requirements**

(1)    Allowable input voltage and current

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


(2)    Current waveform (reference)

Figure 3.8 shows the +5 VDC waveform at start of spindle motor rotation.
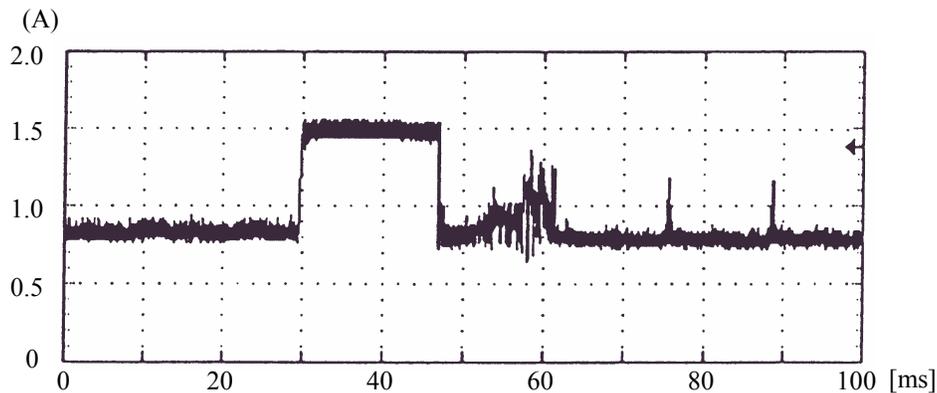


**Figure 3.8    Current waveform (+5 VDC)**

## 3.4    Cable Connections

### 3.4.1    Drive connectors

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

- AT interface connector (40-pin) and power supply connector (4-pin)
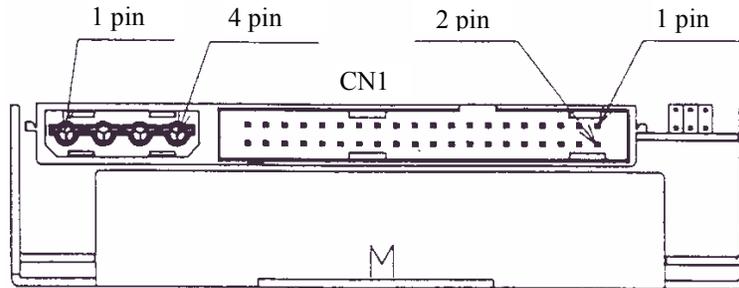


**Figure 3.9    Connector and terminal locations**

Power supply connector

| 1 | +12 VDC or not connected |
|---|---|
| 2 | +12 VDC RETURN (GND) or not connected |
| 3 | +5 VDC RETURN (GND) |
| 4 | +5 VDC |

### 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-pin) | Cable socket (Close 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

*The host interface cable must be a flat cable in terms of its overall length.  (Do not use a cable with a flat crimp terminal and loose lines or twisted pairs.)*

### 3.4.3 Drive connection

Figure 3.10 is a diagram showing cable connections between equipment.
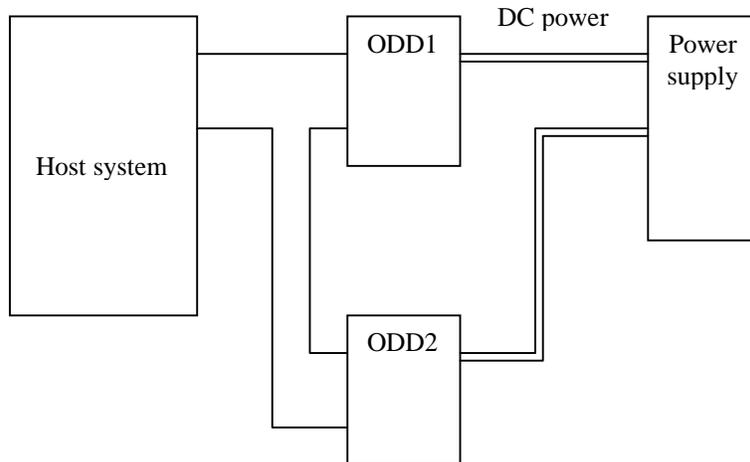


**Figure 3.10   Cable connection diagram**

## 3.5    Jumper Settings

### 3.5.1    Jumper settings at factory shipping

Figure 3.11 shows jumper settings at factory shipping.

CNH5



5-6 short-circuited:  Sets the master device.
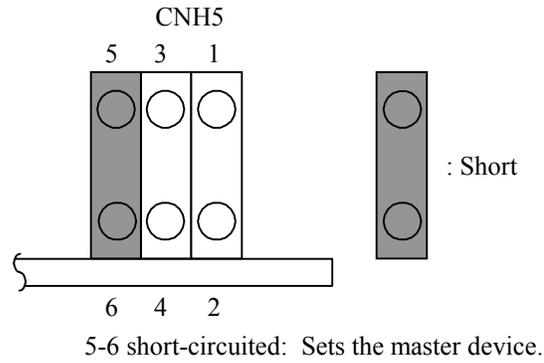
**Figure 3.11    Jumper settings at factory shipping**

### 3.5.2    Mode setting

(1)    Setting master device mode

Figure 3.12 shows the setting for recognizing the master device (device 0).

CNH5
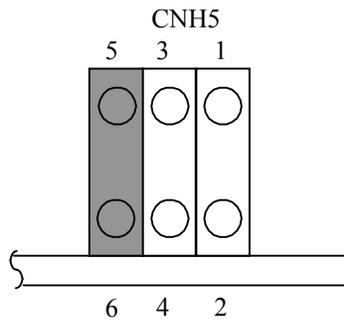


**Figure 3.12    Master device setting**

(2)     Setting slave device mode

Figure 3.13 shows the setting for recognizing the slave device (device 1).

CNH5
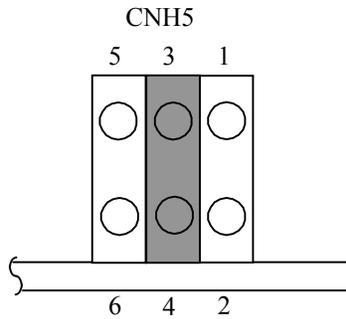
Figure 3.13   Slave device setting

(3)     Setting cable select mode

Figure 1.14 shows the master device/slave device setting when the CSEL signal is connected to the interface.  In the example shown in Figure 3.16, this setting requires a special interface connection.

CNH5
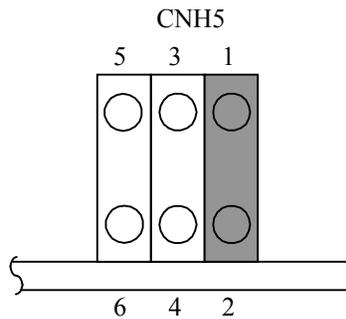
Figure 3.14  Cable select mode setting

Figure 3.15 shows a cable select example using a special interface cable.

This example connects CSEL of the master device to the CSEL line (conductor) of the cable, then grounds it so that the drive recognizes that it is the master.  At this time, the CSEL conductor of the slave device is removed and cannot be connected to CSEL of the cable, so that the drive recognizes that it is the slave.
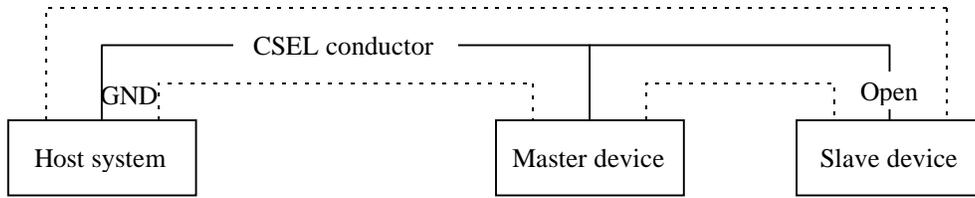
Example ①
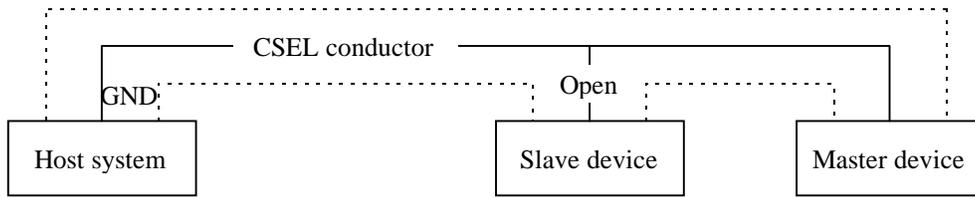


Example ②

**Figure 3.15   Cable select examples**

**3.6      Notes on Drive Handling**

(1)      General notes

Note the following points to maintain drive performance and reliability:

**⚠ CAUTION**

*Device damage*
*1)      Shock or vibration applied to the drive that exceeds the values defined in the standard damage the drive.  Use care when unpacking.*

*2)      Do not leave the drive in dirty or contaminated environments.*

*3)      Since static discharge may destroy the CMOS devices in the drive, pay attention to the following points after unpacking:*

   *•      Use an antistatic mat and wrist strap when handling the drive.*

   *•      Hold the mounting frame  when handling the drive.  Do not touch the PCA except when setting the switches.*

*4)      When handling the drive, hold both sides of the mounting frame. When touching other than both sides of the mounting frame, avoid putting force.*

*5)      Do not forcibly push up the end of the header pin of the printed circuit board unit when handling or setting the drive.*

(2)      Unpackaging

a)      Make sure that the UP label on the package is pointing upward and start unpacking on a level surface.  Handle the drive on a soft surface such as a rubber mat, not on a hard surface such as a desk.

b)      Use care to avoid exerting excessive pressure on the unit when removing the cushions.

c)      Use care to avoid exerting excessive pressure on the PCA surface and interface connectors when removing the drive from the antistatic bag.

d)      If the temperature difference between installation locations is 10 degrees or more, leave the drive in the new location for at least two hours before unpackaging it.

(3)  Installation

   a)  Do not connect or disconnect the connectors or change the terminal settings when the power is on.

   b)  Do not move the drive with the power on.

   c)  Eject the optical disk cartridge, lock the carriage securing the head, turn off the power, then move the drive.

⚠**CAUTION**

*Device damage*
*Be sure to turn on the power supply before inserting your cartridge for the first time.  It releases the device from transport protection and enables you to insert the cartridge.*
*The device may be damaged if you insert the cartridge without releasing the protection.  From the next time, you don't need to turn on the power supply beforehand.*
*Before moving the drive, remove the optical disk cartridge. 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 and reading the data may fail.*

(4)  Packaging

   a)  Before packaging, remove the optical cartridge.

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

   c)  Use the same cushions and packaging supplied with the drive.  If they are not available, ensure that adequate shock absorbent material is used. In this case, some method of protecting the PCA surface and interface connectors must be used.

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

Figure 3.16 shows the individual packaging style and Figure 3.17 shows the gathered packaging style.  (The form and material of the cushion may be changed.)

Desiccant
Conductive bag
Use a sealing tape
MCE3130AP,
MCE3064AP, MCF3064AP
Eject pin (Use a sealing tape)
Support (Front, Rear)
Support (Middle)
Shipping Label (2)
box
Master carton
(12/24 units)
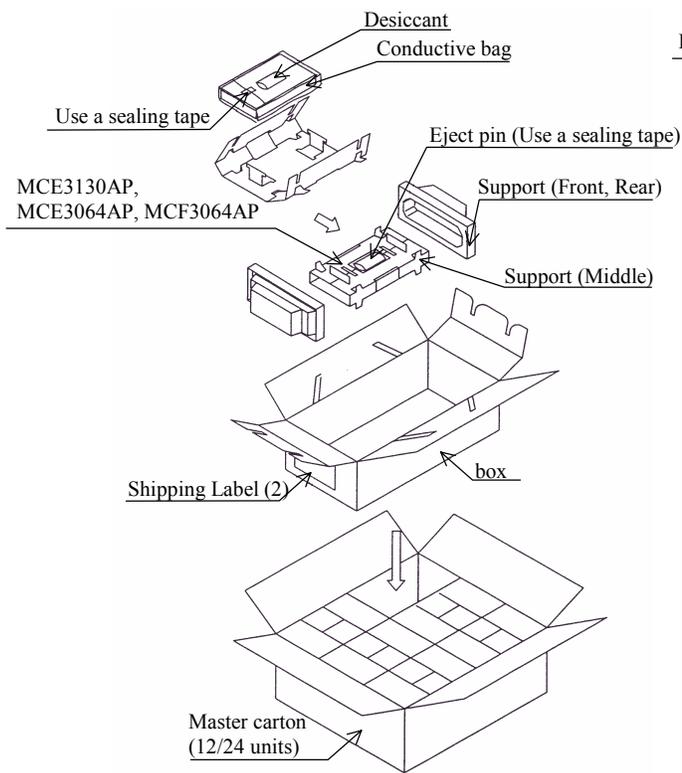
**Figure 3.16   Individual packaging style**

Eject Pin (× 20)
Desiccant
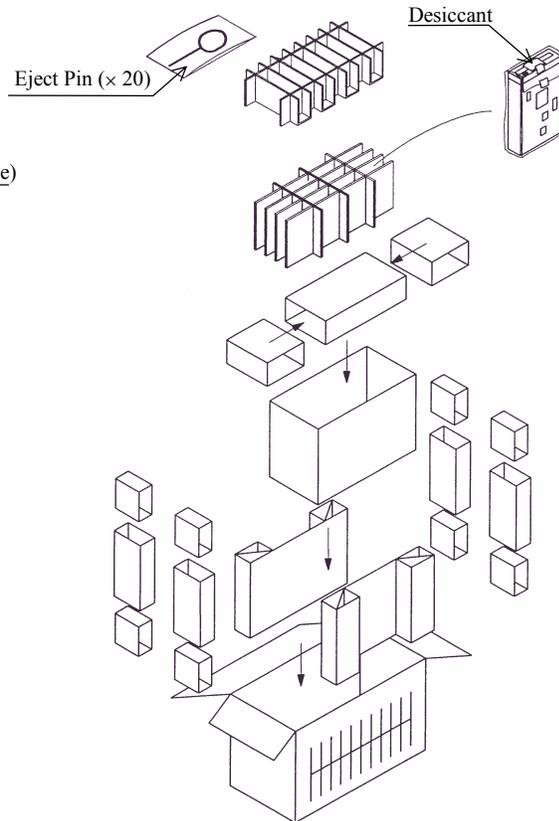
**Figure 3.17   Gathered packaging style**

(5)   Transportation

a)   Transport the package with the UP sign upward.

b)   After unpacking, minimize the transportation distance and use cushions to avoid shock and vibration.   Transport the drive in one of the orientations described in Subsection 3.2.2 after unpacking.   (The horizontal direction is recommended.)

(6)   Storage

a)   Use moistureproof packaging when storing the drive.

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

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

### 3.7 Mounting

### 3.7.1 Checks before mounting the drive

Before mounting the optical disk drive in the system cabinet, check whether the jumper settings are set correctly.

### 3.7.2 Mounting procedure

How the drive is mounted depends on the system cabinet structure. Determine the mounting procedure in consideration of the requirements of each system. This section contains the general mounting procedure and check items.

See Section 3.2 for details on mounting 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 using the four mounting holes on both sides or the bottom.
- Use mounting screws whose lengths are 3 mm or less from the external wall of the mounting frame of the drive when they are tightened. (See Figure 3.6)
- When mounting with screws, the screw tightening torque should be 0.4 to 0.45Nm (4 to 4.6kgfcm).
- Be careful not to damage the parts on the PCA when mounting the drive.

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

### 3.8 Cable Connections

Use the following cables to connect the drive to the system. See Subsection 3.4.2 for details on the connector positions and cable requirements.

- Power supply cable
- AT interface cable
- DC ground cable (if required)

The general procedure for cable connection and notes on connecting cables are given below. Pay attention to the insertion direction of each cable connector.

**⚠CAUTION**

1) *Make sure that the system power is off.*

2) *Do not connect or disconnect any cable when the power is on.*

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

2) Connect the power cables.

3) Connect the AT interface cable.

4) After each cable connector is connected, secure the cable so that the cable does not touch the drive or the parts on the PCA or obstruct the flow of cooling air in the system cabinet.

## 3.9 Operation Confirmation and Preparation for Use after Installation

### 3.9.1 Confirming initial operations

This section provides the operation check procedures after the power is turned on.

(1) Initial operation when the power is turned on

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

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

- In case of not inserted the cartridge, when the power is turned on, the eject motor automatically turns once.

(2) Checks if errors occur at initial self-diagnosis

- Make sure that the cables are connected correctly.

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

- Make sure that the settings of all terminals are correct.

- If the LED on the front panel blinks continuously, an error was detected during initial self-diagnosis.  In this case, issue the REQUEST SENSE command from the initiator (host system) to obtain sense data for error analysis.

## IMPORTANT

*The BUSY LED is on while the optical disk drive is executing seek, write, or read operations.  The BUSY LED is on momentarily, so it seems as if it blinked or is off.*

*The eject motor turns once when the power is turned on so that in case the spindle motor position deviates due to shocks received by the drive during transport the position is corrected to allow the cartridge to be inserted normally. If the cartridge fails to be inserted, remove the cartridge and turn on the drive power to turn the eject motor once and reinsert the cartridge.*

### 3.9.2 Connection check

When initial operation check terminates normally after the power is turned on, check whether the drive is correctly connected by issuing command from the host system. Checking procedure depends on the host system configuration.

If processing terminates abnormally:

a) If sense data has been obtained by the REQUEST SENSE command, analyze the sense data. If the error is recoverable, retry the processing.

b) Check the following items for AT interface cable connection:

- All connectors, including other devices, are connected correctly.
- Make sure the correct cable is being used (whether it corresponds with the cable selection mode).

c) Make sure again that the jumper settings are correct.

### 3.10 Dismounting Drive

How to demount an optical disk drive (for setting terminal checking, setting change, or device replacement) depends on the system cabinet configuration. Determine the demounting procedure in consideration of the requirements of each system. This section describes the general demounting procedure and notes on demounting drives.

**⚠CAUTION**

*Device damage*
*Before demounting the optical disk drive, turn off the system power.*
*Do not remove screws securing the cables and drive when the power is on.*

1) Remove the power cable.

2) Remove the AT interface cable.

3) Remove the DC ground cable.

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

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

# CHAPTER 4    HOST INTERFACE

The differences in host interface specifications between the MCE3130AP, MCE3064AP and MCF3064AP are shown in Table 4.1, Differences in Host Interface Specifications of Each Model. In this chapter, even if there are no special explanatory notes in the text, please refer to this table to make the appropriate substitutions for each model.

**Table 4.1    Differences in Host Interface Specifications of Each Model**

| Support Item | MCE3130AP | MCE3064AP/ MCF3064AP |
|---|---|---|
| Media Capacity | 128MB to 1.3GB | 128MB to 640MB |
| Host Interface | • PIO<br>• Multiword DMA | • PIO<br>• Multiword DMA |

## 4.1 Pin Assignment

The table below lists pin assignments of the interface connector.

**Table 4.2    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 | 23 | DIOW- |
| Ground | 24 | Ground |
| I/O Read | 25 | DIOR- |
| Ground | 26 | Ground |
| I/O Ready | 27 | IORDY |
| Cable Select | 28 | CSEL |

**Table 4.2    Connector pin assignments (2/2)**

| Description | PIN | Signal name |
|---|---|---|
| DMA Acknowledge | 29 | DMACK- |
| Gound | 30 | Ground |
| Interrupt Request | 31 | INTRQ |
| 16 Bit I/O | 32 | IOCS16- |
| Device Address Bit 1 | 33 | DA1 |
| PASSED DIAGNOSTICS | 34 | PDIAG- |
| 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 4.3 Signal description**

| 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- | I | Write strobe signal. |
| 25 | DIOR- | I | Read strobe signal |
| 27 | IORDY | 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. |
| 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 |
| 37 | CS0- | O | Select signal used to select the command block register |
| 38 | SC1- | 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 4.4    I/O port functions and mapping**

| \<td colspan=5\> 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 | Device 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 4.5    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 4.39.

#### 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 4.6    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 4.7    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 4.8    Bit definitions of ATAPI Byte Count register**

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
|---|---|---|---|---|---|---|---|---|
| Byte Count (Bits 0-7) | | | | | | | | R/W |
| Byte Count (Bits 8-15) | | | | | | | | 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 4.9    Bit definitions of ATAPI Block Device Select register**

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

- Bits 7, 6, 5, and 3 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.

- LUN (Logical Unit Number) is not supported.  The ODD ignores all values in these bits.

#### 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 4.10   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 4.96.

- 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 4.11   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 ignored.

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

### 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 4.12   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 | IO | CoD | Read |

- A value of 1 in RELEASE indicates that the ODD released the ATA bus before completion of the current command.

- IO indicates the direction of data transfer.  See Table 4.13.

- CoD indicates the type of transfer.  See Table 4.13.

**Table 4.13 IO and Cod**

| IO | CoD | 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 4.14   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 SERVICE, set the same value as that of DRDY. The SERVICE 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 reset (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 reset, the ODD initializes the task file as shown below.

    Status = X'00'
    Error = (Depending on the SRST sequence)
    Sector Count = X'01'
    Sector number = X'01'
    Cylinder Low = X'14'
    Cylinder High = X'EB'
    Drive/Head = X'00'

  - RDBY is set to 1 with the first command after ATA reset.

  - If ATA 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 the GIGAMO 90 mm Magneto-optical Disk System - System Description standard for 1.3 GB . 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.

Table 4.15 lists criteria used to execute alternate sector assignment.

**Table 4.15   Alternate sector assignment criteria**

| Process | Alternate sector assignment criteria | Remarks |
| --- | --- | --- |
| ID read error | 128 MB/230 MB media:<br>  3 read errors in 3 sectors<br>540 MB/640 MB/1.3 GB media:<br>  2 read errors in 2 sectors | - |
| Data error | Error in five bytes or more per interleaving | Not checked if verify check is disabled. (Except ERASE command) |

### 4.4.4 Data error detection criteria

Table 4.16 lists criteria used to detect ID errors and data errors for data access commands and error handling.

**Table 4.16  ID error and read error detection criteria and error handling**

| Command | ID read error | Data error | Error handling |
|---|---|---|---|
| FORMAT UNIT | 128 MB/230 MB media:<br>  3 read errors in 3 sectors<br>540 MB/640 MB/1.3 GB media:<br>  2 read errors in 2 sectors | Error in 4 bytes or more per interleaving section | Register error sectors in the PDL (Primary Defect List).  If there are many defect sectors, they are also registered in the SDL (Secondary Defect List). |
| WRITE (10)<br>WRITE (12)<br>WRITE AND VERIFY and ERASE | 128 MB/230 MB media:<br>  3 read errors in 3 sectors<br>540 MB/640 MB/1.3 GB media:<br>  2 read errors in 2 sectors | Error in 5 bytes or more per interleaving (Except ERASE command) | Register error sectors in SDL. |
| READ (10)<br>READ (12) | Error free (If no ID can be read, reassignment is executed.) | Error in 9 bytes or more per interleaving section | Respond with Check Condition. Sense Key indicates a medium error. |
| WRITE LONG | 128 MB/230 MB media:<br>  3 read errors in 3 sectors<br>540 MB/640 MB/1.3 GB media:<br>  2 read errors in 2 sectors | No check | Respond with Check Condition. Sense Key indicates a medium error. |
| READ LONG | Error free<br>(If no ID can be read, the ODD tries to read from the sector before and after the possibly faulty location  and performs reassignment.) | No check | Respond with Check Condition. Sense Key indicates a medium error. |
| VERIFY | 128 MB/230 MB media:<br>  3 read errors in 3 sectors<br>540 MB/640 MB/1.3 GB media:<br>  2 read errors in 2 sectors | Error in 9 bytes or more per interleaving section | Respond with Check Condition. Sense Key indicates a 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 prereads the specified sector, then prereading the next sector when receiving a READ (10) or READ (12) command (called Read command in this document).  While prereading 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 preread data, the ODD transfers data directly from the buffer without any mechanical operation.

Preread stops under the following conditions:


- Access to the alternate sector

- Read error and retry

- Logical zone boundary of media

- When a read command is received for a sector not continuous from the sector specified by the previous read command

- When a command other than Read is received

- When the data buffer is full

- Media ejection instruction using the Eject switch

- Hardware reset, software reset, DEVICE RESET command is received, 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 once transferred to the host during prereading

- Data read before hardware reset, software reset, DEVICE RESET command is received, or power-off

- Data already stored before media is mounted

All buffer data is discarded under the following conditions:

- Hardware reset, software reset, DEVICE RESET command is received, or power-off

- When media is ejected

- When the FORMAT UNIT command is received

- In standby mode

- In sleep mode

- When the system receives a command (such as MODE SELECT and SET FEATURES) that may change the operating 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).  If Write commands are continuously issued, the ODD responds to the host with command end when the data transfer is completed.  This occurs if the specified sector is continuous from the sector specified by the previous command.

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

- When data can be written on media during data transfer with a Write command or while the ODD is waiting for a command

- When a command that requires a new segment is received while all segments in the data buffer are used

- When the Eject switch is pressed

- When the SYNCHRONIZE CACHE command is received/DEVICE RESET command is received

- Software reset

Particularly under the condition described below, a command end response or data transfer to the host may be delayed until the write operation to media is completed.

- When a command that requires a new segment is received while all segments in the data buffer are used

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, ATAPI reset, 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 1.0 seconds (standard) to access media.

If no command is issued within a specified time (180 seconds) 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 mode stops.  The ODD can receive a command from the host, but since the spindle motor stops, the recovery to access media takes 5 seconds (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 uses power consumption as standby mode.　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 seconds (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.

#### 4.4.7.8　Power mode transition

The power mode transits as shown in Figure 4.1.
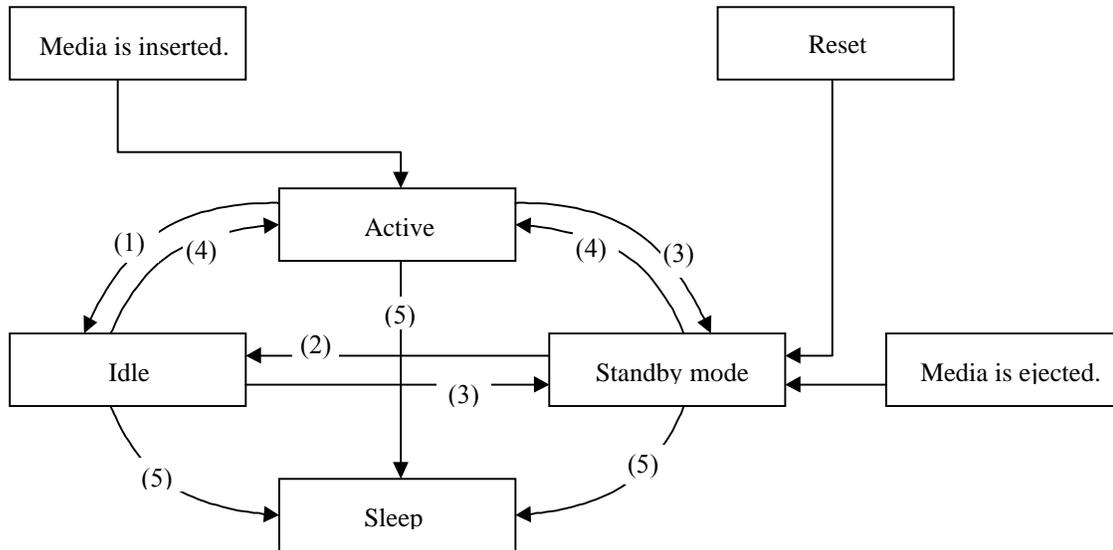


(1)　　　The ODD enters idle mode because it receives the Idle Immediate command or because it receives no commands within a specified time.

(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 4.17 lists indication modes and operation.

**Table 4.17 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 a second and off for a second repeatedly) | Starting the download only firmware (*1) |
| Blinking (on for 0.25 second and off for 0.25 second repeatedly) | A power-on diagnostics error occurred. |
| Blinking (on for 0.5 second and off for 0.5 second 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 4.18 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 4.18 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 | D | 4.5.2 |
| ND | DEVICE RESET | 08h | | | | | D | 4.5.3 |
| ND | CHECK POWER MODE | 98h E5h | | y | | | D | 4.5.4 |
| ND | EXECUTE DEVICE DIAGNOSTIC | 90h | | | | | D* | 4.5.5 |
| ND | GET MEDIA STATU | DAh | | | | | D | 4.5.6 |
| ND | IDLE IMMEDIATE | 98h E5h | | | | | D | 4.5.7 |
| ND | NOP | 00h | | | | | y | 4.5.8 |
| ND | SERVICE (Not supported) | A2h | | | | | D | 4.5.9 |
| ND | SET FEATURES | EFh | y | y | | | D | 4.5.10 |
| ND | SLEEP | 99h E6h | | | | | D | 4.5.11 |
| ND | STANDBY IMMEDIATE | 94h E0h | | | | | D | 4.5.12 |
| -- | RESERVED: Other codes | | | | | | | |

**Note:**

1.        CY = Cylinder register
        SC = Sector register
        DH = Device/Head register
        SN = Sector Number register
        FR = Features register
        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 (X'A1')

**Table 4.19  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 4.20 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 4.20  Device parameter information (1/5)**

| Word | Value | Bits | Description |
|------|-------|------|-------------|
| 0 | 87c0h | | General configuration information |
| | | 15-14 | Protocol type (B'10' = ATAPI device) |
| | | 13 | Reserved |
| | | 12-8 | Device type B'00111' = Optical disk unit |
| | | 7 | Replaceable media device (B'1') |
| | | 6-5 | CMD DRQ type (B'10' = Accelerated DRQ) |
| | | 4-2 | Reserved |
| | | 1-0 | Command packet size (B'00' = 12 bytes) |
| 1-9 | 0000h | | Reserved |
| 10-19 | "xxx...xxx" | | Base serial number<br>(Left justified, ASCII codes) |
| 20-22 | 0000h | | Reserved |
| 23-26 | "aaab" | | Firmware version number<br>aaa:  Major level version number (000 - 999)<br>b:  Minor level version number (0 - 9, a - z, and A - Z)<br>(Left justified, ASCII codes, blank indicating space character) |
| 27-46 | In the case of the MCE3130AP, "FUJITSU MCE3130AP"<br>In the case of the MCE3064AP, "FUJITSU MCE3064AP"<br>In the case of the MCF3064AP, "FUJITSU MCF3064AP" | | Product number<br>(Left justified, ASCII codes, blank indicating space character) |
| 47-48 | 0000h | | Reserved |
| 49 | 0F00h | 15-14 | Reserved (B'0') |
| | | 13 | Overlap function supported (B'0') |
| | | 12 | Reserved (B'0') |
| | | 11 | IORDY supported (B'1') |
| | | 10 | IORDY can be disabled (B'1') |
| | | 9 | LBA mode supported (B'1') |
| | | 8 | DMA transfer mode supported (B'1') |
| | | 7-0 | Reserved (B'0') |
| 50 | 0000h | | Reserved |

**Table 4.20　Device parameter information (2/5)**

| Word | Value | Bits | Description |
|---|---|---|---|
| 51 | 0200h | 15-8 | PIO data transfer cycle timing mode |
|  |  | 7-0 | Reserved |
| 52 | 0000h | 15-0 | Reserved |
| 53 | 0003h | 15-3<br>2 | Reserved<br>88 word information is valid.<br>(In the case of models which do not support Ultra-DMA transfers, B'0'.) |
|  |  | 1 | Information in words 64 to 70 is valid. (B'1') |
|  |  | 0 | Information in words 54 to 58 is valid. (B'1') |
| 54-62 | 0000h |  | Reserved |
| 63 | 0407h | | Multiword DMA transfer mode |
|  | (Default value) | | Active mode |
|  |  | 15-11 | Reserved (B'0') |
|  |  | 10 | 1 is shown when Mode 2 is selected. |
|  |  | 9 | 1 is shown when Mode 1 is selected. |
|  |  | 8 | 1 is shown when Mode 0 is selected. |
|  |  |  | Multiword DMA transfer mode supported |
|  |  | 7-3 | Reserved (B'0') |
|  |  | 2 | Mode 2 (B'1') |
|  |  | 1 | Mode 1 (B'1') |
|  |  | 0 | Mode 0 (B'1') |
| 64 | 0003h | | Flow control PIO transfer mode |
|  |  | 15-8 | Reserved |
|  |  |  | PIO transfer mode supported |
|  |  | 7-2 | Reserved (B'0) |
|  |  | 1 | Mode 4 (B'1') |
|  |  | 0 | Mode 3 (B'1') |
| 65 | 0078h (120) |  | Minimum multiword DMA transfer time per word (ns) |
| 66 | 0078h (120) |  | Recommended multiword DMA transfer time (ns) |
| 67 | 017Fh (383) |  | Minimum PIO transfer cycle time when flow control is disabled (ns) |
| 68 | 0078h |  | Minimum PIO transfer cycle time when flow control using IORDY is enabled (ns) |

**Table 4.20  Device parameter information (3/5)**

| Word | Value | Bits | Description |
|---|---|---|---|
| 69-70 | 0000h | | Reserved |
| 71 | 07D0h (2000) | | Required time after the PACKET command is received until the bus is released (μs)  (Typical) |
| 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-4) |
| 81 | 0000h | | Minor Version number (unused) |
| 82 | 4278h | | Command set supported |
| | | | (A value of less than 1 indicates that the command is supported.) |
| | | 15 | IDENTIFY DEVICE DMA command (B'0') |
| | | 14 | NOP command (B'1') |
| | | 13 | READ BUFFER command (B'0') |
| | | 12 | WRITE BUFFER command (B'0') |
| | | 11 | WRITE VERIFY command (B'0') |
| | | 10 | Host protect area function (B'0') |
| | | 9 | DEVICE RESET command (B'1') |
| | | 8 | SERVICE command interrupt (B'0') |
| | | 7 | Interrupt at release (B'0') |
| | | 6 | Read ahead cache (B'1') |
| | | 5 | Write cache (B'1') |
| | | 4 | Packet command function (B'1') |
| | | 3 | Power management function (B'1') |
| | | 2 | Removable media function (B'0') |
| | | 1 | Security mode (B'0') |
| | | 0 | SMART function (B'0') |
| 83 | 4000h | | Command set supported |
| | | | (A value of less than 1 indicates that the command is supported.) |
| | | 15 | Always B'0'. |
| | | 14 | Always B'1'. |
| | | 13-1 | Reserved |
| | | 1 | DOWNLOAD MICROCODE command supported (B'0') |

**Table 4.20 Device parameter information (4/5)**

| Word | Value | Bits | Description |
|------|-------|------|-------------|
| 84 | 4000h | | Command set supported |
| | | 15 | Always B'0'. |
| | | 14 | Always B'1'. |
| | | 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 (B'0') |
| | | 14 | NOP command support (B'1') |
| | | 13 | READ BUFFER command support (B'0') |
| | | 12 | WRITE BUFFER command support (B'0') |
| | | 11 | WRITE VERIFY command support (B'0') |
| | | 10 | Host protect area function support (B'0') |
| | | 9 | DEVICE RESET command support (B'1') |
| | | 8 | SERVICE command interrupt is enabled (B'0': Default value) |
| | | 7 | Interrupt at release is enabled (B'0': Default value) |
| | | 6 | Read ahead cache is enabled (B'1': Default value) |
| | | 5 | Write cache is enabled (B'1': Default value) |
| | | 4 | Packet command function support (B'1') |
| | | 3 | Power management function support (B'1') |
| | | 2 | Removable media function support (B'0') |
| | | 1 | Security mode enabled (B'0') |
| | | 0 | SMART function is enabled (B'0') |
| 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 (B'0') |
| | | 0 | DOWNLOAD MICROCODE command supported (B'0') |
| 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 | Always B'0'. |
| | | 14 | Always B'1'. |
| | | 13-0 | Reserved |

**Table 4.20  Device parameter information (5/5)**

| 88 | 0000h | 15-0 | Reserved. |
|---|---|---|---|
| 89-126 | 0000h | | Reserved |
| 127 | 0001h | 15-9 | Reserved |
| | | 8 | Device write protected |
| | | | A value of 1 indicates device write protected.<br>See 9.5.5 Timer & Protect Page |
| | | 7-2 | Reserved |
| | | 1-0 | Media status notification function supported (B'01') |
| 128-255 | 0000h | | Reserved |

## 4.5.2    PACKET (X'A0')

**Table 4.21  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 an ATAPI packet command.

### 4.5.3 DEVICE RESET (X'80')

**Table 4.22 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 BUSY 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 (X'98'/X'E5')

**Table 4.23 CHECK POWER MODE command**

|      | Bit | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|      | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| CM | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
|    | 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 4.24  When the drive is in sleep mode, the interface is inactive and the ODD cannot receive this command.

**Table 4.24  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 (X'90')

**Table 4.25   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 DRV 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 X'01' 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 X'80' 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 X'01' in the Error register and ends the command.

**Table 4.26   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 (X'DA')

**Table 4.27    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 4.28 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 4.28   Error register**

| Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|------|------|------|------|------|------|------|------|
| 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.

### 4.5.7   IDLE IMMEDIATE (X'95'/X'E1')

**Table 4.29   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 (X'00')

**Table 4.30  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 (X'A2') (Not supported)

**Table 4.31  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 |

### 4.5.10 SET FEATURES (X'EF')

**Table 4.32 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 4.33 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 4.16. | |
| 31 | Disables the media status notification function. | * |
| 55 | Disables the read ahead cache. | |
| 5D | Enables the interrupt signal to release the bus after the overlap command is received. | |
| 5E | Enables the reception of the DRQ interrupt signal by the SERVICE command. | |
| 66 | Does not reset various setting values to the power-on default value by software reset. (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 the bus after an overlap command is received. | * |
| DE | Disables the DRQ interrupt signal by the SERVICE command. | * |

**Table 4.34 Transfer setting values in the SC register**

| Setting value | | Function | ODD response |
|---|---|---|---|
| Bits 7 to 3 | bits 2 to 0 | | |
| 00000 | 000 | PIO default transfer mode | Normally end |
| 00000 | 001 | PIO default transfer mode | Normally end |
| | 010 to 111 | (without IORDY signal) | Report Aborted Command |
| 00001 | 000 | PIO flow control transfer mode | Normally end |
| | 001 | (with IORDY signal) | Normally end |
| | 010 | | Normally end |
| | 011 | | Normally end |
| | 100 | | Normally end |
| | 101 to 111 | | Report Aborted Command |
| 00010 | 000 to 111 | Reserved | Report Aborted Command |
| 00100 | 000 | Multiword DMA transfer mode | Normally end |
| 00100 | 001 | | Normally end |
| 00100 | 010 | | Normally end |
| 00100 | 011 to 111 | | Report Aborted Command |
| 01000 | 000 to 111 | Reserved | Report Aborted Command |
| 10000 | 000 to 111 | Reserved | Report Aborted Command |

When the FR register is X'95', the ODD responds with the following value at the end of the command.

- The CL register is set with X'00'.
- The CH register is set as shown below.

**Table 4.35  Cylinder High register**

| Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
|------|------|------|------|------|----------|------|----------|
| 0 | 0 | 0 | 0 | 0 | POWER_EJ | LOCK | PRV_ENAB |

POWER_EJ:  Set to 1.
LOCK:  Set to 1.
PRV_ENAB:  Set to 1 when the media status notification function is enabled.


## 4.5.11   SLEEP (X'99'/X'E6')

**Table 4.36   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.

A software reset or hardware reset is required for a return from sleep mode.

Software reset is recommended for returning from sleep mode.

**4.5.12    STANDBY IMMEDIATE (X'94'/X'E0')**

**Table 4.37   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 4.38    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 | 5Ah | 4.6.6 |
| PREVENT/ALLOW MEDIUM REMOVAL | 1Eh | 4.6.7 |
| READ (10) | 28h | 4.6.8 |
| READ (12) | A8h | 4.6.9 |
| READ CAPACITY | 25h | 4.6.10 |
| READ FORMAT CAPACITIES | 23h | 4.6.11 |
| READ DEFECT DATA | 37h | 4.6.12 |
| READ LONG | 3Eh | 4.6.13 |
| RECEIVE DIAGNOSTIC RESULTS | 1Ch | 4.6.14 |
| REQUEST SENSE | 03h | 4.6.15 |
| SEND DIAGNOSTIC | 1Dh | 4.6.16 |
| SEEK (10) | 2Bh | 4.6.17 |
| START STOP UNIT | 1Bh | 4.6.18 |
| SYNCHRONIZE CACHE | 35h | 4.6.19 |
| TEST UNIT READY | 00h | 4.6.20 |
| VERIFY | 2Fh | 4.6.21 |
| WRITE (10) | 2Ah | 4.6.22 |
| WRITE (12) | AAh | 4.6.23 |
| WRITE AND VERIFY | 2Eh | 4.6.24 |
| WRITE BUFFER | 3Bh | 4.6.25 |
| WRITE LONG | 3Fh | 4.6.26 |

### 4.6.1 Logical Unit Number

A value other than 0 is not supported for Logical Unit Number (LUN). It must always be 0.

### 4.6.2 ERASE command

**Table 4.39   ERASE command**

| Bit<br>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 4.40  FORMAT UNIT command**

| Bit<br>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. When the FMtDAta bit is 1, the Defect List Format must be specified. Defect List Format can be 7 only.

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 bit must be 0. If it is 1, the command responds with Check Condition.

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

**Table 4.41  FORMAT UNIT parameter list**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0-3 | Defect List Header | | | | | | | |
| 0-7 | Format Descriptor | | | | | | | |

**Table 4.42  Defect list header**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Reserved | | | | | | | |
| 1 | Reserved | | DCRT | Reserved | | | IMMED | Reserved |
| 2-3 | 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 4.43   Format descriptor**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0-3 | Number of Blocks | | | | | | | |
| 4 | Reserved | | | | | | | |
| 5-7 | Block Length | | | | | | | |

The values in the format descriptor must match the formattable descriptor to be reported to the host with the READ FORMAT CAPACITIES command. If no value matches, the command responds with Check Condition.

### 4.6.4   INQUIRY command

**Table 4.44   INQUIRY command**

| Bit<br>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 4.45  INQUIRY data**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Reserved | | | Peripheral Device Type Optical memory Device (07h) | | | | |
| 1 | RMB<br>(1b) | Reserved | | | | | | |
| 2 | ISO Version<br>(00b) | | ECMA Version<br>(000b) | | | ANSI Version<br>(000b) | | |
| 3 | Reserved | | | | Response data format (X'1') | | | |
| 4 | Additional length (X'23') | | | | | | | |
| 5 | Reserved | | | | | | | |
| 6 | Reserved | | | | | | | |
| 7 | Reserved | | | | | | | |
| 8-15 | Vendor Information<br>"FUJITSU" (in ASCII)<br>Left justified.  The rightmost data field not used is filled with space characters. (X'20') | | | | | | | |
| 16-31 | Products Identification<br>MCE3130AP, MCE3064AP, MCF3064AP (in ASCII)<br>Left justified.  The rightmost data field not used is filled with space characters. (X'20') | | | | | | | |
| 32-35 | Firmware Revision Level<br>"0000" - "999z" (in ASCII) | | | | | | | |
| 36-37 | Boot Firmware Revision Level<br>0000h - FFFFh (in HEX) | | | | | | | |
| 38-39 | OEM Code | | | | | | | |

**4.6.5    MODE SELECT command**

**Table 4.46   MODE SELECT command**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Operation Code (55h) | | | | | | | |
| 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 4.47 lists mode parameters supported.

**Table 4.47   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 4.48 lists the mode parameter list.

**Table 4.48   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 4.49 lists the mode parameter header.

**Table 4.49   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 | | | | | | | |

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

The value in Medium Type Code and WP are ignored.

Table 4.50 lists the page descriptor.

**Table 4.50   Page descriptor**

| Bit Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 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<br>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 DVW (Disable Verify for WRITE) bit is 0, verification is made for the WRITE (10), WRITE (12), or WRITE AND VERIFY command.  When the bit of DVW is 1, no verification is made.

The SLM (Select LUN Mode) bit and the SLR (Select LUN for Rewritable) bit has no multiple LUNs and are always 0.

The DDE (Disable Deferred Error) bit indicates whether errors in the write cache are reported. These errors are reported as deferred error with the next command regardless of the value of the bit.

The drive operation mode page can be saved.

**Table 4.52  Changeable values in drive operation mode page**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 2 | 0 | 0 | 1 | 00000b | | | | |
| 3 | 000b | | | 1 | 0000b | | | |

**Table 4.53  Default values for the drive operation mode page**

| Bit<br>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<br>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) or READ (12) 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) or 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.

Write Retry operation is complicate and not always executed three times.

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<br>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<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 1Fh | | | | | | | |
| 4-7 | 00h | | | | | | | |
| 8 | 03h | | | | | | | |
| 9-11 | 00h | | | | | | | |

#### 4.6.5.3  Flexible disk page

**Table 4.57  Flexible disk page**

| Bit<br>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<br>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<br>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<br>Others or Not Ready = 200h | | | | | | | |
| 8-9 | Number of LBA for media / (40h × 20h)<br>In case of Not Ready = the value of the maximum capacity media among the supported<br>512 sectors media | | | | | | | |
| 10-19 | 00h | | | | | | | |
| 20 | FFh | | | | | | | |
| 21-27 | 00h | | | | | | | |
| 28-29 | MCE3130AP, MCE3064AP = 1194h<br>MCF3064AP = 1000h | | | | | | | |
| 30-31 | 00h | | | | | | | |

#### 4.6.5.4 Caching page

**Table 4.60   Caching page**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | PS | 0 | Page Code (08h) | | | | | |
| 1 | Page Length (0Ah) | | | | | | | |
| 2 | Reserved | | | | | WCE | Reserved | RCD |
| 3-11 | 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) or READ (12) 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<br>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 cashing page**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 3-11 | 00h | | | | | | | |

**4.6.5.5 Removable block access capabilities page**

**Table 4.63   Removable block access capabilities page**

| Bit<br>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 SFLP (System Floppy Type) bit indicates the system floppy disk device.

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

The NCD (Non CD Optical Device) bit indicates an optical disk device other than CD.

The SML (Single/Multiple LUN supported) bit indicates that the CD system disk device and an optical disk device other than CD use the same LUN.

TLUN (Total LUN Supported) indicates the number of LUNs supported.

The removable block access capabilities page cannot be saved.

**Table 4.64   Changeable values in the removable block access capabilities page**

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

**Table 4.65   Default values for the removable block access capabilities page**

| Bit<br>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<br>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 indicates the minimum time from the end of an access command until the ODD enters standby mode.  Table 4.66 lists the relationship between the specified value and time.  When a value of X'1' to X'9' is specified, the command assumes X'A' and responds with Recovered Error.

**Table 4.67   Inactivity Time Multiplier value**

| Inactivity Time<br>Multiplier | Minimum time after the end of an access command until the ODD<br>enters 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 DISP (Disable Media Access until Power cycle) bit is 1, the ODD responds with Not Ready for any command from the host until power-off or hardware reset. The ODD doesn't support DISP function.

When the SWPP (Software Write Protect until Power-down) is 1, media is write-protected. The ODD doesn't support SWPP function.

The DISP bit and SWPP bit can be saved.

**Table 4.68   Changeable values for the timer & protect page**

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

**Table 4.69   Default values for the timer & protect page**

| Bit<br>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 command**

**Table 4.70   MODE SENSE command**

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

The MODE SENSE command transfers the mode parameter list to the host.  The mode parameter list is shown in Table 4.71.

PC (Page Control) specifies the type of the page descriptor to be sent.

**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 | Saved value |

Page Code specifies the page descriptor to be transferred.  If Page Code is X'3F', all page descriptors are transferred.  For page descriptors supported, see Table 4.74.

Mode pages are transferred in ascending page code order except for Drive Operation Mode Page (00h).  Drive Operation Mode Page is transferred after all other mode pages.

**Table 4.72   Mode parameter list**

| Bit<br>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(s).  The mode parameter header is shown in Table 4.73.

**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:

- X'03' for normal FRAM (MO) media

- X'07' for overwrite FRAM media

- X'01' for FROM media

- X'05' for PROM media

- X'03' for other media and Not Ready state

The WP (Write Protect) bit indicates the state of the write protect key on the cartridge.  A value of 1 indicates write protected

Mode Data Length indicates the length of mode data following the header in bytes.

The page descriptor is shown in Table 4.74.

**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 | | | | | | | |

A value of 1 in PS indicates that the page descriptor can be saved on the flash ROM.  For details of the mode parameters, see the MODE SELECT command.

### 4.6.7 PREVENT/ALLOW MEDIUM REMOVAL command

**Table 4.75  PREVENT/ALLOW MEDIUM REMOVAL command**

| Bit<br>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 4.76  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:<br>Eject the cartridge |
| (Ejection with START/STOP UNIT command) | Inhibited | Error:<br>SENSE KEY 5<br>ASC/ASCQ  5302 | Error:<br>SENSE KEY 5<br>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. |

**4.6.8    READ (10) command**

**Table 4.77    READ command**

| Bit<br>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.

**4.6.9    READ (12) command**

**Table 4.78    READ command**

| Bit<br>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 | | | | | | | |

The READ (12) 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.

It is recommended that the READ (10) command is used because there is ATAPI device which does not support the READ (12) command.

### 4.6.10   READ CAPACITY command

**Table 4.79   READ CAPACITY command**

| Bit<br>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 4.80 lists the READ CAPACITY data (PMI =0) to be transferred when the PMI (Partial Medium Indicator) bit is 0.

**Table 4.80   READ CAPACITY data (PMI = 0)**

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

Last Block Address specifies LBA of the last accessible block.

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

When the PMI (Partial Medium Indicator) bit is 1, the data transferred depends on the type of media used.  Transfer data for each type of media is listed in Tables 4.81 and 4.82.

**Table 4.81   READ CAPACITY data (PMI = 1, MO media, FROM media)**

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

**Table 4.82 READ CAPACITY data (PMI = 1, PROM media)**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0-3 | Last Logical Block Address for MO area | | | | | | | |
| 4-7 | Block Length in Bytes | | | | | | | |

## 4.6.11 READ FORMAT CAPACITIES command

**Table 4.83 READ FORMAT CAPACITIES command**

| Bit<br>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 4.84 READ FORMAT CAPACITIES data format**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| | Capacity List Header | | | | | | | |
| | Current / Maximum Capacity Header | | | | | | | |

**Table 4.85 Capacity list header**

| Bit<br>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 4.86   Current/Maximum capacity descriptor**

| Bit<br>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 4.87   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) |

### 4.6.12   READ DEFECT DATA command

**Table 4.88   READ DEFECT DATA command**

| Bit<br>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.

The defect list format supported is listed in Table 4.89.  If any other format is specified, the command assumes the format listed in Table 4.90 and reports Recovered Error.

**Table 4.89   Defect list formats**

| Defect List Format | Data format |
|---|---|
| 101 | Physical sector address format |

**Table 4.90   Defect descriptor**

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

The detect list header is shown in Table 4.91.

**Table 4.91   Defect list header**

| Bit<br>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) | | | | | | | |

**4.6.13   READ LONG command**

**Table 4.92   READ LONG command**

| Bit<br>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 (X'258') bytes for 512 byte media and a multiple of 2380 (X'94C') bytes for 2048 byte media.

**4.6.14   RECEIVE DIAGNOSTIC RESULTS command**

**Table 4.93   RECEIVE DIAGNOSTIC RESULTS command**

| Bit<br>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 successively or if there is no data to be transferred, the command transfers no data and ends normally.

### 4.6.15 REQUEST SENSE command

**Table 4.94   REQUEST SENSE command**

| Bit<br>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.

The sense data format is shown in Table 4.95.

**Table 4.95   Request sense data**

| Bit<br>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 4.96.

**Table 4.96   Error code**

| Error Code | Report timing |
|---|---|
| X'70' (Current error) | Reported for a normal error. |
| X'71' (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 4.97.

**Table 4.97   Sense key**

| 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. |
| 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 4.98.

**Table 4.98   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 4.99.

**Table 4.99   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 | 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 |
| 4 | 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 |

**Table 4.99   ASC/ASCQ list (2/2)**

| Sense Key | ASC | ASCQ | Error description |
|---|---|---|---|
| 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 |
| 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 |
| 2 | 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 4.100. 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 X'00'. This field is defined for the FORMAT UNIT command having the Immed bit of 1.

**Table 4.100 Format Progress Indication Bytes**

| Bit<br>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 655356 (X'10000').

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

### 4.6.16    SEND DIAGNOSTIC command

**Table 4.101  SEND DIAGNOSTIC command**

| Bit<br>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.

### 4.6.17 SEEK command

**Table 4.102  SEEK command**

| Bit<br>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.

### 4.6.18 START/STOP UNIT command

**Table 4.103  START/STOP UNIT command**

| Bit<br>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 4.104.

**Table 4.104  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). |

**4.6.19   SYNCHRONIZE CACHE command**

**Table 4.105  SYNCHRONIZE CACHE command**

| Bit<br>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.

**4.6.20    TEST UNIT READY command**

**Table 4.106    TEST UNIT READY command**

| Bit<br>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.

**4.6.21    VERIFY command**

**Table 4.107    VERIFY command**

| Bit<br>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 Lenght | | | | | | | |
| 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.

**4.6.22    WRITE (10) command**

**Table 4.108  WRITE (10) command**

| Bit<br>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 Lenght | | | | | | | |
| 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.

**4.6.23    WRITE (12) command**

**Table 4.109  WRITE (12) command**

| Bit<br>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 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.

It is recommended that the WRITE (10) command is used because there is ATAPI device which does not support the WRITE (12) command.

### 4.6.24 WRITE AND VERIFY command

**Table 4.110  WRITE AND VERIFY command**

| Bit<br>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.

It is the same as the WRITE (10) and WRITE (12) commands.

### 4.6.25 WRITE BUFFER command

**Table 4.111  WRITE BUFFER command**

| Bit<br>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.  See Table 4.112.

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 4.112  Code-ID**

| Code-ID | Microcode type | Download file size |
|---------|----------------|--------------------|
| 0h | Main Code | 78040h |
| 1h-Fh | Reserved | - |

**Download procedure**

Example 1 - To transfer the download file of X'78040' bytes in size in one operation

Step 1:  Set X'78040' in Allocation Length, X'0' in Buffer Offset, 5 in Mode, and 0 in the TNFY bit and issue the command to transfer download file of X'78040' bytes to the device.  Make sure that the command ends normally.

Example 2 - To transfer the download file of X'78040' bytes in size by unit 32 K Byte max

Step 1:  Set X'40' in Allocation Length, X'0' in Buffer Offset, 5 in Mode, and 1 in the TNFY bit and issue the command to transfer download file data from X'0' to X'3F' to the device.

Step 2:  Set X'8000' in Allocation Length, X'40' in Buffer Offset, 5 in Mode, and 1 in the TNFY bit and issue the command to transfer download file data from X'40' to X'803' to the device.

Step 3:   Set X'8000' in Allocation Length, X'8040' in Buffer Offset, 5 in Mode, and 1 in the TNFY bit and issue the command to transfer download file data from X'8040' to X'1003F' to the device.

Step 4:   Similarly, issue the command by changing Buffer Offset to transfer all data in the download file.

Step 5:  Set X'0' in Allocation Length, X'0' in Buffer Offset, 5 in Mode, and 0 in the TNFY bit and issue the command.  Make sure that the command ends normally.

### 4.6.26  WRITE LONG command

**Table 4.113  WRITE LONG command**

| Bit<br>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 (X'258') bytes for 512 byte media and a multiple of 2380 (X'94C') bytes for 2048 byte media.

**4.7    Timing**

**4.7.1    Register/PIO data transfer timing**
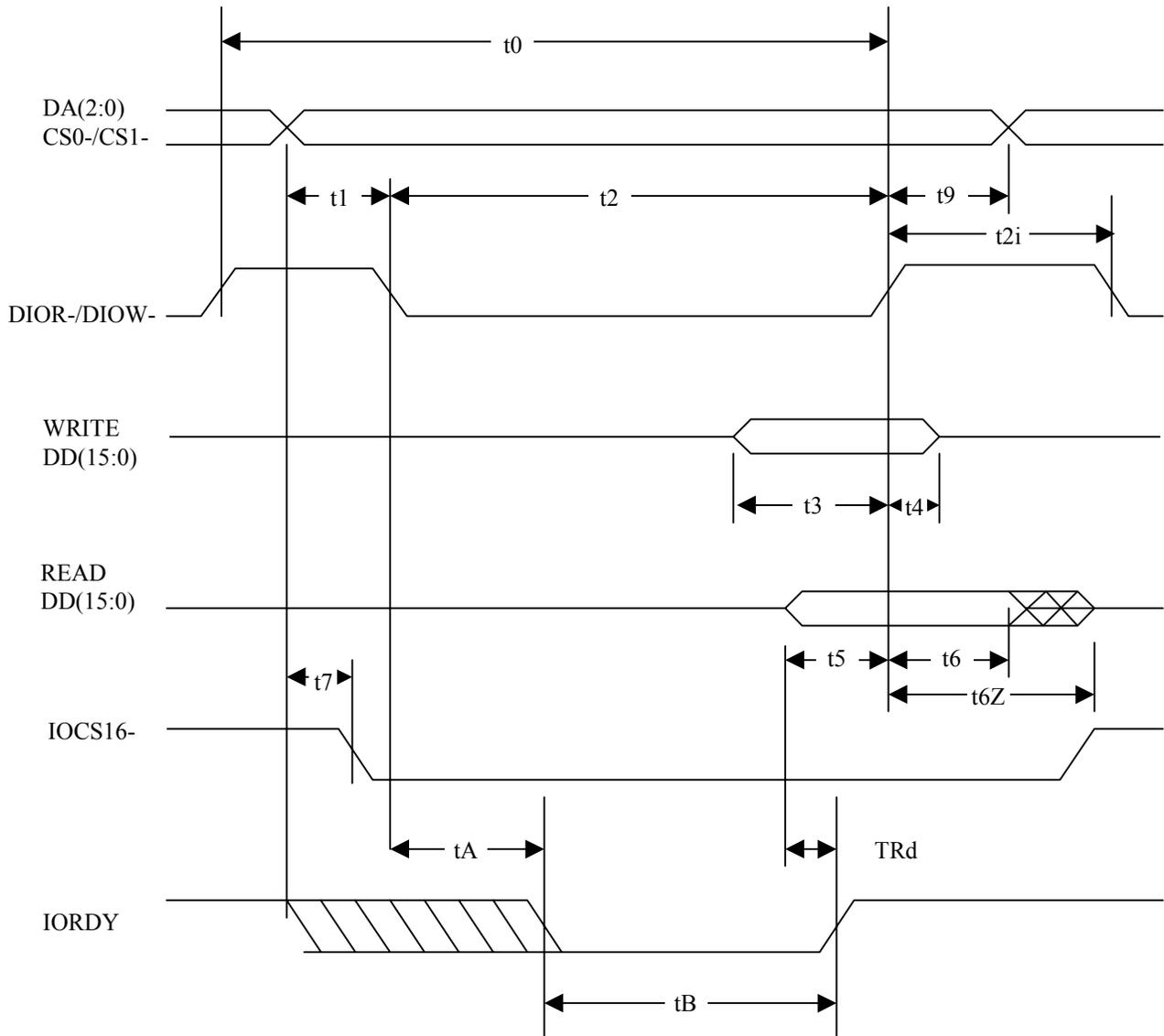


**Figure 4.2    Register/PIO data transfer**

**Table 4.114  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 | Address valid to DIOR-/DIOW- setup | 25 | - | |
| t2 | DIOR-/DIOW- pulse width | 70 | - | |
| t2i | DIOR-/DIOW- recovery time | 25 | - | |
| t3 | DIOW- data setup | 20 | - | |
| t4 | DIOW- data hold | 10 | - | |
| t5 | DIOR- data setup | 20 | - | |
| t6 | DIOR- data hold | 5 | - | |
| t6Z | DIOR- data tristate | - | 30 | |
| t7 | From address decided to IOCS16 asserted | - | 30 | |
| t8 | From address decided to IOCS16 released | - | 30 | |
| t9 | DIOR-DIOW- to address valid hold | 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
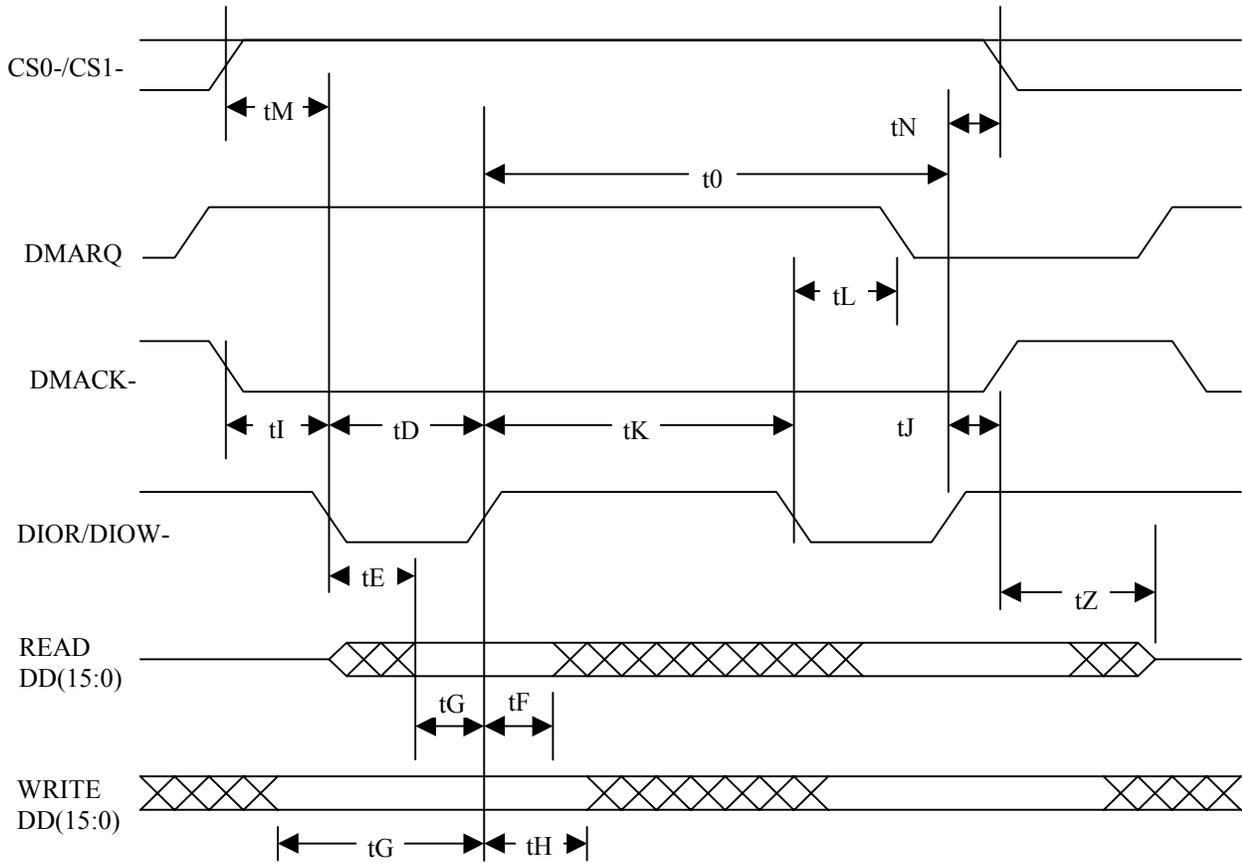


**Figure 4.3 Multiword DMA data transfer**

**Table 4.115  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 time | 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   Power-on and Reset Timing
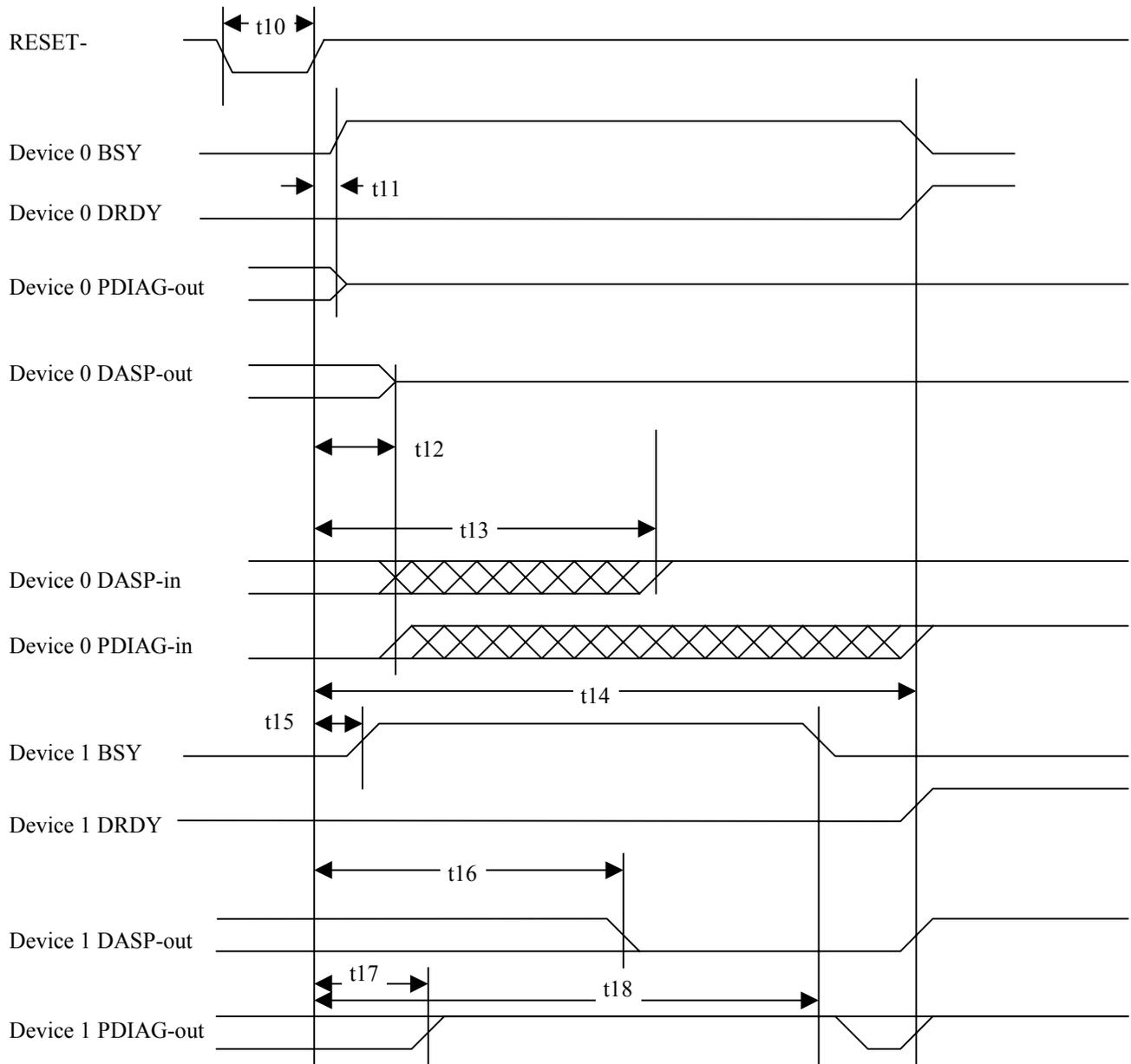


*1   Device 0 sets the BSY bit to 0 when device 1 is not connected.
*2   Device 0 uses DASP- to indicate that it is in operation when device 1 is not connected.
*3   DASP- is used to indicate that the device is in operation.

**Figure 4.4    Power-on and reset timing**

**Table 4.116  Power-on and reset timing**

| Symbol | Timing parameter | min | max |
|--------|------------------|-----|-----|
| t10 | RESET- pulse width | 25 ns | - |
| 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 of DASP- | 1 ms | 450 ms |
| t14 | Device 0 sample 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

<div style="border">

5.1    Operating Optical Disk Drive

5.2    Cleaning Drive

5.3    Optical Disk Cartridge Operation

5.4    Cleaning Optical Disk Cartridge

</div>

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

## 5.1    Operating Optical Disk Drive

The drive has an automatic load function.  All the operator must do is to insert the optical disk cartridge and operate the eject button.

This section explains loading and ejection methods, assuming that the drive is mounted horizontally.  (When mounted vertically, the drive is operated in the same manner as when mounted horizontally.)

Figure 5.1 shows the front view of the optical disk drive. For operation, users should be familiar with the parts in the figure and their function.  Loading and ejection methods are described below.

### 5.1.1    Optical disk drive



1) Disk insertion slot    2) Eject button/BUSY LED

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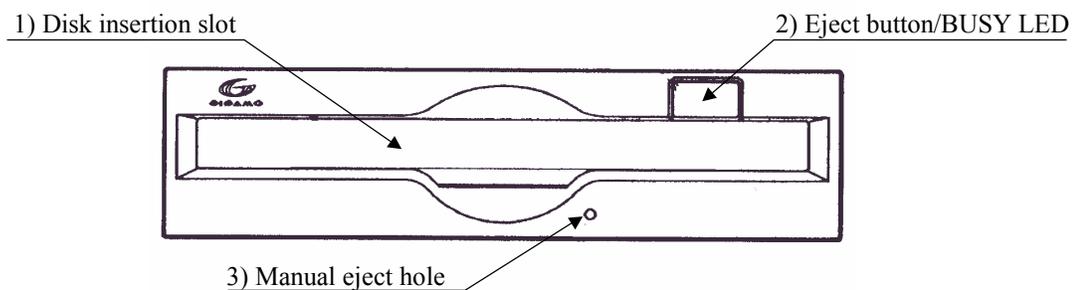
**Figure 5.1    Optical disk drive front view (with panel)**

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

1) Disk insertion slot

Use this slot to insert and eject the optical disk cartridge.

2) Eject button & BUSY LED (display lamp)

On this optical disk drive, this is the push button combining the eject button with the BUSY LED (display lamp) for ejecting the optical disk cartridge (it lights in green during seeking and during erasing, writing or reading of data). When ejection is disabled by the SCSI command, the optical disk cartridge cannot be taken out.

3) Manual eject hole

This hole is used to eject the optical disk cartridge manually at power-off.  Manual ejection may not be possible just after the power is off.

### 5.1.2  Note

To maintain the performance and reliability of the drive, keep the following point in mind:

- When the drive is in the busy state, do not eject the optical disk cartridge.

- Particularly, do not manually eject the cartridge by force.

- Be careful sufficiently not to insert the different drive (etc. floppy disk) or substance, so it is cause of the accident.

### 5.1.3  Inserting cartridge

Insert the cartridge as explained below.

(1)     When the drive power is on:

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

2) Keep the cartridge shutter surface upward.

3) Insert the cartridge, shutter first, into the disk insertion slot.

4) Push the cartridge into the slot until it completes moving below (a little further in than the operator panel).
Loading is started when the cartridge is inserted. After several seconds, the BUSY LED indicator lamp is turned on and immediately turned off to complete loading.

**Notes**

1) The cartridge must be completely inserted until the BUSY LED indicator lamp is lit.

2) If the cartridge is inserted by pushing either left or right side of the cartridge rear, it may not be inserted completely. Be sure to push the central part straight into the drive until it is completely inserted.

3) If the BUSY LED indicator lamp does not light when the cartridge is inserted, once eject the cartridge by pressing the eject/BUSY LED button and insert it again.

4) If you attempt to insert the cartridge by force, trouble may result in the drive. In such a case, be sure to once remove the cartridge and check the insertion direction and the face and back of the cartridge before inserting it again.

(2)     When the drive power is off:

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

2) Keep the cartridge shutter surface upward.

3) Insert the cartridge, shutter first, into the disk insertion slot.

4) Push the cartridge into the slot until it completes moving below (a little further in than the operator panel).

The cartridge remains inserted in the drive. The BUSY LED indicator lamp lights when the drive power is turned on.

The cartridge remains inserted in the drive. Turning on the drive power starts loading. (The LED indicator lamp should light.)

**Notes**

1) If the BUSY LED indicator lamp does not light when the power is turned on, once eject the cartridge by pressing the eject button and insert it again until the lamp is lit.

2) If the cartridge is inserted by pushing either left or right side of the cartridge rear, it may not be inserted completely. Be sure to push the central part straight into the drive until it is completely inserted.

3) If you attempt to insert the cartridge by force, trouble may result in the drive. In such a case, be sure to once remove the cartridge and check the insertion direction and the face and back of the cartridge before inserting it again.

Inserting direction

Shutter

Push by hand the width of 20mm to the right and left from the cartridge rear center, to the position shown at right.
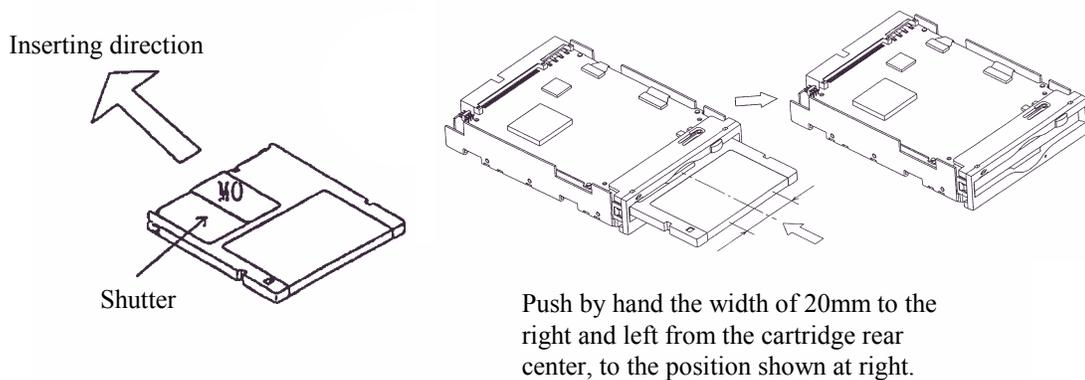
**Figure 5.2    Inserting cartridge**

### 5.1.4    Ejecting (removing) cartridge

Remove the cartridge as explained below.

(1)    When the drive power is on:

1)    The cartridge can be removed by pressing the eject button.

**Notes:**

    1.    If the command prevents ejection, the cartridge cannot be removed.

    2.    Remove the cartridge when completely ejected.

**Note:**

Even if the drive set-up conditions are met, note that the cartridge can drop from the drive after ejection depending on the ambient environment and the cartridge's condition.

(2)    When the drive power is off:

If the drive power is off, the cartridge cannot be removed by pressing the eject button.  The cartridge can be removed by insert the eject jig (accessory) or a pin (diameter: about 1 mm) into the manual eject hole.

**Notes**

    1)    NEVER attempt to eject the cartridge while the BUSY LED lamp is on. The data may be destroyed or trouble may result in the drive.

    2)    Note that the cartridge may drop from the drive when it is ejected.

3)    The optical disk drive unit should not be carried around with a cartridge loaded inside.



Push the eject button
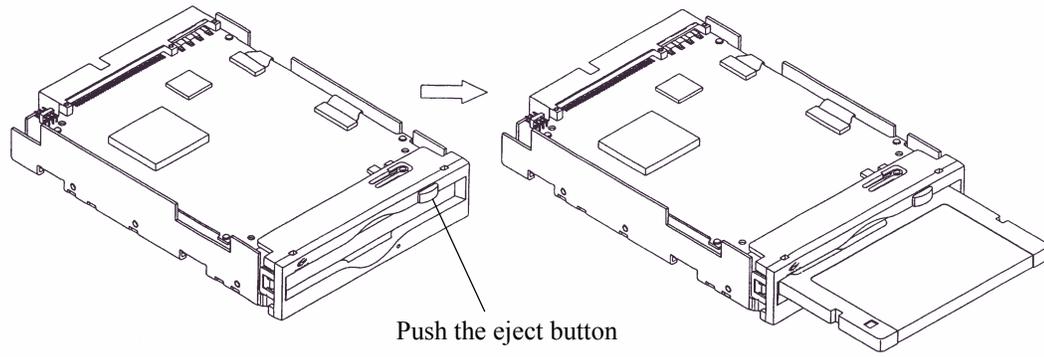
**Figure 5.3      Removing cartridge**

**5.2**     **Cleaning Drive**

When a dust or smoke of cigarette is stained to the lens actuator, a performance of whole drive may be down. Clean the lens actuator periodically using following head cleaner.

**Note:**

Cleaning period differs depending on the installation condition. Usually, cleaning period is once a three months.

**Table 5.1     Head cleaner**

| Part name | Order number |
|---|---|
| Head cleaner | CA90002-C980 |

(1)     Cleaning method

Clean the head actuator with following method.

1. Turn on the power of the drive.

2. Insert the head cleaner.

3. When the head cleaner is automatically loaded, the optical head positioner moves back and forth and the cleaning brush mounted on the head cleaner cleans the object lens.

4. When the cleaning is finished, the head cleaner is automatically unloaded. (cleaning time: 15 seconds)

**⚠CAUTION**

*Device Damage*
*Be sure to use the dedicated head cleaner described above.*

**IMPORTANT**

*Check the cleaning brush state by opening the shutter of the head cleaner. If the tip of brush is open, use new head cleaner.*

### 5.3 Optical Disk Cartridge Operation

### 5.3.1 Optical disk cartridge

Figure 5.4 shows the optical disk cartridge. For operation and cleaning, users should be familiar with the parts shown in the figure.

See Subsection 2.3.2 for the functions of the parts.

- Shutter closed
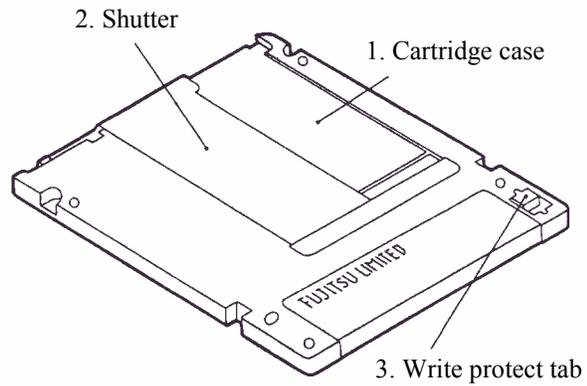


- Shutter open
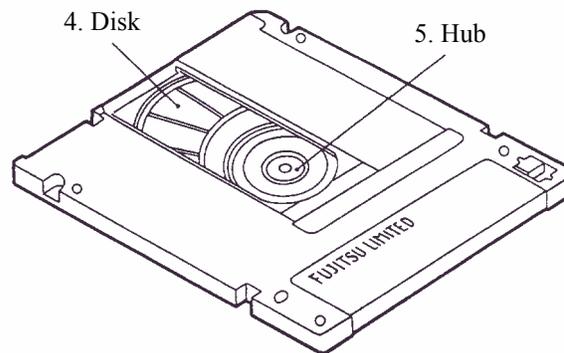


**Figure 5.4    Optial disk cartridge**

### 5.3.2 Write protect tab

Moving the write protect table determines whether to enable or disable writing of the optical disk cartridge. Use a fingernail to move the write protect tab (it must be completely moved to the end because there is play in the middle).

Figure 5.5 shows the write protect tab location on the optical disk cartridge and the moving state of the write protect tab (see "write enabled" and write disabled" entered on the label).
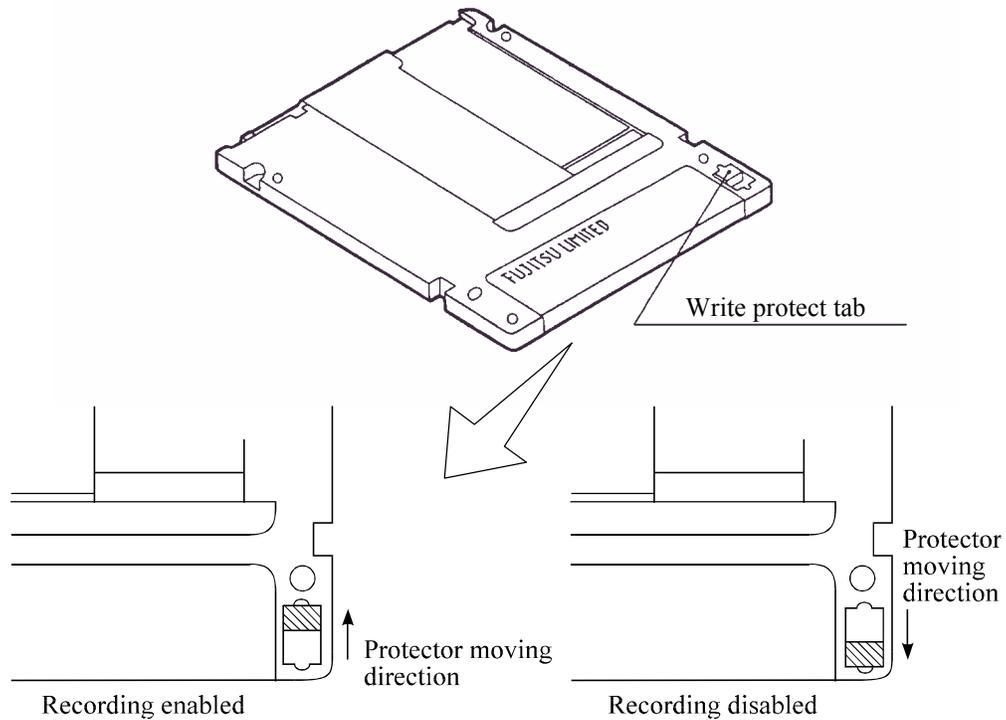


**Note:**

The hatched part indicates the write protect tab location.

**Figure 5.5    Write protect tab**

### 5.3.3 Notes

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

(1) When using the cartridge:

- Do not use the cartridge where exposed to direct sunlight or where the temperature changes sharply, the temperature is high, or the humidity is high.
- Do not apply excessive pressure to the cartridge case or shutter.  Avoid dropping the cartridge.
- Do not use the cartridge in a dusty or smoky place.
- Do not open the shutter or touch the disk surface.

(2) When storing the cartridge:

- Do not place a heavy objects on the cartridge.
- Do not store the cartridge where exposed to direct sunlight or where the temperature changes sharply, the temperature is high, or the humidity is high.
- Do not store the cartridge in a dusty or smoky place.

(3) When transporting the cartridge:

- Put the cartridge in a nylon bag to protect it from moisture.
- Put the cartridge in a strong container and cover the cartridge with cushioning material.

### 5.4 Cleaning Optical Disk Cartridge

Dust or cigarette smoke particulates on the disk surface lowers the performance of the cartridge. Regularly clean the disk.   The cleaning frequency depends on the drive installation environment. Determine how often the drive should be cleaned in consideration of the environment. A standard of he cleaning period is every 300 hours usage or once a 2 to 3 months.

### 5.4.1 Cleaning tool

Use the cleaning kit to clean the disk cartridge.

(1) Cleaning kit

This cleaning kit is only for 3.5-inch optical disk cartridge.   Use with reading the attached operation guide well.  Table 5.2 shows the order number of the cleaning kit.

**Table 5.2    Cleaning kit**

| Part name | Order number |
|-----------|--------------|
| Cleaning kit | CA90003-0702 |

Table 5.3 shows the packaged items in the cleaning kit.

**Table 5.3    Packaged items (cleaning kit)**

| Name | Contents |
|---|---|
| Setting case | 1 piece |
| Cleaning cloth | 5 pieces (70mm ×70mm) |
| Cleaning solution | 1 bottle (20ml) |

The following sub-kit is available as a set of the cleaning solution and cleaning cloth as supplement.

- Order No. CA90002-D901

**⚠CAUTION**

*Damage for disk medium*
*Use the cleaning solution and cleaning cloth specified in Table 5.2.  If other than the specified items is used, disk media surface may be damaged.*

(2)    Notes on usage and storage of cleaning kit

- When storaging the cleaning solution, tighten the cap.
- As the magnet is used at revolving knob of the setting case, do not place the floppy disk near the revolving knob.
- Do not use or storage where exposed to direct sun light or near the inflammables.
- Keep out of the reach of children.

**⚠CAUTION**

*Damage for data medium*
*Do not use this cleaning kit for the floppy disk or the optical disk cartridge used for other optical disk drive.*

**5.4.2    Cleaning procedure**

Clean the disk cartridge with a following procedure.

# ⚠CAUTION

*Damage for disk medium*
*Clean the cartridge at clean place.  Put a disposable groves at cleaning so that the fingerprint does not put on the disk media (recommendation).*

1)  Slide the shutter completely open.
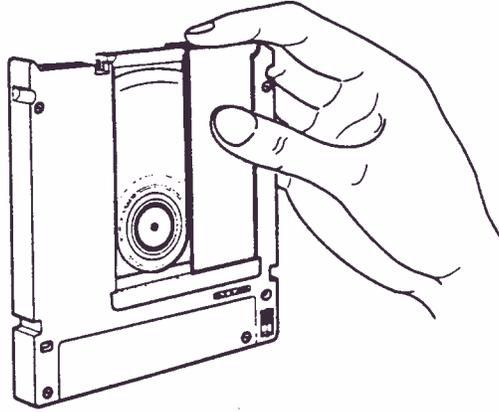


**Figure 5.6     Cleaning procedure (1)**

2)  Set the cartridge with keeping label side down and shutter open to the shutter stopper of the setting case as shown in Figure 5.7.
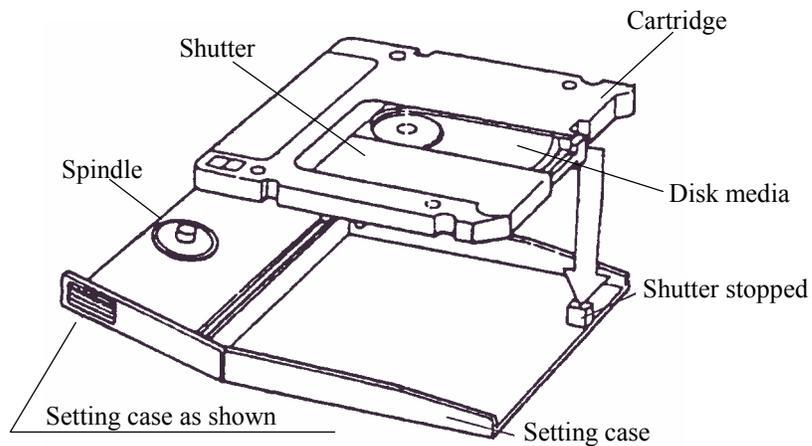


**Figure 5.7     Cleaning procedure (2)**

## ⚠CAUTION

*Damage for disk medium*
*At setting the cartridge to the setting case, do not apply the heavy shock*
*and push hardly.*


3)  Cover the cartridge with the setting case cover, then insert the spindle pin into the center hub
of the cartridge.
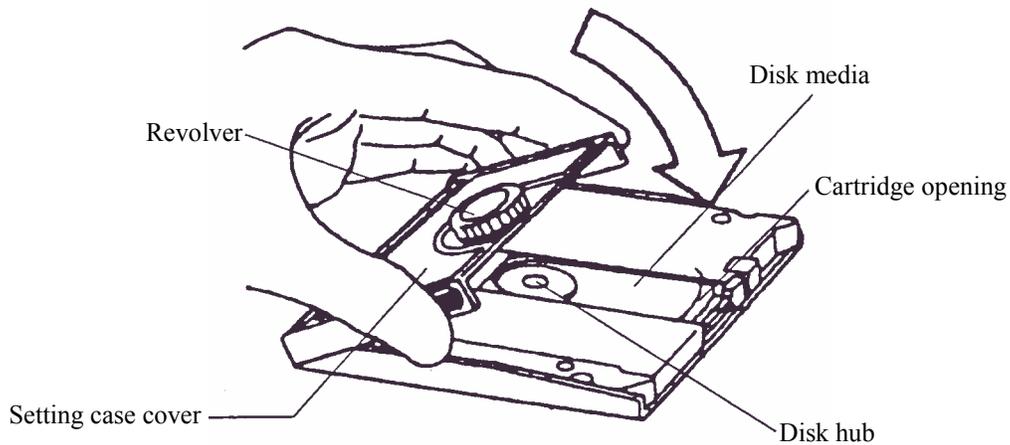


**Figure 5.8    Cleaning procedure (3)**


4)  Remove a slender piece that causes a defect from the disk surface at wiping the disk media.

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


## ⚠CAUTION

*Eye inflammation*
*In case of contact with eyes, immediately flush eyes with water.*


6)  Wipe the disk surface from the hub outward.

7) Turn the revolving knob, then wipe the disk surface.
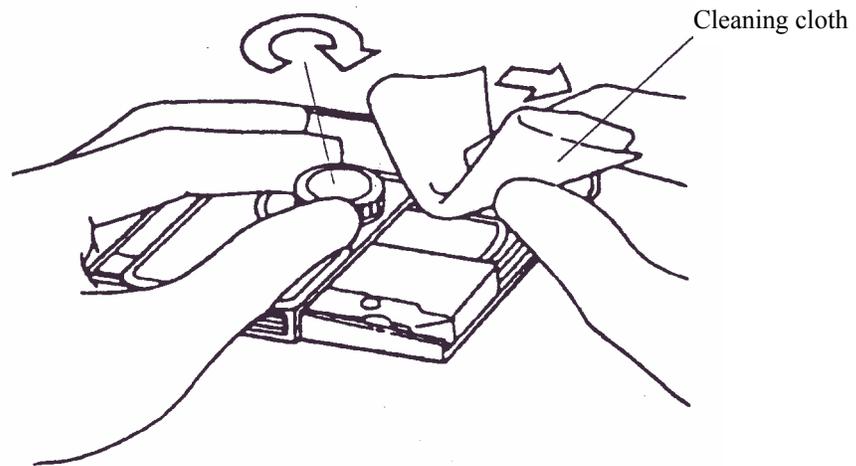
Cleaning cloth

**Figure 5.9    Cleaning procedure (4)**

8) If the excess cleaning solution remains on the disk surface, wipe out with the cleaning cloth.

# CHAPTER 6        DIAGNOSIS AND MAINTENANCE

> **6.1**    **Diagnosis**
>
> **6.2**    **Maintenance Information**

This chapter contains diagnosis and maintenance information.

## 6.1    Diagnosis

Table 6.1 shows a test executed by the diagnostic function.

The drive has a self-diagnostic function.  This function can check the basic operations of the drive.

A test program running in the host system is required to check general operations, including operations of the interface with the host system.  (See Subsection 6.1.3.)

**Table 6.1    Self-diagnostic function**

| Diagnostic contents | Target |
|---|---|
| Initial self diagnosis | Basic operation (hardware function test) |
| Diagnostic command | Basic operation |
| Test program | General operation |

### 6.1.1 Initial self-diagnosis

When the power is turned on, the optical disk drive starts initial self-diagnosis. Basic hardware functions are tested during initial self-diagnosis.

The hardware function test checks the normality of the basic controller operation. This test includes the normality check of the ROM in which microcodes are stored, microprocessor (MPU) peripheral circuit test, memory (RAM) test, and data buffer test.

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


### 6.1.2 Diagnostic command

The host system can make the ODD execute the self diagnosis by issuing the EXECUTIVE DEVICE DIAGNOSTIC command. See Section 4.7.2, "EXECUTIVE DEVICE DIAGNOSTIC", in details.


### 6.1.3 Test program

A test program running in the host system is required to check general operations such as operations of the interface with the host system and simulated operations.

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

The test program should include the following tests:


(1) Random/sequential read test

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


(2) Write/read test

Use a disk whose operation check data may be destroyed so that a write or read test can be executed with an arbitrary data pattern.

## 6.2    Maintenance Information

### 6.2.1    Maintenance requirements

(1)    Preventive maintenance

No preventive maintenance is required.


(2)    Service life

No overhaul is required within the first five years if the drive is used and handled in an appropriate environment.


(3)    Service system and repair

Fujitsu provides a service system and repair facility for its optical disk drive.  Submit information required to replace or repair the drive to your Fujitsu representative.  The following information should be included:

a)  Optical disk drive model, part number (P/N), revision number, serial number (S/N), and date of manufacture

b)  Failure status

- Date of the failure
- System configuration
- Environment conditions (temperature, humidity, and supply voltage)

c)  Failure history

d)  Failure

- Description of the failure
- Issued commands and specified parameters
- Sense data
- Other error analysis information

## ⚠ CAUTION

*Data loss*
*In case of regular repair, the optical disk cartridge should not be attached except where the cartridge causes the error.  And before having the drive repaired, save the data in the cartridge.  Fujitsu is not responsible for data lost during maintenance or repair.*


See Section 5.3.3 for details on packing and handling the drive when sending it to Fujitsu.

### 6.2.2 Revision number

The revision number of an optical disk drive is represented with an alphabetic character and a single-digit number.  The revision number is shown on the revision label attached to the drive.  For example, Figure 6.1 shows the MCE3130SS revision label format.



— Revision number

**Figure 6.1      Revision label**

(1)      Revision number indication

When the drive is shipped, the revision number is indicated by deleting the numbers up to the corresponding number on the line of alphabetic characters.  (Each number is deleted with double lines =.  See Figure 6.2.)

(2)      Changing the revision number on site

When the revision number is changed on site because of parts replacement or modification, the new revision number is indicated by circling the number on the line of alphabetic characters.  (See Figure 6.2.)

<u>**NOTICE**</u>

*When 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 when changing the revision number.*

Revision number indicated on shipment

REV.    NO.    A    0̶    1̶    2̶    3    4    5    6    7    8    9        ⇒ Revision A2

Revision number changed on site

REV.    NO.    A    0̶    1̶    2̶    ③    4    5    6    7    8    9        ⇒ Revision A3

**Figure 6.2      Revision number indication**

# Glossary

### Axial acceleration

Acceleration on the recording layer along with the line perpendicular to the disk reference surface to a specified rotation speed. Axial acceleration is detected by optical means.

### Axial displacement

A displacement at a point on the recording layer in a direction perpendicular to the disk reference surface from its original standard position. The standard position on the recording layer is detected optically using the thickness of the protective layer and refraction rate based on the disk reference surface.

### Case

A cover of the optical disk. The case protects the disk from being damaged during handling and also allows the operator to exchange disks easily. The case also contains a label, write protection tab, automatic handling support, and media identification hole.

### CDB (Command Descriptor Block)

A series of data describing input-output commands. CDB is sent from the initiator to the target.

### Clamp area

A ring area on the disk on which a clamp force is applied by the clamp mechanism.

### 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 the optical disk.

### Defect management

In real time, an automatic program used to change the power, focus, tracking of reading and recording if an error is detected and to decide if many error sectors should be discarded. In batch mode, a guideline used to re-record or save the disk.

### Disk reference surface

An ideal flat ring surface of an ideal spindle that is in contact with the clamp area on the disk. It 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 data by adding a redundant code to data in the existing format. In read mode, the decoder removes a redundant code and detects and corrects errors using 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 layer on the disk on which data is recorded at production or recording .

### Recording power

An incidence power specified on the incidence surface. Used to form marks.

### Sense code

A single-byte code set in sense data. This information is used to determine the type of error detected.

### Sense data

Information generated by the target to report detailed error information if any error information is contained in the command end status.

**Sense key**

A 4-bit code set in sense data. This information is used to classify the type of error detected.

**Spindle**

A component of the disk drive unit that is in contact with the disk and hub.

**Status**

A single-byte information reported from the target to the initiator at the end of each command execution. The status indicates the end status of a command.

# Abbreviations

## A

| | |
|---|---|
| AC | Alternating Current |
| ACK | ACKnowledge |
| ALPG | 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 for Information Interchange |
| ASCQ | Additional Sense Code Qualifier |
| ATN | ATteNtion |
| AWG | American Wire Gauge |
| AWRE | Automatic Write Reallocation Enabled |

## B

| | |
|---|---|
| BCV | Buffer Control Valid |
| BPV | Bit Pointer Varid |
| BSY | BuSY |
| BytChk | Byte Check |

## C

| | |
|---|---|
| C/D | Control/Data |
| CCS | Common Command Set |
| CDB | Command Descriptor Block |
| CDRH | Center for Devices and Rediological Health |
| CRC | Cyclic Redundancy Code |
| CSA | Canadian Standards Association |

## D

| | |
|---|---|
| DB | Data Bus |
| DBD | Disable Block Descripter |
| 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 Processor |

## E

| | |
|---|---|
| EBC | Enable Blank Check |
| EBP | Erase By-Pass |
| ECC | Error Correction 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 | MeSeaGe |
| MTBF | Mean Time Between Failures |
| MTTR | Mean Time To Repair |

**N**

N.C.        No Connection

**O**

ODD        Optional 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 ground
SKSV        Sense Key Specific Valid
SM        Sector Mark
SNSKEY        SeNSe KEY
SP        Save Page
SP        Save Parameter
STPF        SToP Format
SYNC        SYNCronization 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

# Index

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