FUJITSU

MAF3364FC SERIES
MAG3182FC, MAG3091FC SERIES

DISK DRIVES

FIBRE CHANNEL INTERFACE

PRODUCT MANUAL

C141-E078-02EN

REVISION RECORD

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The contents of this manual is subject to change without prior notice.

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FOR SAFE OPERATION

Handling of This manual

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

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

Functional Limitations

There may be certain functional limitations concerning the specifications and functions of the products covered by this manual depending on the equipment version, especially concerning the following functions.

Versions in which there functions can be used will be communicated through “ENGINEERING CHANGE REQUEST/NOTICE”, issued by Fujitsu.

	Function	Equipment Version Which Supports These Functions		
		Equipment Version No.	EPROM Version No.	Standard INQUIRY Data Product Revision (ASCII)
	READ RAM Command WRITE RAM Command	┐ ├ These commands cannot be used in the current version. ┘		

(Proceed to the Copyright Page)

Related Standards

Specifications and functions of products covered by this manual comply with the following standards.

Standard (Text) No.		Name	Enacting Organization
NCITS TR-19		FIBRE CHANNEL PRIVATE LOOP SCSI DIRECT ATTACH (FC-PLDA)	American National Standards Institute (ANSI)
ANSI	X3.230-1994	FIBRE CHANNEL PHYSICAL AND SIGNALING INTERFACE (FC-PH)	American National Standards Institute (ANSI)
ANSI	X3.297-1996	FIBRE CHANNEL PHYSICAL AND SIGNALING INTERFACE-2 (FC-PH-2)	American National Standards Institute (ANSI)
ANSI	X3.272-199X	FIBRE CHANNEL ARBITRATED LOOP (FC-AL)	American National Standards Institute (ANSI)
ANSI	X3.269-199X	FIBRE CHANNEL PROTOCOL FOR SCSI (SCSI-FCP)	American National Standards Institute (ANSI)

PREFACE

This manual describes the MAF3364FC, MAG3182FC and MAG3091FC (hereafter, MAG series) series 3.5-inch fixed disk drives with an embedded fibre-channel controller.

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

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

Chapter 1 GENERAL DESCRIPTION

This chapter introduces the MAF3364FC and MAG series disk drives and discusses their standard features, hardware, and system configuration.

Chapter 2 SPECIFICATIONS

This chapter gives detailed specifications of the MAF3364FC and MAG series disk drives and their installation environment.

Chapter 3 DATA FORMAT

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

Chapter 4 INSTALLATION REQUIREMENTS

This chapter describes the basic physical and electrical requirements for installing MAF3364FC and MAG series disk drives.

Chapter 5 INSTALLATION

This chapter explains how to install MAF3364FC and MAG series disk drives. It includes the notice and procedures for setting device number and operation modes, mounting the disk drive, and confirming drive operation.

Chapter 6 DIAGNOSIS and MAINTENANCE

This chapter describes the automatic diagnosis, and maintenance of the MAF3364FC and MAG series disk drives.

APPENDICES A to D

The appendixes give supplementary information, including the locations of mounting connectors, a list of setting items, the signal assignments of interface connectors, lists of model names and product numbers, and SCSI interface functions.

Glossary

Abbreviations

CONVENTIONS

This manual uses the following conventions for alerts to prevent physical or property damages to users or by standards.

⚠DANGER

⚠ DANGER indicates that personal injury *will* occur if the user does not perform the procedure correctly.

⚠WARNING

⚠ WARNING indicates that personal injury *could* occur if the user does not perform the procedure correctly.

⚠CAUTION

⚠ CAUTION indicates that either minor or moderate personal injury *may* occur if the user does not perform the procedure correctly.

NOTICE

NOTICE indicates that inconvenience to the user such as damages to the product, equipment, data, and/or other property may occur if the user does not pay attention or perform the procedure correctly.

IMPORTANT

IMPORTANT indicates information that the helps the user use the product more effectively.

Indicates

This manual indicates;

Decimal number: Indicates as it is.

Hexadecimal number: Indicates as X'17B9', 17B9h, or 17B9H

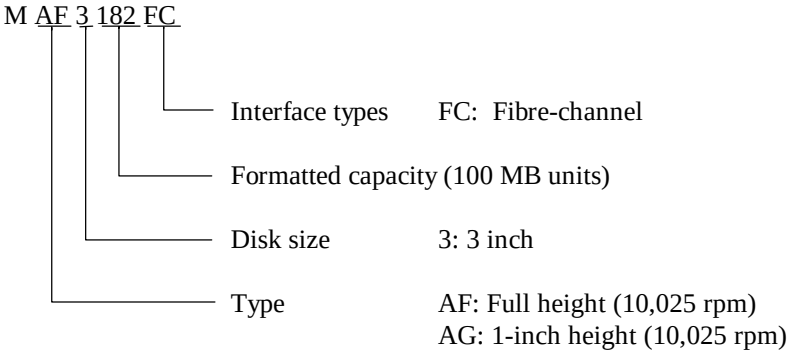
Binary number: Indicates as "010" or 010b

DISCLAIMER

Failure of the MAF3364FC and MAG series intelligent disk drive is defined as a failure requiring adjustments, repairs, or replacement. Fujitsu is not responsible for drive failures caused by misuse by the user, poor environmental conditions, power trouble, host problems, cable failures, or any failure not caused by the drive itself.

The suffix of the model name of this disk drive varies depending on the two device types and storage capacity (Note 1). However, in this manual, the typical model names (Note 2) are used unless otherwise noted. These disk drives may be called intelligent disk drives (IDD), drives, or devices in this manual.

Note 1: Model names



Note 2: Type model name

Type model name	Model name
MAF3364	MAF3364FC
MAG3182	MAG3182FC
MAG3091	MAG3091FC

SAFETY PRECAUTIONS

List of Important Precautions

This manual includes the following important precautions:

⚠CAUTION Indicates that either minor or moderate personal injury may occur or may cause damages to this product itself or property of other users if the user does not perform the procedure correctly.

Work division	Precaution	Page
Assembly/installation	Damage to drive A hole or screw portion as shown in Figure 4.8 is used for adjusting air pressure balance between inside and outside the DE. Do not fill with a seal or label. Seals on the DE prevent the DE inside from the dust. Do not damage or peel off labels.	4-8
	Damage 1. When dismounting the drive which is mounted on the system while power is supplied to it. • The drive to be dismounted must be separated from the loop. Dismounting the drive which is not separated from the loop may cause an unexpected error. • If the drive is not separated from the loop, issue an LPB to the drive from the initiator in a primitive sequence of the order set. • It is recommended to stop the spindle motor prior to this loop separation operation. The spindle motor can be stopped by a START/STOP command. It takes about 30 seconds for the spindle motor to stop completely. • Then, dismount the drive using the drive mounting/dismounting mechanism, etc. of the system. If the drive is dismounted while the spindle motor is running, special care is required to avoid excessive vibration or shock to the drive. It is recommended to stop the operation once the SCA connector breaks off contact and wait until the spindle motor stops (about 30 seconds) before dismount the drive. • When storing or transporting the drive, put it in an antistatic bag. (Shown in Section 5.1). 2. When dismounting the drive which is mounted on the system while power is not supplied to it • Do not move the drive until the drive stops completely (about 30 seconds if the spindle motor was stopped by a START/STOP UNIT command, and about 30 seconds after powering-off when the power was simply turned off). • Then, dismount the drive using the drive mounting/dismounting mechanism, etc. of the system. • When storing or transporting the drive, put it in an antistatic bag. (Shown in Section 5.1).	5-15

Work division	Precaution	Page
	Data loss When the SEND DIAGNOSTIC command terminates with the CHECK CONDITION status, the INIT must collect the error information using the REQUEST SENSE command. The RECEIVE DIAGNOSTIC RESULTS command cannot read out the error information detected in the self-diagnostics.	6-4
	Damage Do not open the DE in the field because it is completely sealed.	6-5
	Data loss Save data stored on the disk drive before requesting repair. Fujitsu does not assume responsibility if data is destroyed during servicing or repair.	6-6

MANUAL ORGANIZATION

FIBRE CHANNEL INTERFACE PRODUCT MANUAL (This manual)	1. General Description 2. Specifications 3. Data Format 4. Installation Requirements 5. Installation 6. Diagnostics and Maintenance
FIBRE CHANNEL INTERFACE SPECIFICATIONS	1. Fibre Channel Interface 2. Command Processing 3. Data Buffer Management 4. Command Specification 5. Sense Data and Error Recovery Procedure 6. Disk Medium Management
FIBRE CHANNEL INTERFACE MAINTENANCE MANUAL	1. Specifications and Equipment Configuration 2. Maintenance and Diagnostic 3. Error Analysis 4. Removal and Replacement Procedures 5. Principle of Operation

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FIGURES

TABLES

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CHAPTER 1 GENERAL DESCRIPTION

This chapter describes the feature and configuration of the intelligent disk drives (IDD).

MAF3364FC and MAG series intelligent disk drives (IDDs) are high performance large capacity 3.5-inch fixed disk drives with an embedded fibre-channel controller.

The interface between the MAF3364FC/MAG series intelligent disk drives and host system conforms to the fibre channel PLDA standard [NCITS TR-19 FIBRE CHANNEL PRIVATE LOOP SCSI DIRECT ATTACH (FC-PLDA] which covers from the fibre channel physical layer to SCSI command protocol.

A combination of the high transfer speed and long-distance transfer of the fibre channel and high function command set of the MAF3364FC and MAG series intelligent disk drives will facilitate construction of a high performance and highly reliable disk subsystem with large storage capacity.

With respect to data formatting, it is possible to change it to a format different from the one at the time of shipment by performing reinitialization on the installed system.

1.1 Standard Features

(1) Compactness

The IDD has the FC-AL controller which supports the Arbitrated Loop (FC-AL) of the fibre channel modes defined by the ANSI standard, embedded in the 3.5-inch fixed disk drive form factor.

(2) FC-AL standard

The IDD provides not only FC-AL basic functions but also the following features:

- Arbitration
- Data frame CRC function
- Command set which meets the logical specification of the SCSI CCS (Common Command Set for Direct Access Device) requirements (Rev. 4.B)

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

(3) Dual port support

In order to support dual ports, the IDD is equipped with two pairs of fibre channel driver/receiver.

(4) High speed data transfer

The data transfer rate on the fibre channel loop is 106.25 MB/s maximum. In addition, the large capacity data buffer of the IDD allows the user to make full use of the high speed data transfer capability of the fibre channel loop.

(5) High speed spindle motor

The IDD increases the number of revolutions of the spindle motor from conventional 7,200 rpm to 10,025 rpm. Increasing the number of revolutions of the spindle motor will make it possible to improve the data transfer rate and reduce the rotation wait time.

(6) Continuous block processing

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

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

(7) 4MB programmable multi-segment data buffer

Data is transferred between fibre-channel loop and disk media through the embedded 4MB data buffer in the IDD. This buffer can be divided into maximum 32 areas. This feature provides the suitable usage environment for users.

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

(8) Read-ahead cache feature

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

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

(9) Command queuing feature

The IDD can queue maximum 63 commands, and optimizes the issuing order of queued commands by the reordering function. This feature realizes the high speed processing.

(10) Reserve and release functions

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

(11) Enclosure service function

The IDD supports an enclosure service interface (ESI) compliant with the SFF-8067. This interface provides the function of setting/readin enclosure service information using the SCSI-3 enclosure service command set (SES).

(12) Error recovery

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

(13) Automatic alternate block reassignment

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

(14) Programmable data block length

Data can be accessed in fixed-block length units. The data block length is programmable, and can at initializing with a multiple of four for the 512 to 528 bytes.

(15) Defective block slipping

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

(16) High speed positioning

A rotary voice coil motor achieves fast positioning.

(17) Large capacity

A large capacity can be obtained from 3-inch disk drives by dividing all cylinders into several partitions and changing the recording density on each partition (constant density recording). The disk subsystem with large capacity can be constructed in the good space efficiency.

(18) Start/Stop of spindle motor

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

(19) Diagnosis

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

(20) Low power consumption

By using highly integrated LSI components, the power consumption of the IDD is very low, and this enables the unit to be used in wide range of environmental conditions.

(21) Low noise and low vibration

The noise level is low: Approx. 4.2 bels for the MAF3364FC and 4.0 bels for the MAG series. This makes it ideal for office use. The IDD has rubber vibration isolators, which minimize the transfer of vibration.

(22) Microcode downloading

The IDD implements the microcode download feature. This feature achieves easy maintainability of the IDD and function enhancing.

1.2 Hardware Structure

An outer view of the IDD is given in Figures 1.1 and 1.2. The IDD is composed of the disk, head, spindle motor, hermetically sealed disk enclosure (DE) with actuator and air circulation filter, as well as read/write pre-amp with the print card unit (PCA) of the controller.

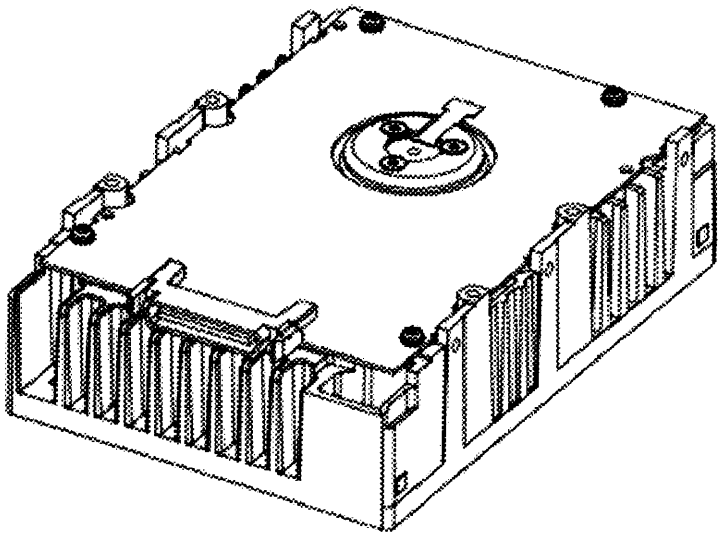


Figure 1.1 MAF3364FC outer view

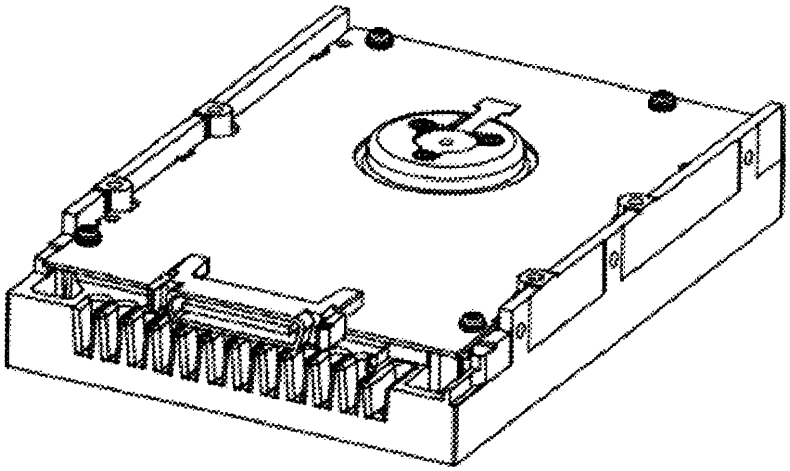


Figure 1.2 MAG series outer view

(1) Disks

The disks have an outer diameter of 84 mm (3.31 inch) and inner diameter of 25 mm (0.98 inch). The disks are good for at least 15,000 contact starts and stops. Each model contains following number of disks.

MAF3364:10
MAG3182:5
MAG3091:3

(2) Heads

The MR (Magnet - Resistive) of the CSS (contact start/stop) type heads are in contact with the disks when the disks are not rotating, and automatically float when the rotation is started. Figure 1.5 shows the configuration of disks and heads.

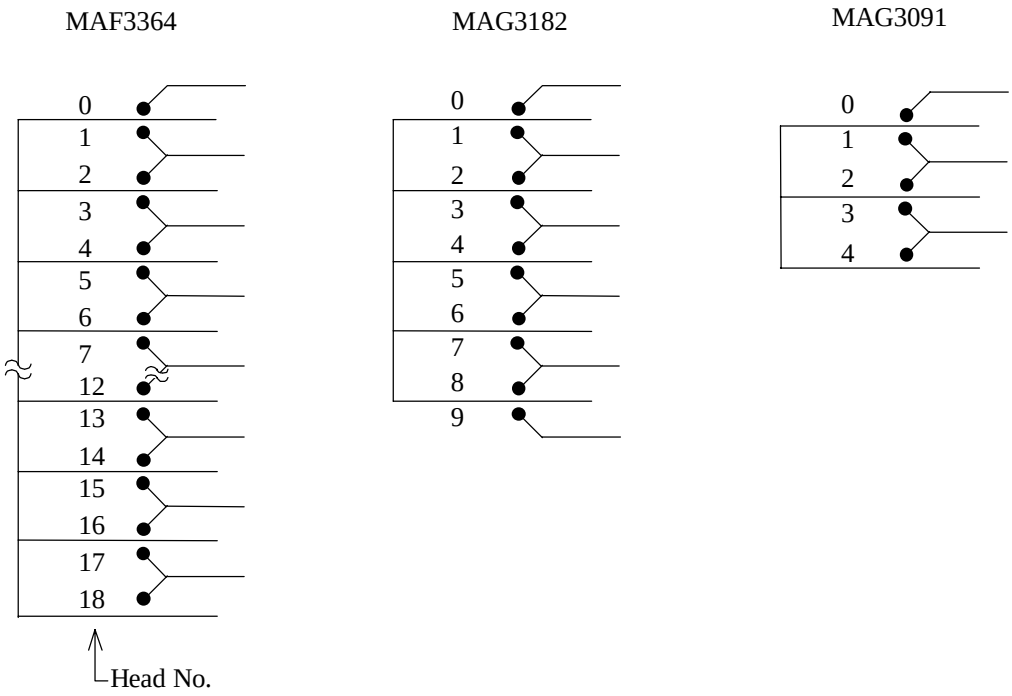


Figure 1.3 Disk/head configuration

(3) Spindle motor

The disks are rotated by a direct-drive hall-less DC motor. The motor speed is controlled by a feedback circuit using the counter electromotive current to precisely maintain the speed at ±0.5% of the specified speed.

(4) Actuator

The actuator, which uses a rotary voice coil motor (VCM), consumes little power and generates little heat. The head assembly at the end of the actuator arm is controlled and positioned via feedback of servo information in the data.
The actuator positions heads on the CCS zone over the disk and is locked by the mechanical lock when the power is off or the spindle motor is stopped.

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

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

(6) Read/write circuit

The read/write circuit uses head LSI chips and extended partial response class 4 maximum likelihood (EPR4ML) modulator and demodulator circuit to prevent errors caused by external noise, thus improving data reliability.

(7) Controller circuit

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

1.3 System Configuration

As the fibre channel mode, the ANSI standard defines three modes: Arbitrated Loop, Fabric and Point-to-Point. This drive supports Arbitrated Loop (FC-AL). Figure 1.4 shows an example of the system configuration.

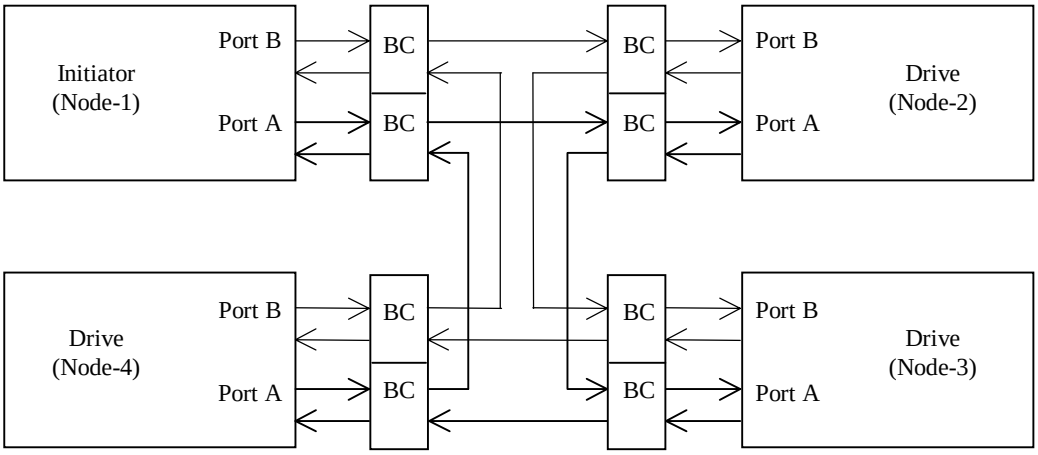


Figure 1.4 FC-AL system configuration

The mode of connection of all devices to the fibre channel is called “node.” The drive and initiator correspond to the node shown in Figure 1.4. Each node has at least one port called “N-port.” In the FC-AL, a port is particularly called “node loop (NL) port.” The MAF3364FC and MAG series have two ports; one is connected to one FC-AL and a maximum of 126 NL ports can be connected to one loop.

(1) Loop configuration

One port incorporates a transmit circuit and receive circuit. Information is transmitted/received by differential signals via electric signal lines. This pair of signal lines is called a link. Since signals on a link are transmitted in one direction, wiring must be conducted so that it may form a loop connection on the system.

In the case of the FC-AL interface, information is transmitted/received via each node connected on a loop. Accordingly, if the power supply is off at a node connected to the loop or if interface signals cannot be transmitted/received normally, the loop will no longer function. To avoid such a nonconformity, a circuit called “port bypass circuit” is generally provided on the back plane of the system. BC in Figure 1.4 shows this port bypass circuit.

(2) Node addressing

Each node on the fibre channel loop is assigned its specific model number (SEL ID). The SEL ID of the drive is set at the signal level on the back plane through 7 signals from SEL_0 to SEL_6 of the SCA interface connector (CN1). In signal bit weighting, SEL_6 is the MSB indicating 2^6 and SEL_0 is the LSB indicating 2^0.

The SEL ID setting of the drive ranges from #0(x‘00’) to #125(x‘7D’).

CHAPTER 2 SPECIFICATIONS

2.1 Hardware Specifications

This chapter describes specifications of the IDD.

2.1 Hardware Specifications

2.1.1 Model name and part number

The IDD is provided with various models according to the device type, device capacity, etc.

For the model name (type) and product number, refer to the model name/product number list Appendix D.
With respect to data formatting, it is possible to change it to a format different from the one set at the time of shipment by performing reinitialization on the installed system.

2.1.2 Function specifications

Table 2.1 shows the function specifications of the IDD.

Table 2.1 Function specifications

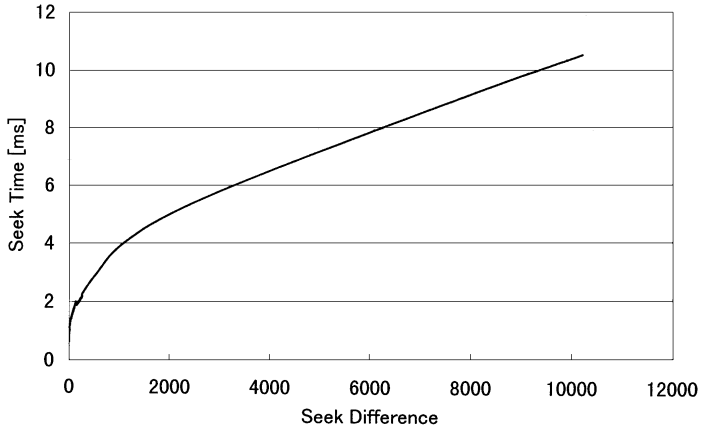
Item		Specification		
		MAF3364	MAG3182	MAG3091
Formatted capacity/device (*1)		36.4 GB	18.2 GB	9.1 GB
Unformatted capacity/device		45.6 GB	23.0 GB	11.5 GB
Number of disks		10	5	3
Number of heads		19	10	5
Number of cylinders (*2)		10,200	9,866	
Formatted capacity/track		143,872 to 215,040	139,776 to 215,040	
Number of rotations (rpm)		10,025±0.5%		
Average latency time		2.99 ms		
Seek time (*3) (Read/Write)	Minimum Average Maximum	0.7 ms (Read)/ 0.9 ms (Write) 5.7 ms (Read)/ 6.2 ms (Write) 12.0 ms (Read)/ 13.0 ms (Write)	0.7 ms (Read)/ 1.1 ms (Write) 5.2 ms (Read)/ 5.8 ms (Write) 11.0 ms (Read)/ 12.0 ms (Write)	
Start/stop time (*4)	Start time Stop time	30 s typ. (60 s max.) 30 s typ.		
Recording mode		16/17 EPR4ML		
Recording density		283,000 bpi	275,000 bpi	
Track density		13,500 TPI		
External dimensions	Height Width Depth	41.3 mm 101.6 mm 146.0 mm	25.4 mm 101.6 mm 146.0 mm	
Weight		1.1 kg	0.7 kg	
Power consumption (*5)		17 W	13 W	
Interface		Cable length: 30 m max.		
Data transfer rate	Disk drive	29.5 to 45.0 MB/s		
	FC-AL	106.25 MB/s max.		
Logical data block length		512 to 528 byte		
SCSI command specification		SCSI-2 (ANSI X3T9.2/86-109 Rev 10h) command support SCSI-3 command partial support Fujitsu-specific command		
Data buffer		4 MB FIFO ring buffer, multi-segment buffer: Segment count 1 to 32, Read-ahead cache		

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

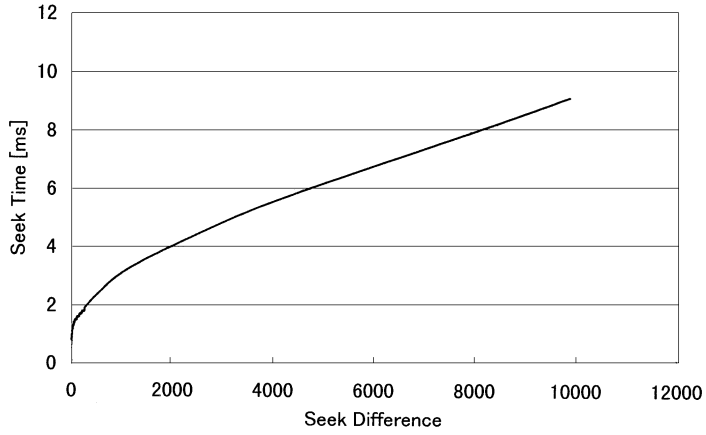
(*2) The number of user cylinders indicates the max., and includes the alternate cylinder. The number of user cylinders and alternate cylinders can be specified at format of the IDD.

(*3) The seek time is as follows:

MAG3364FC Seek Time



MAG series Seek Time



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

(*5) This value indicates at ready mode.

2.1.3 Environmental specifications

Table 2.2 lists environmental and power requirements.

Table 2.2 Environmental/power requirements

Item			Specification		
			MAF3364FC	MAG3182FC	MAG3091FC
Temperature (*1)	Operating		5 to 50°C		
	Non-operating		– 40 to 60°C		
	DE surface temperature at operating		5 to 55°C		
	Gradient		15°C/h or less		
Relative humidity	Operating		20 to 80%RH		
	Non operating		20 to 80%RH Packaged (inside of a week) 5 to 90%RH		
	Maximum wet bulb temperature		29°C (no condensation)		
Vibration (*2)	Operating (*3)		0.3 mm (5 to 20Hz)/0.5G (20 to 250 Hz) or less		
	Non-operating (*4)		3.1 mm (5 to 20Hz)/5G (20 to 250Hz) or less Packaged 3.1 mm (5 to 20Hz)/5G (20 to 250Hz) or less		
Shock (*2)	Operating		20G (2 ms)		
	Non-operating		175G (2 ms)		
Altitute	Operating		– 60 m to 3,000 m (above sea level)		
(above sea level)	Non-operating		– 60 m to 12,000 m (above sea level)		
Power requirements Input power (*5)	+12 VDC ±5%	Ready (Average) Spin-up, Seek Peak within 100 µs at spin-up	0.95 A 2.5 A (Max) 3.2 A	0.65 A 2.5 A (Max) 3.0 A	
	+5 VDC ±5%	Ready	1.4 A	1.3 A	
		Random W/R (about 80 IOPS)	1.7 A	1.6 A	
	Ripple (*6)		+5 V 250 mVp-p, +12 V 250 mVp-p		

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

(*2) Vibration applied to the drive is measured at near the mounting screw hole on the DE base as much as possible.

(*3) At random seek write/read and default on retry setting with log sweep vibration.

(*4) At power-off state after installation

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

(*6) High frequency noise is less than 250 mVp-p.

2.1.4 Error rate

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

(1) Unrecoverable error rate

Errors which cannot be recovered within 63 retries and ECC correction should not exceed 10 per 10^{15} bits.

(2) Positioning error rate

Positioning errors which can be recovered by one retry should be 10 or less per 10^{8} seeks.

2.1.5 Reliability

(1) Mean Time Between Failures (MTBF)

MTBF of the IDD during its life time is 1,000,000 hours (operating: 24 hours/day, 7 days/week average DE surface temperature: 40°C or less).

Note:

The MTBF is defined as:

$$\text{MTBF} = \frac{\text{Operating time (hours) at all field sites}}{\text{The number of equipment failures (*1) from all field sites}}$$

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

(2) Mean Time To Repair (MTTR)

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

(3) Service life

The service life is depending on the environment temperature. Therefore, the user must design the system cabinet so that the average DE surface temperature is as possible as low.

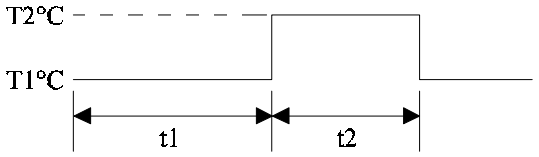
The service life under suitable conditions and treatment is as follows.

- DE surface temperature: 40°C or less 5 years
- DE surface temperature: 41°C to 45°C 4.5 years
- DE surface temperature: 46°C to 50°C 4 years
- DE surface temperature: 51°C to 55°C 3.5 years
- DE surface temperature: 56°C and more Strengthen cooling power so that DE surface temperature is 55°C or less.

Even if the IDD is used intermittently, the longest service life is 5 years.

Note:

The "average DE surface temperature" means the average temperature at the DE surface throughout the year when the IDD is operating.



$$\text{Average DE surface temperature} = \frac{T1 \times t1 + T2 \times t2}{t1 + t2}$$

(4) Data security at power failure

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

CHAPTER 3 DATA FORMAT

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

3.1 Data Space

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

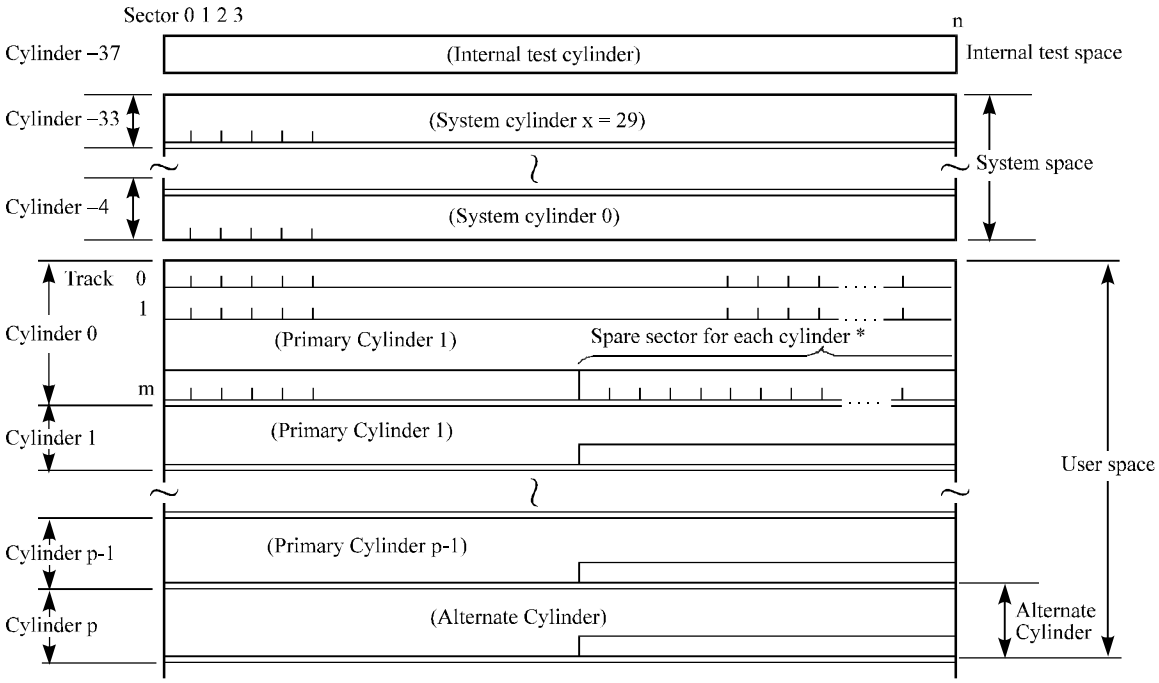
- User space: Storage area for user data
- Internal test space: Reserved area for diagnostic purposes
- System space: Area for exclusive use of IDD itself

The user space allow a user access by specifying data. These space can be accessed with the logical data block addressing method described in Section 3.2. The internal test space is used by Read/write test of self-diagnostics test, but user can't use direct access. The system space is accessed inside the IDD at power-on or during the execution of a specific command, but the user cannot directly access the system space.

3.1.1 Cylinder configuration

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

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



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

Figure 3.1 Cylinder configuration

Apart from the above logical configuration, the IDD intends to increase the storage capacity by dividing all cylinders into several zones and changing a recording density of each zone. Tables 3.1 and 3.2 show the zone layout and the track capacity.

Table 3.1 Zone layout and track capacity (MAF3364FC)

Zone	0	1	2	3	4	5	6
Cylinder	0 to 899	900 to 1,999	2,000 to 3,019	3,020 to 3,729	3,730 to 4,029	4,030 to 4,669	4,670 to 5,189
Byte/track	267,428	267,428	267,428	260,017	256,665	249,755	244,019
Sector/track	420	420	420	405	400	390	380

Zone	7	8	9	10	11	12	13
Cylinder	5,190 to 5,459	5,460 to 6,459	6,460 to 7,369	7,370 to 7,929	7,930 to 8,399	8,400 to 9,519	9,520 to 10,199
Byte/track	240,931	229,596	218,471	211,617	205,757	191,178	181,401
Sector/track	376	360	340	330	320	300	281

Remarks: The sector/track capacities are expressed in values when the logical data block is 512 bytes long.

Table 3.2 Zone layout and track capacity (MAG series)

Zone	0	1	2	3	4	5	6
Cylinder	0 to 679	680 to 1,559	1,560 to 2,409	2,410 to 3,139	3,140 to 3,469	3,470 to 4,119	4,120 to 4,659
Byte/track	267,428	267,428	267,428	260,410	256,969	250,231	244,449
Sector/track	420	420	420	405	400	390	381

Zone	7	8	9	10	11	12	13
Cylinder	4,660 to 4,939	4,940 to 5,989	5,990 to 6,919	6,920 to 7,499	7,500 to 7,979	7,980 to 9,149	9,150 to 9,865
Byte/track	241,779	229,631	218,894	211,976	206,169	191,474	176,273
Sector/track	377	360	340	330	320	300	273

Remarks: The sector/track capacities are expressed in values when the logical data block is 512 bytes long.

(1) User space

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

The default number of cylinders in the user space is 10,200 for MAF3364FC and 9,866 for MAG series. The user, however, can select the number of cylinders to be allocated in the user space by specifying 10,200 for MAF3364FC and 9,866 for MAG series as the maximum and the number of alternate cylinders + 1 as the minimum. The user can also specify the number of logical data blocks to be placed in the user space with the MODE SELECT or MODE SELECT EXTENDED command. When the number of logical data blocks is specified, as many cylinders as required to place the specified data blocks are allocated in the user space.

A number starting with 0 is assigned to each cylinder required in the user space in ascending order. If the number does not reach 10,200 (MAF3364FC) and 9,866 (MAG series), the rest of the cylinders will not be used.

Always one alternate cylinders can be established in the user space. Alternate cylinders will be used for alternate blocks when primary cylinders in the user space are used up. See Subsections 3.1.2 and 3.3.2 for details.

(2) Internal test space

The Internal test space is an area for diagnostic purposes only and its data block length is always 512 byte. The internal test space consists of only 1 cylinder and outer-host cylinder (–37) is always assigned. The user cannot change the number of cylinders in the internal test space or their positions.

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

(3) System space

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

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

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

Note:

The system space is also called SA space.

3.1.2 Alternate spare area

The alternate spare area is provided in the last track of each primary cylinder in the user space, and in the last track of the cylinder and the alternate cylinder.

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

Size can be specified by the MODE SELECT or MODE SELECT EXTENDED command.

The number of spare sectors per cylinder can be specified exceeding 32. The default number of spare sectors per cylinder is 20 for the MAF3364FC and MAG3182FC and 12 for the MAG3091FC.

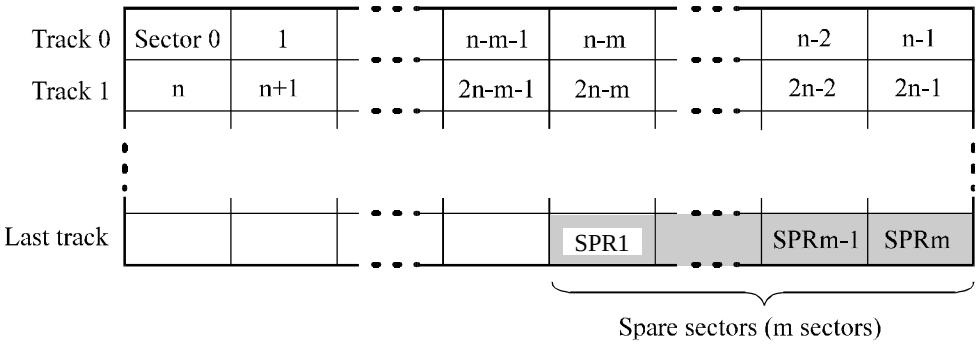


Figure 3.2 Spare area in cylinders

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

The number of alternate cylinder is 1.

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

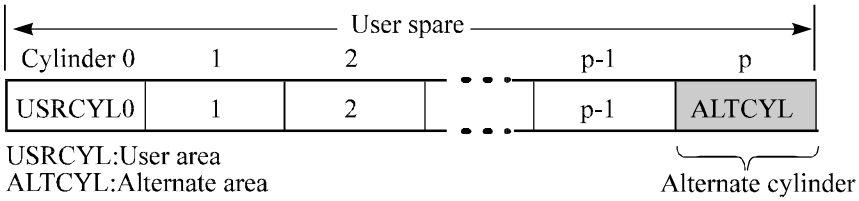


Figure 3.3 Alternate cylinder

3.1.3 Track format

(1) Physical sector allocation

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

The interval of the sector pulse (length of the physical sector) is decided by multiple of 20MHz free running frequency. This clock is not equal to the interval of the byte clock for each zone. Therefore, the physical sector length cannot be described with a byte length.

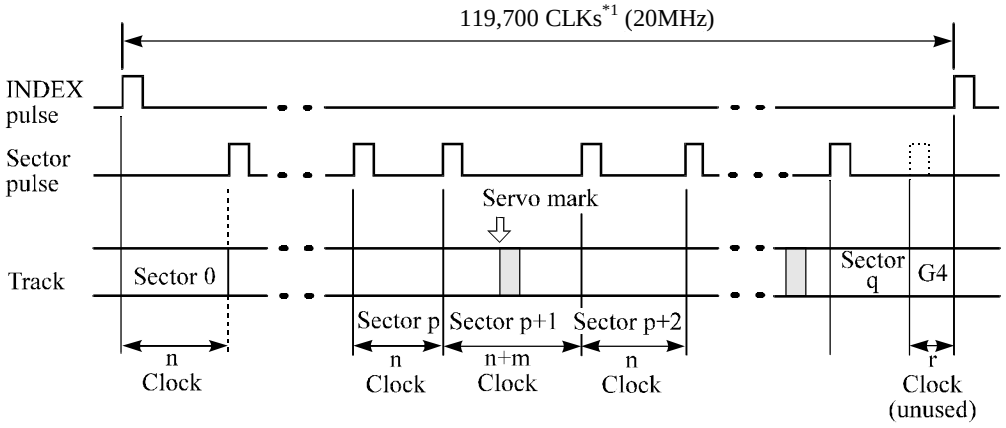


Figure 3.4 Track format

*1: MAF3364FC, MAG series

(2) Track skew and cylinder skew

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

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

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

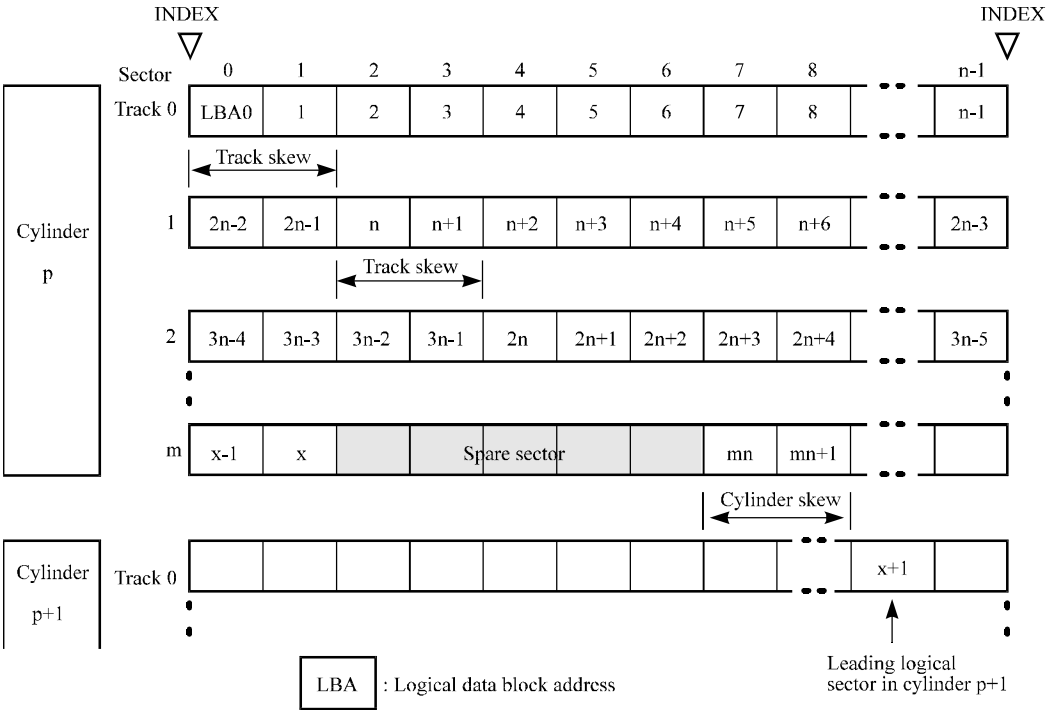
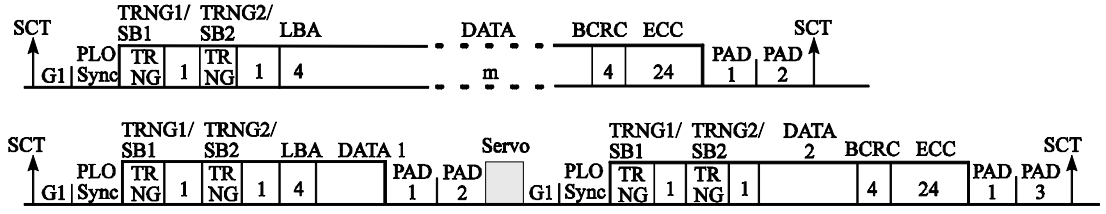


Figure 3.5 Track skew/cylinder skew

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

3.1.4 Sector format

Each sector on the track consists of an ID field, a data field, and a gap field which separates them. Figure 3.6 and Table 3.3 gives sector format examples.



G1: 8 bytes
PLO Sync: 17 bytes
TRNG1/SB1: 5 bytes
TRNG2/SB2: 6 bytes
PAD 1: 7 bytes
PAD 2: 8 bytes
PAD 3: 6 bytes

Figure 3.6 Sector format

Each sector on the track consists of the following fields:

(1) Gaps (G1)

The gap length at the time of formatting (initializing) is listed in Figure 3.7. Pattern X'00' is written on the gap field.

(2) PLO Sync

In this field, pattern X'00' in the length in bytes listed in Figure 3.6 is written.

(3) Trailing (TRNG)/Sync Byte (SB)

In this field, special pattern in the length in bytes listed in Figure 3.6 is written.

(4) LBA

The logical block address is written in this field.

(5) Data field

User data is stored in the data field of the sector. The length of the data field is equal to that of the logical data block which is specified with a parameter in the MODE SELECT command. Any even number between 512 to 528 bytes can be specified as the length.

(6) BCRC

It is a 4-byte error detection code. Errors in the ID field. Single burst errors with lengths of up to 32 bits for each logical block can be detected.

(7) ECC

24-byte data error detection/correction code for the data field. It is possible to on-the-fly correct the single burst errors with lengths of up to 89 bits.

(8) PAD 1

A specified length of x‘00’ pattern shown in Figure 3.6 is written in this field. This field includes the variation by rotation and circuit delay till reading/writing.

(9) PAD 2/PAD 3

A specified length of x‘00’ pattern shown in Figure 3.6 is written in this field. This field contains the processing time necessary to process next sector continuously. This field have rotational speed variation.

3.1.5 Format capacity

The size of the usable area for storing user data on the IDD (format capacity) varies according to the logical data block or the size of the spare sector area. Table 3.3 lists examples of the format capacity when the typical logical data block length and the default spare area are used. The following is the general formula to calculate the format capacity.

[Number of sectors of each zone] = [number of sectors per track × number of tracks (heads) – number of alternate spare sectors per cylinder] × [number of cylinders in the zone]

[Formatted capacity] = [total of sectors of all zones] – [number of sectors per track in last zone × number of tracks (heads) × number of alternate cylinders] ÷ [number of physical sectors in logical block] × [logical data block length]

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

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

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

Table 3.3 Format capacity

Model	Data heads	Data block length	User blocks	Format capacity (GB)
MAF3364FC	19	512	71,161,520	36.43
MAG3182FC	10	512	35,694,860	18.27
MAG3091FC	5	512	17,827,698	9.12

3.2 Logical Data Block Addressing

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

The logical data block addressing is a function whereby individual data blocks are given addresses of serial binaries in each drive.

(1) Block address of user space

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

The IDD treats sector 0, track 0, cylinder 0 as the first logical data block. The data block is allocated in ascending order of addresses in the following sequence (refer to Figure 3.5):

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

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

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

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

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

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

(2) Alternate area

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

3.3 Defect Management

3.3.1 Defect list

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

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

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

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

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

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

3.3.2 Alternate block allocation

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

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

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

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

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

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

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

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

(1) Alternate block allocation during FORMAT UNIT command execution

When the FORMAT UNIT command is specified, the allocation of the alternate block to those defective sectors included in the specified lists (P, G, or D) is continued until all spare sectors in the same cylinder are used up. When they are used up, unused spare sectors in the alternate cylinder are allocated to the subsequent sectors in the cylinder by means of alternate sector treatment. Figure 3.7 is examples of the alternate block allocation during the FORMAT UNIT command execution.

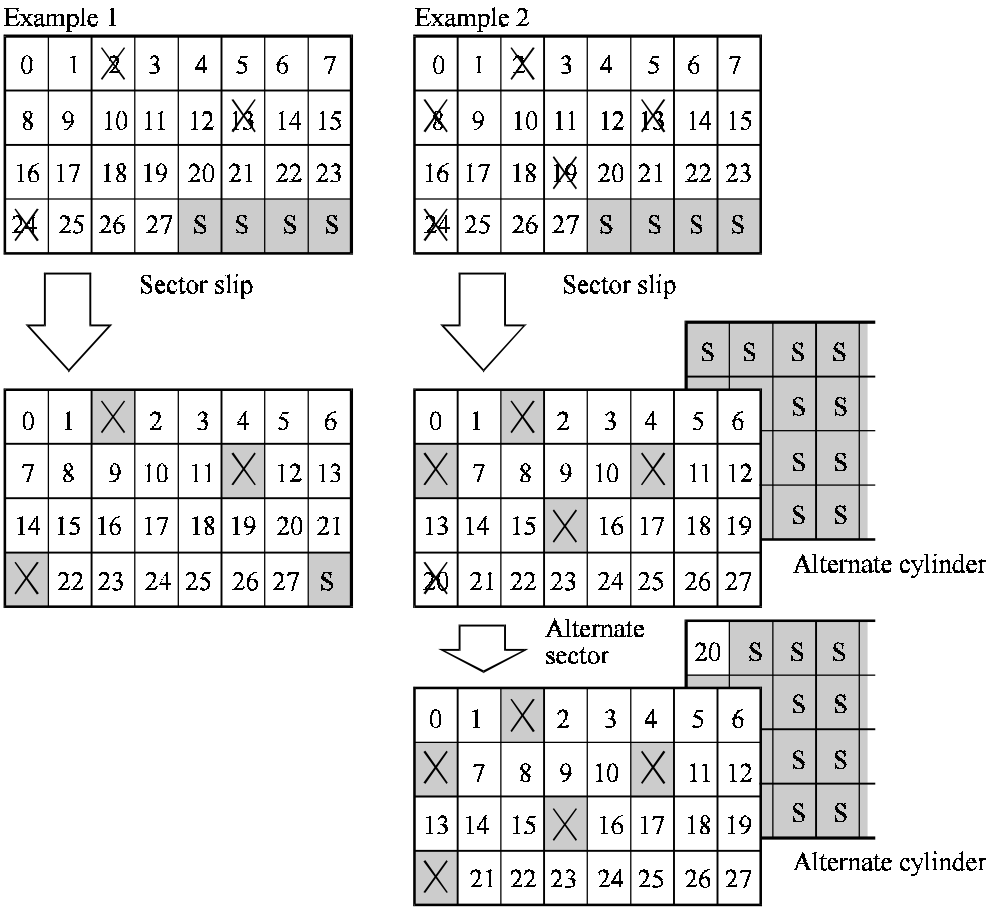


Figure 3.7 Alternate block allocation by FORMAT UNIT command

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

(2) Alternate block allocation by REASSIGN BLOCKS command

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

Figure 3.8 is examples of the alternate block allocation by the REASSIGN BLOCKS command.

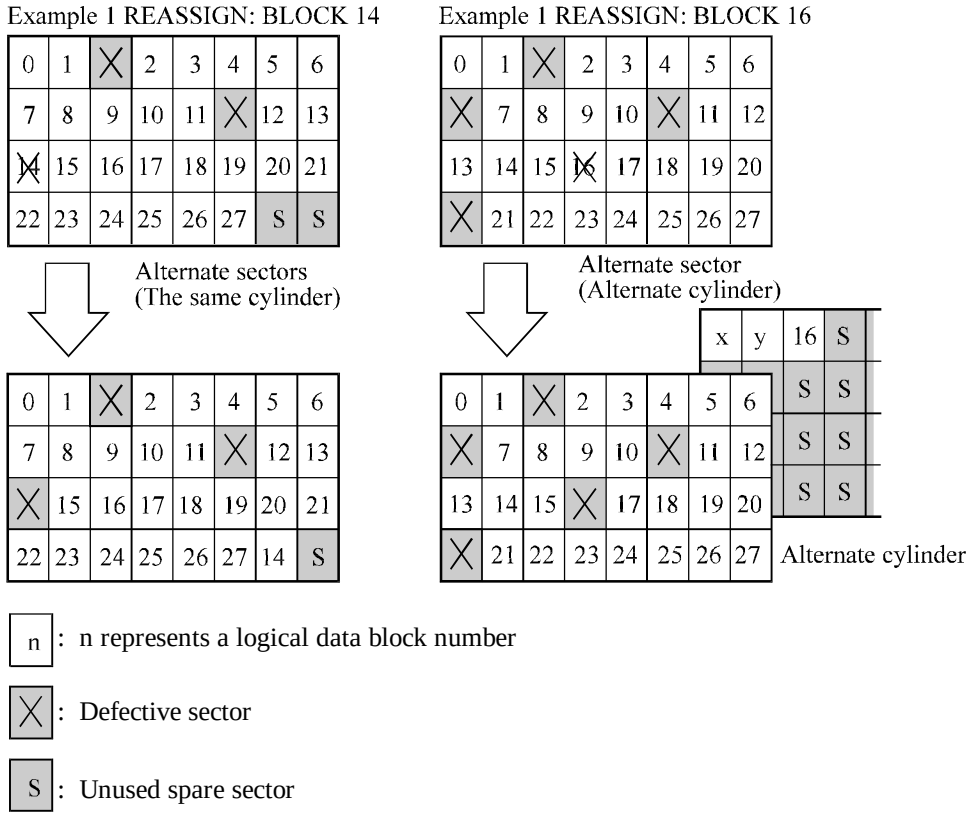


Figure 3.8 Alternate block allocation by REASSIGN BLOCKS command

(3) Automatic alternate block allocation

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

IMPORTANT

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

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

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

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CHAPTER 4 INSTALLATION REQUIREMENTS

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

4.1 Mounting Requirements

4.1.1 External dimensions

Figures 4.1 and 4.2 show the external dimensions of the IDD and the positions of the holes for the IDD mounting screws.

Note:

Dimensions are in mm.

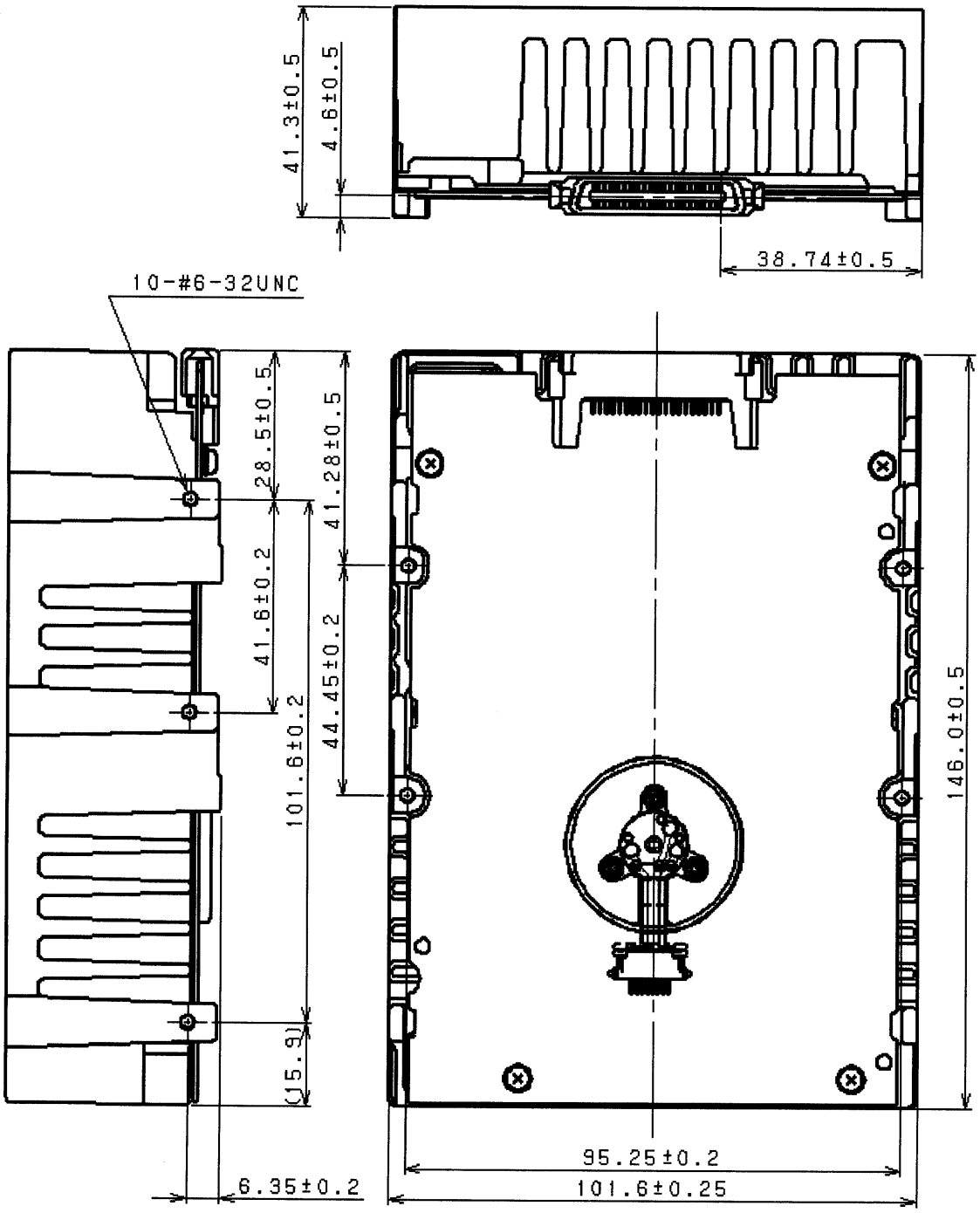


Figure 4.1 External dimensions (MAF3364FC)

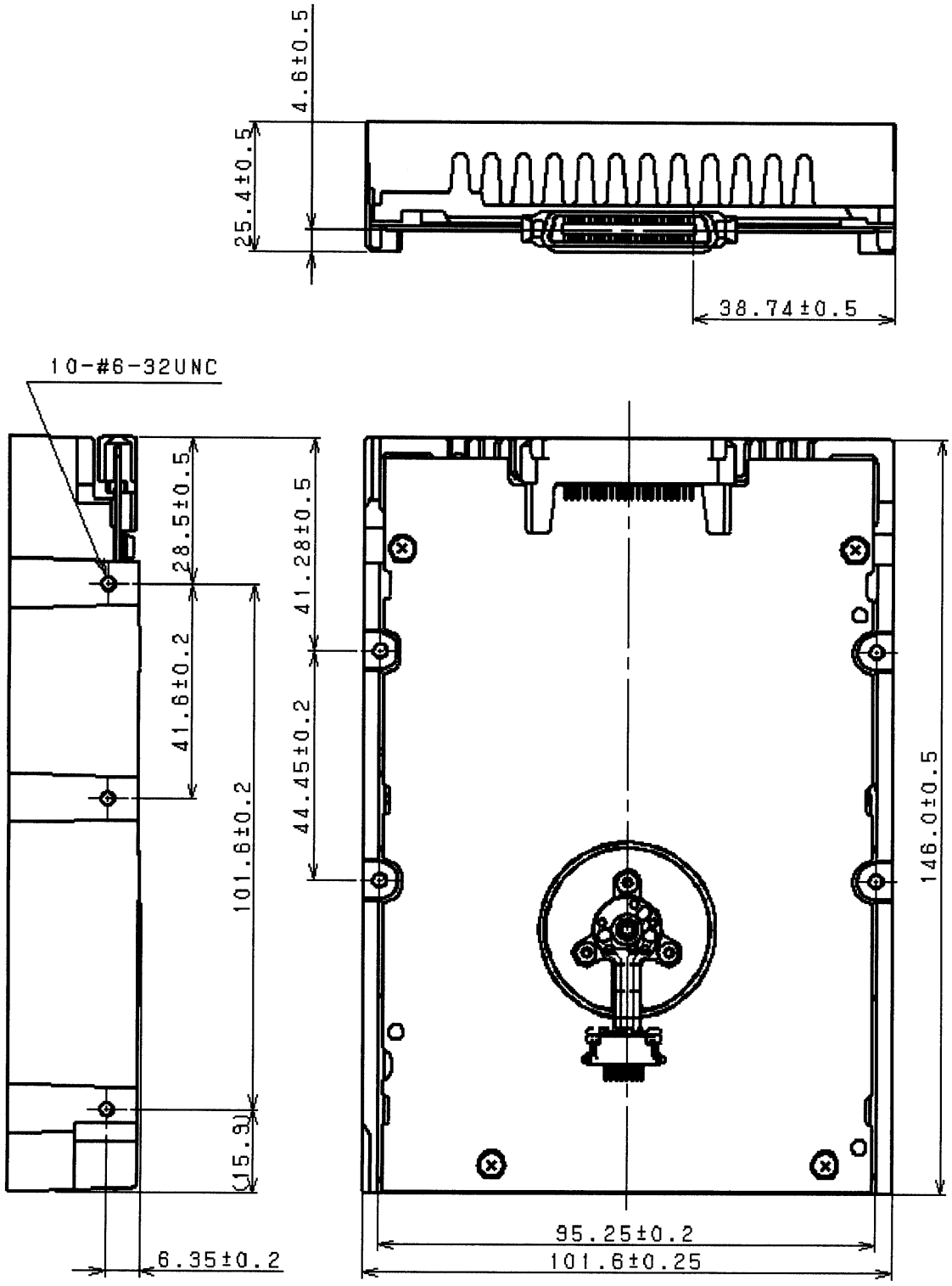
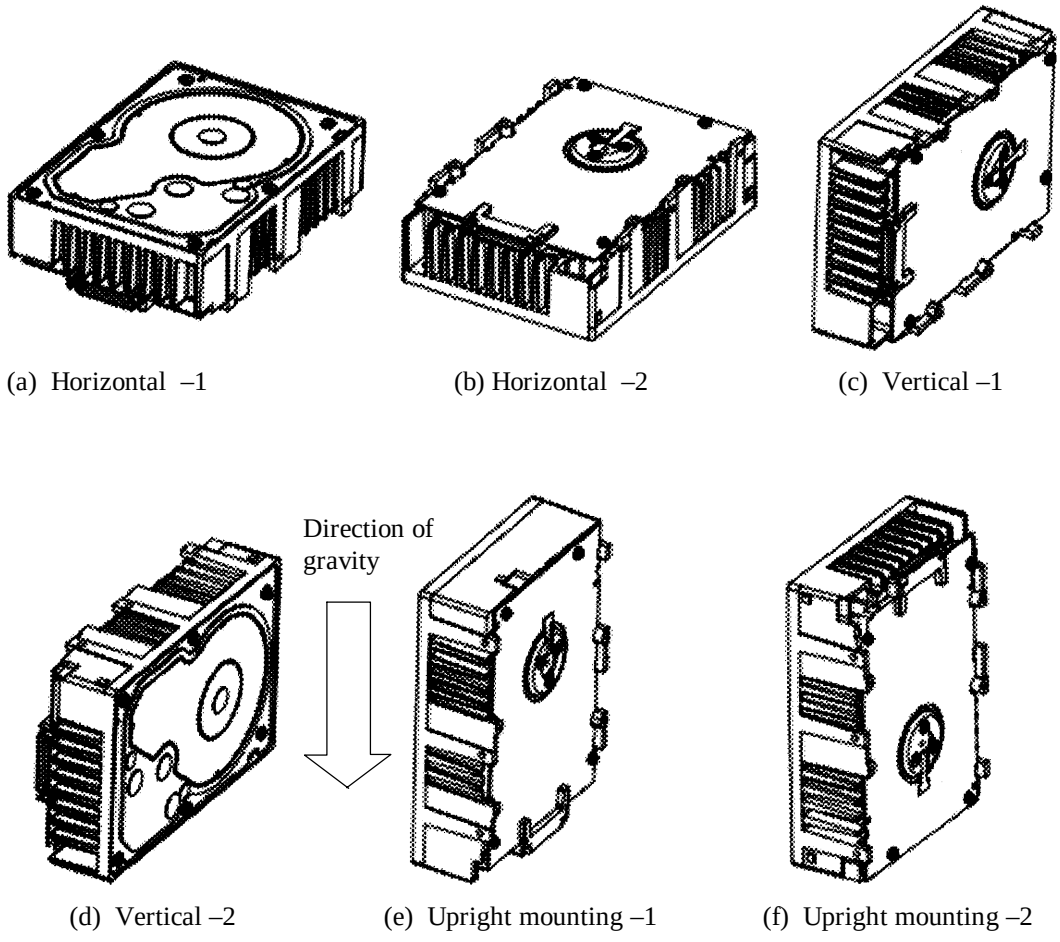


Figure 4.2 External dimensions (MAG series)

4.1.2 Mounting

The permissible orientations of the IDD are shown in Figure 4.3, and the tolerance of the angle is ±5° from the horizontal plane.



(a) Horizontal –1 (b) Horizontal –2 (c) Vertical –1

(d) Vertical –2 (e) Upright mounting –1 (f) Upright mounting –2

Figure 4.3 IDD orientation

4.1.3 Notes on mounting

(1) Mounting frame structure

Special attention must be given to mount the IDD disk enclosure (DE) as follows:

a) Use the frame with an embossed structure, or the like. Mount the IDD with making a gap of 2.5 mm or more between the IDD and the frame of the system.

b) As shown in Figure 4.6, the inward projection of the screw from the IDD frame wall at the corner must be 4 mm or less.

c) Tightening torque of screw must be secured with 6kg-cm or less.

d) Impact caused by the electric driver must be within the device specifications.

e) Must be handled on an anti-static mat.

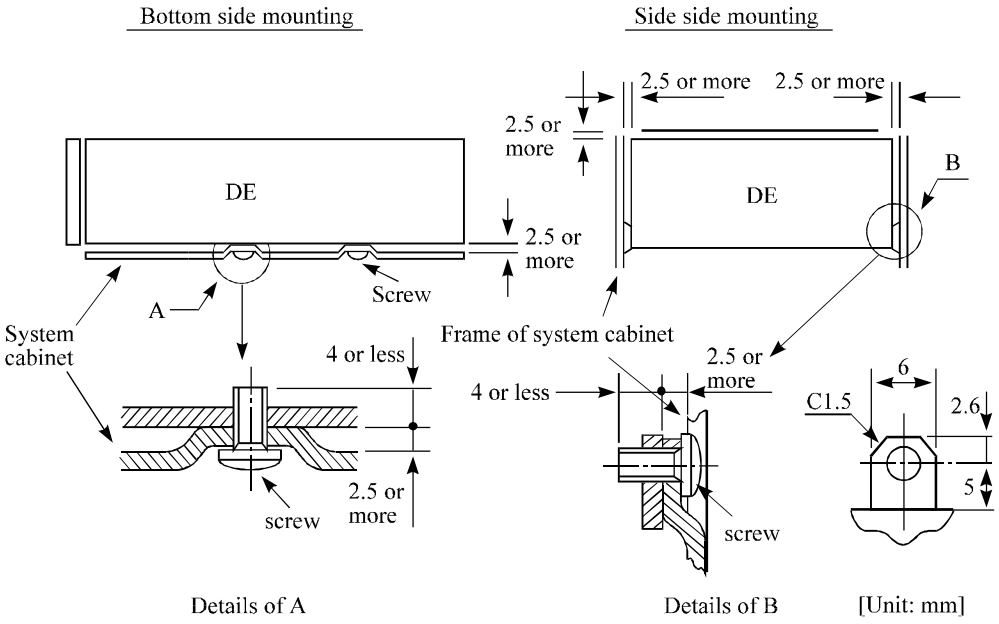


Figure 4.4 Mounting frame structure

(2) Limitation of side-mounting

Mount the side using the screw holes at both the ends as shown in Figure 4.5. Do not use the center hole.

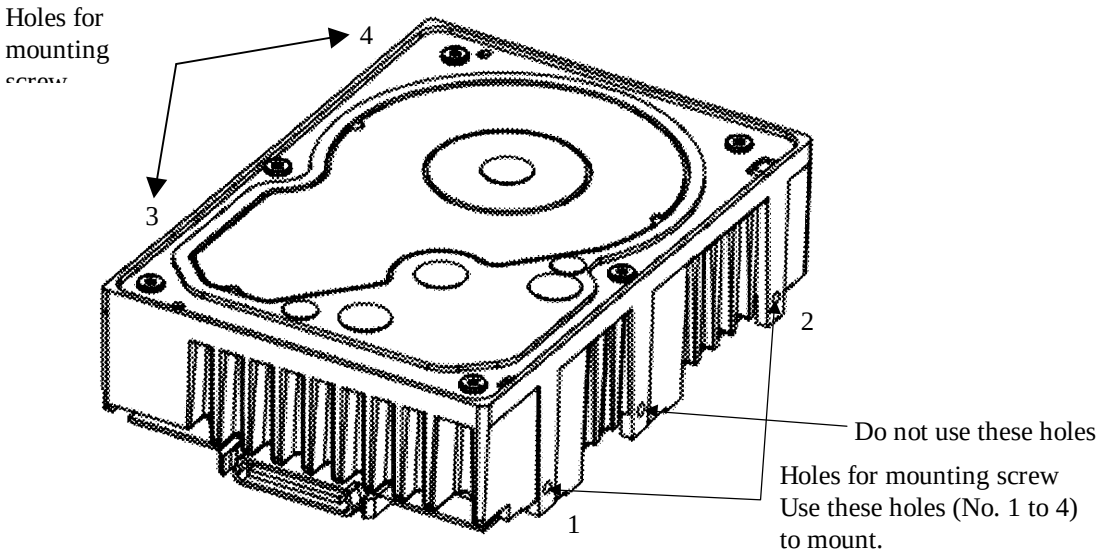


Figure 4.5 Limitation of side-mounting

(3) Environmental temperature

Temperature condition at installed in a cabinet is indicated with ambient temperature measured 3 cm from the disk drive. At designing the system cabinet, consider following points.

- Make a suitable air flow so that the DE surface temperature does not exceed 55°C.

⚠CAUTION

An air flow with an adequate wind velocity must be maintained to deal with much heat generated from the MAC30xxFC.
Reference value: An air flow with a wind velocity of more than 0.5 m/s is required in an environment at 40°C, and an air flow with a wind velocity of more than 1.0m/s in an environment at 45°C (Center of DE cover ≤ 55°C).

- Cool the PCA side especially with air circulation inside the cabinet. Confirm the cooling effect by measuring temperature of specific ICs and the DE. These measurement results should be within a criteria listed in Table 4.1.

Table 4.1 Surface temperature check point

No.	Measurement point	Criteria
1	Center of DE cover	55°C
2	Read channel LSI	83°C
3	VCM/SPM Driver	75°C
4	HDC	85°C

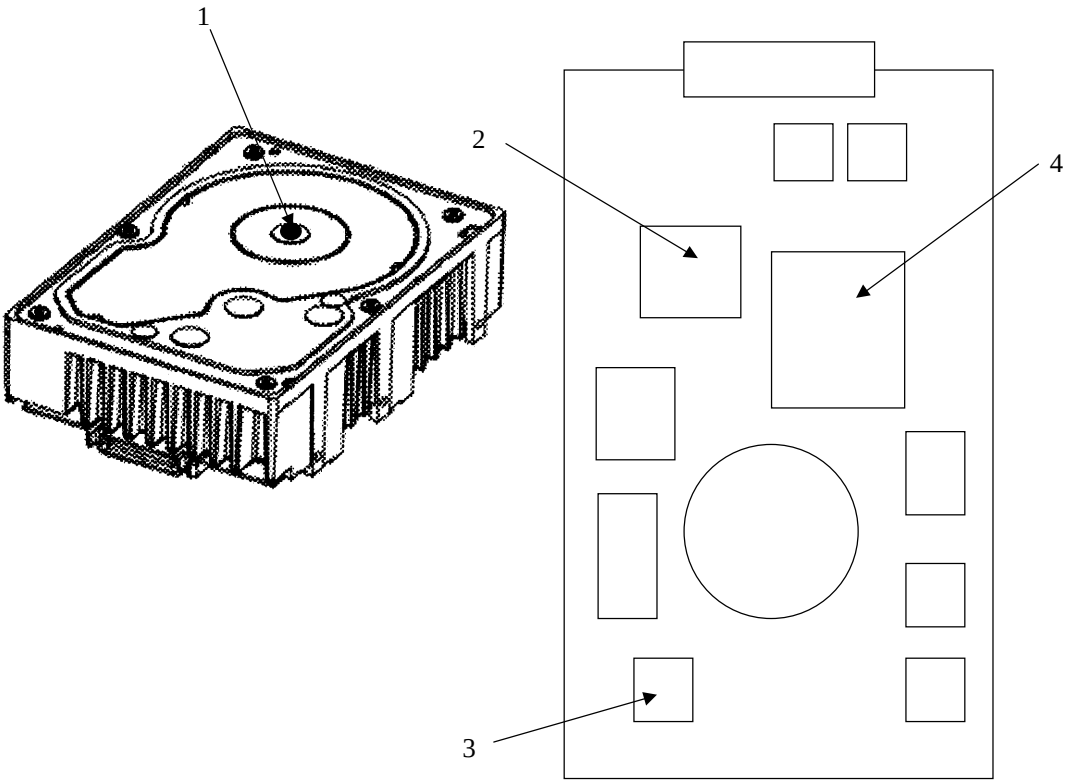


Figure 4.6 Surface temperature measurement points

(4) Service clearance area

The service clearance area, or the sides which must allow access to the IDD for installation or maintenance, is shown in Figures 4.7.

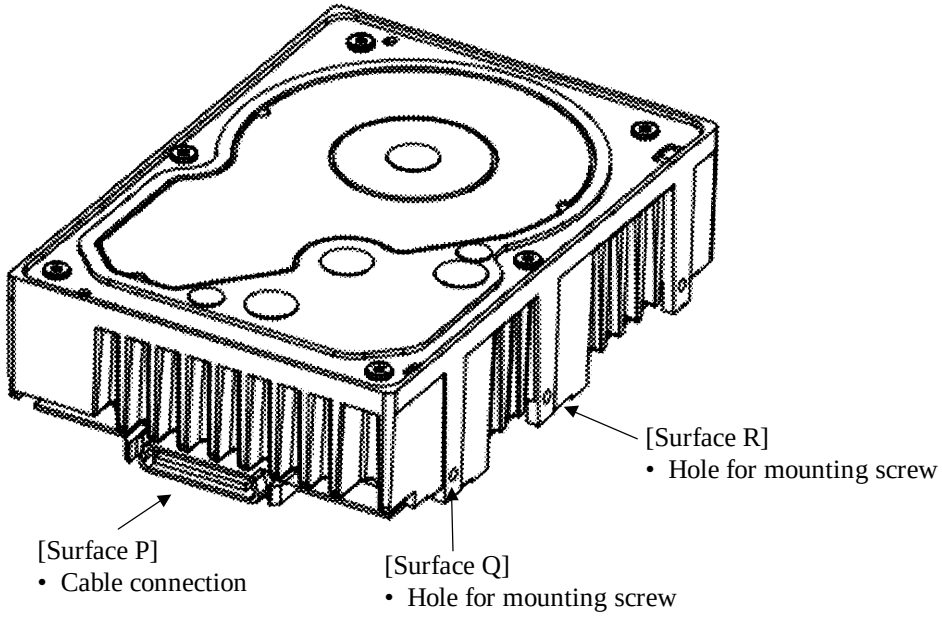


Figure 4.7 Service clearance area

(5) External magnetic field

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

(6) Leak magnetic flux

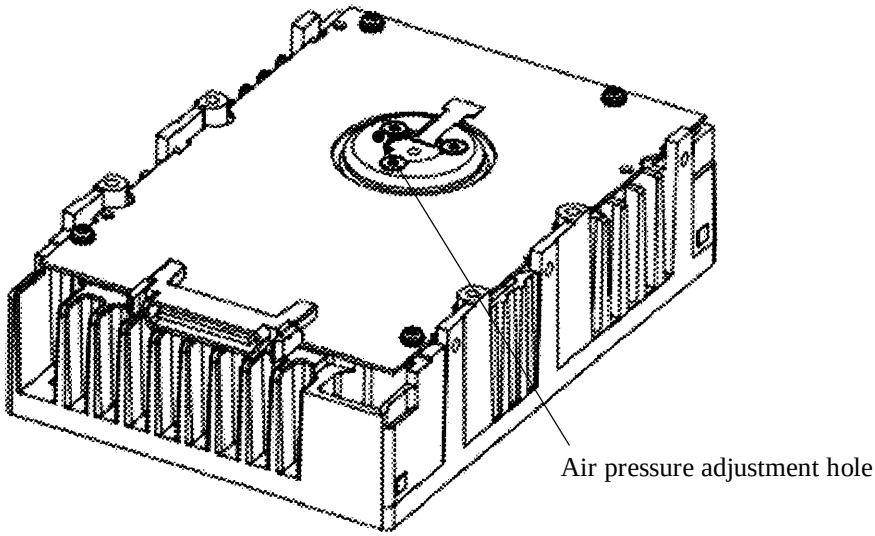
The IDD uses a high performance magnet to achieve a high speed seek. Therefore, a leak magnetic flux at surface of the IDD is large. Mount the IDD so that the leak magnetic flux does not affect to near equipment.

⚠CAUTION

Damage to drive
A hole or screw portion as shown in Figure 4.8 is used for adjusting air pressure balance between inside and outside the DE. Do not fill with a seal or label.

Seals on the DE prevent the DE inside from the dust. Do not damage or peel off labels.

(a) MAF3364FC



(b) MAG series

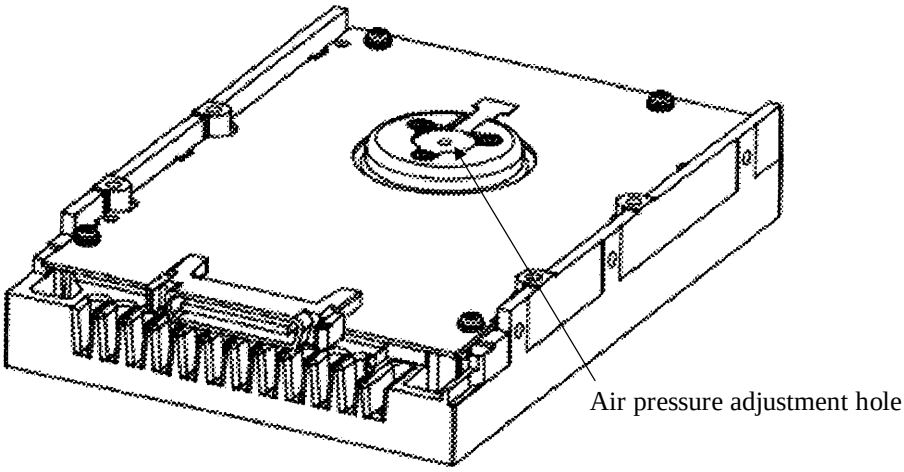


Figure 4.8 Air pressure adjustment hole

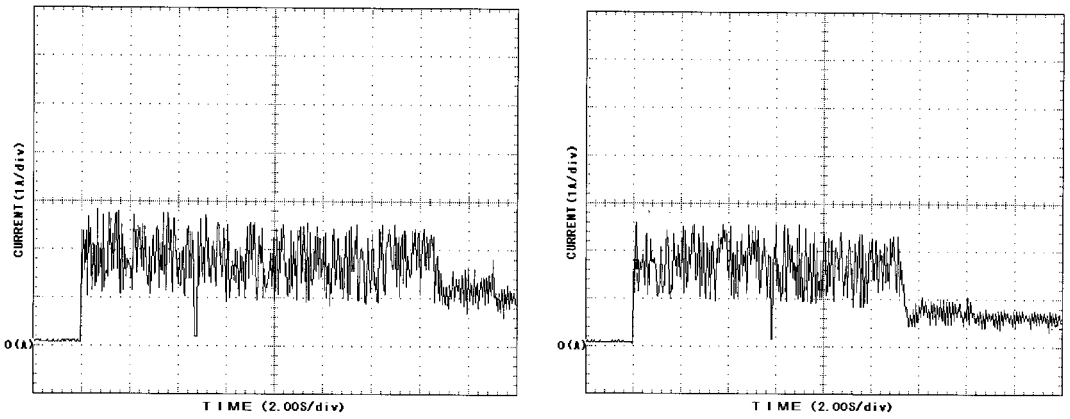
4.2 Power Supply Requirements

(1) Allowable input voltage and current

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

(2) Current waveform (reference)

Figure 4.9 shows the waveform of +12 VDC.



MAF3364FC MAG series

Figure 4.9 Current waveform (+12 VDC)

(3) Power on/off sequence

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

(4) Sequential starting of spindle motors

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

a) Issue START/STOP UNIT command at 20-second intervals to start the spindle motors. For details of this command specification, refer to SCSI Logical Interface Specifications.

For details of this command, see "Chapter 4 Command Specification" of the Fibre Channel Interface Specification.

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

(5) Noise filter

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

- Attenuation: 40 dB or more at 10 MHz
- Circuit construction: T-configuration as shown in Figure 4.10 is recommended.

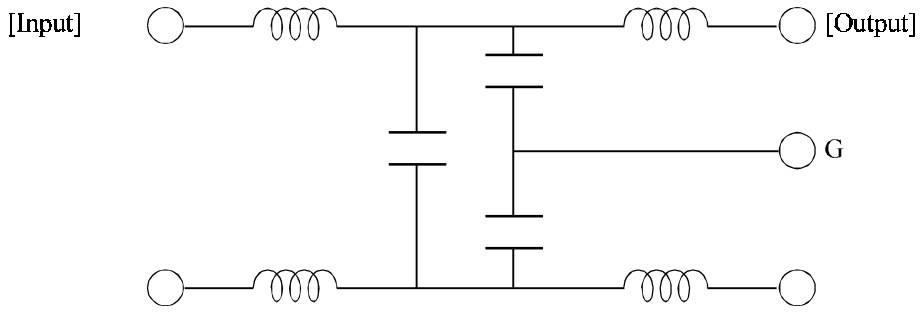


Figure 4.10 AC noise filter (recommended)

4.3 Connection Requirements

4.3.1 Connector

Figure 4.11 shows the locations of connector on the interface model.

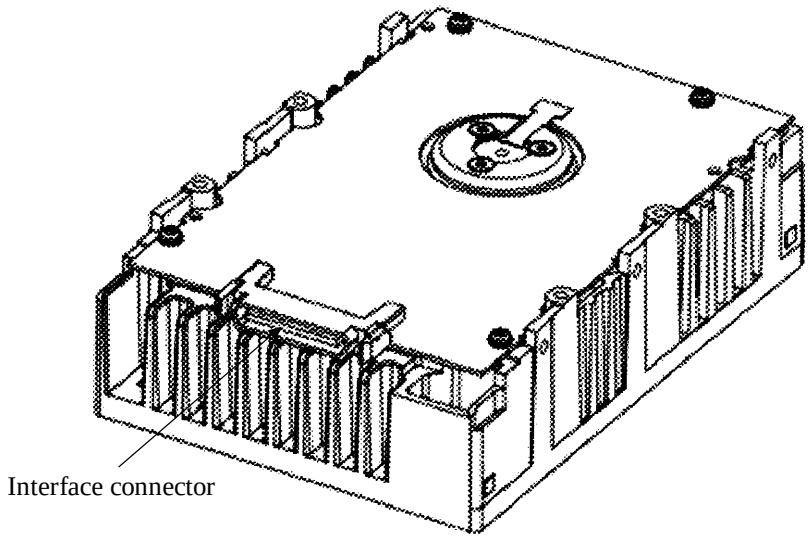


Figure 4.11 Connector location of SCA2 type interface model

4.3.2 Interface connector

The connector for the fibre channel loop bus is an unshielded SCA-2 connector conforming to SCSI-3 type which has two 20-pin rows spaced 1.27 mm (0.05 inch) apart. Figure 4.12 shows the fibre channel connector. See Section C.5 in Appendix C for signal assignments on the connector.

For details on the physical/electrical requirements of the interface signals, refer to Sections 1 Interface Specifications.

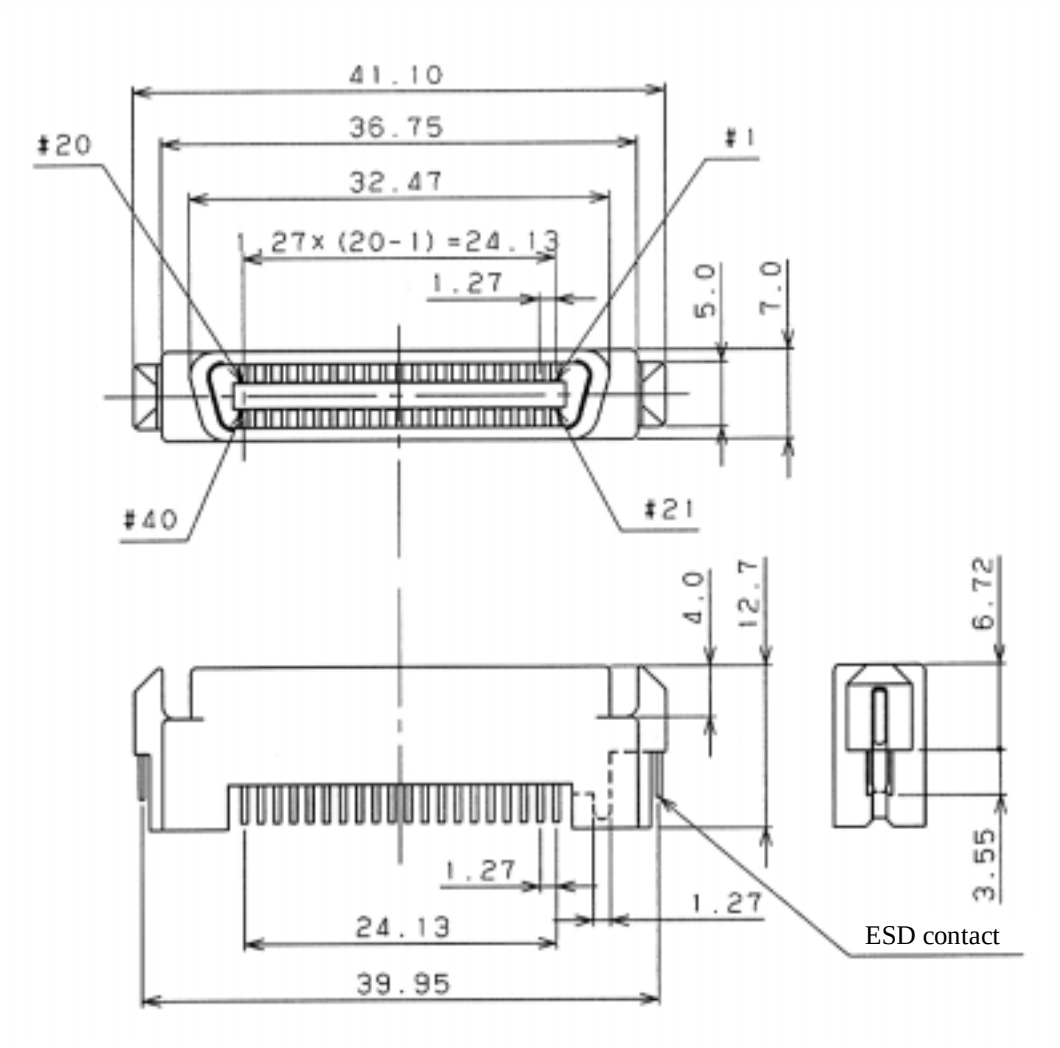


Figure 4.12 SCA2 type interface connector

4.3.3 Recommended components for connection

Applicable model		Name	Par number	Manufacturer
MAF3364FC MAG series	Interface connector (CN1)	Connector	787317-1	AMP

CHAPTER 5 INSTALLATION

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

5.1 Notes on Handling Drives

(1) General notes

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

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

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

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

(2) Unpackaging

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

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

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

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

(3) Installation

a) When mounting/dismounting the drive, make sure the vibration and shock requirements of "2.1.3 Environmental Specification" are met.

b) When removing the spindle motor from the system without stopping it while power is on, pay special attention to shock in particular until the disk drive completely stops running (about 30 seconds).

(4) Packaging

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

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

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

(5) Delivery

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

b) Minimize the delivery distance after unpacking and avoid shocks and vibrations with cushions. For the carrying direction at delivery, use one of the mount allowable directions in Subsection 4.1.2 (vertical direction is recommended).

(6) Storage

a) Provide vaporproof packaging for storage.

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

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

5.2 Setting

5.2.1 Loop ID setting

When setting the fibre channel loop ID, use SEL0 to SEL6 of interface connector CN1. IN bit weighting, SEL6 corresponds to the MSB, SEL0 to the LSB, and 126 types of X'00' to X'7D' can be specified as loop IDs.

5.2.2 Mode settings

(1) Motor start mode

The method for start control of the IDD spindle motor can be set in accordance with Table 5.1.

Table 5.1 Motor start mode

Setting		Start mode
Signal name		
Start_2/Mated	Start_1/Mated	
Connector pin		
CN1-10	CN1-09	
Open	Open	The drive is not connected to the system. The drive does not start the spindle motor.
Open	GND	The drive is connected to the system. After recognizing the connection, the drive starts the spindle motor upon receipt of a START/STOP UNIT command.
GND	Open	The drive is connected to the system. After recognizing the connection, the drive starts the spindle motor after a prescribed delay time has elapsed.
GND	GND	The drive is connected to the system. The driver starts the spindle motor immediately after recognizing the connection.

IMPORTANT

Set the loop ID so that there are no duplicates between devices on the same loop.

5.3 Mounting Drives

5.3.1 Mounting procedures

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

See Subsection 4.1 for the details of requirements for installing the IDD.

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

   - The drive has 8 mounting holes (both sides: 2×2, bottom: 4). Fix the drive by using four mounting holes of both sides or the bottom. (See Figure 4.5)

   - Use mounting screws whose lengths inside the drive mounting frame are 4 mm or less when the screws are tightened (see Figure 4.4).

   - When mounting the drive, be careful not to damage parts on the PCAs.

2) Check to ensure that the DE is not touching the frame on the system side after tightening the screws. At least 2.5 mm of clearance is required between the DE and the frame. (Indicated in Figure 4.4)

3) When an electric driver is in use, less than low-impact device specifications must be used.

5.4 Confirming Operations after Installation and Preparation for Use

5.4.1 Confirming initial operations

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

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

a) When power is turned on, the IDD executes initial self-diagnosis.

b) If an error is detected in initial self-diagnosis, the Fault LED lights up.

Remark:

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

c) When the IDD status is idle, the Active LED remains off (the LED lights up when the initiator accesses the IDD).

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

a) When power is turned on, the IDD executes initial self-diagnosis.

b) If an error is detected in initial self-diagnosis, the Fault LED lights up.

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

d) The disk drive enters the READY status in 30 seconds after the START/STOP UNIT command is issued. At this time, the IDD reads "system information" from the system space on the disk.

e) The active LED blinks during command execution.

(3) Check items at illegal operation

a) Check that IDD are mounted correctly.

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

c) When the Fault LED continues lighting up, indicates that an error is detected in initial self-diagnosis. In this case, it is recommended to issue the REQUEST SENSE command from the initiator (host system) to obtain information (sense data) for error analysis.

IMPORTANT

The LED lights during the IDD is executing a command. However, in same commands, the lighting time is only an instant. Therefore, it seems that the LED blinks or the LED remains off.

5.4.2 Checking connection

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

(1) Checking procedure

Issuing the commands and determining the end status depends on the start mode of the spindle motor and unit attention report mode (specified with setting terminal). Figure 5.1 shows the recommended checking procedure for the mode that the motor starts when power is turned on. Figure 5.2 shows for the mode that the motor starts by the START/STOP UNIT command. In these recommended checking procedures, following items are checked.

Note:

Following steps a) to e) correspond to a) to e) in Figures 5.1 and 5.2.

a) Issue the TEST UNIT READY command and check that the IDD is connected correctly to the loop and the initial operation after power is turned on ended normally. The command issue period of the TEST UNIT READY command shall be more than 20 ms.

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

c) Check the loop operations with the WRITE BUFFER and READ BUFFER commands.

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

Motor starts when power is turned on

For Figure 5.2

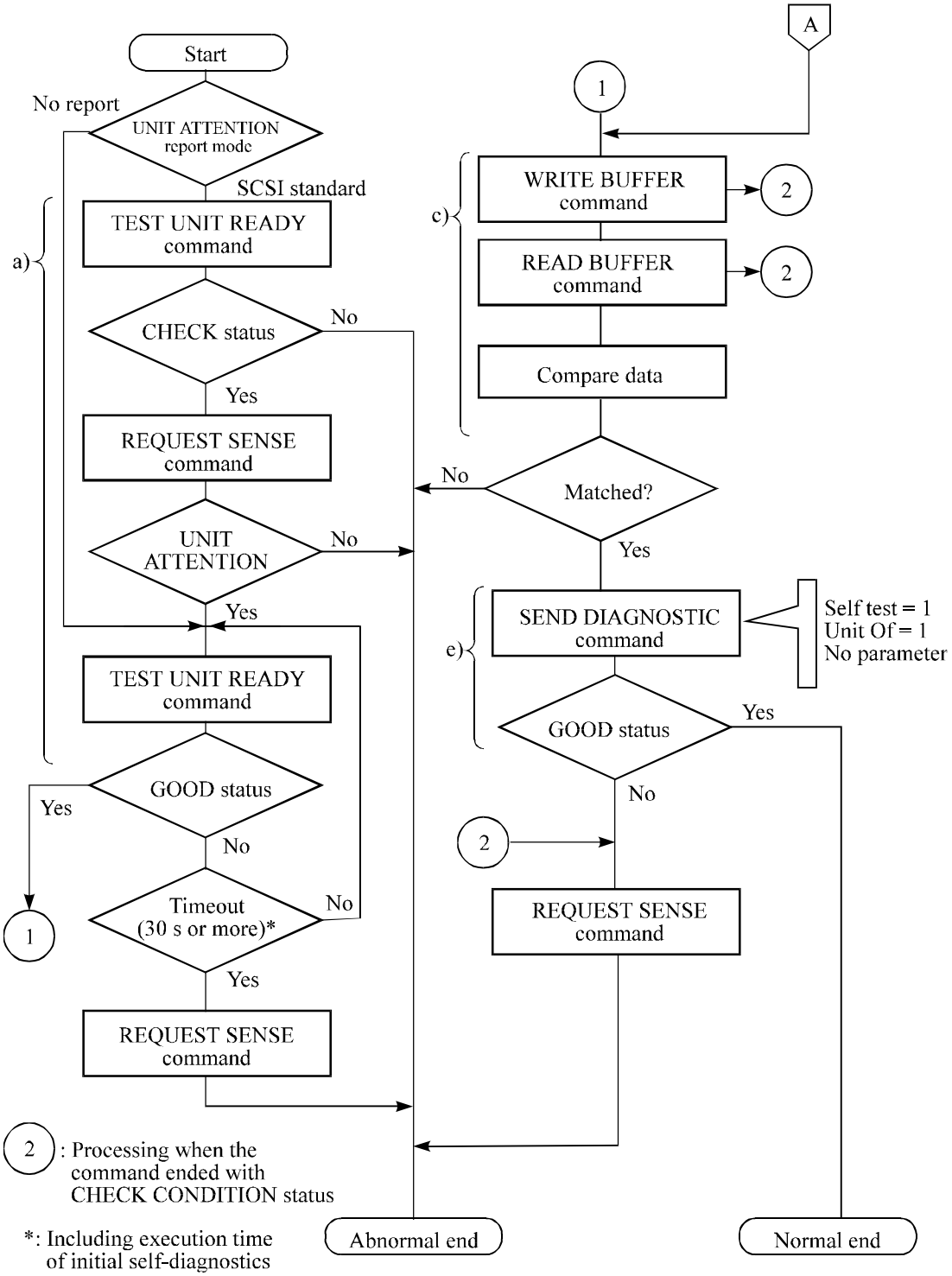


Figure 5.1 Checking the IDD connection (A)

Motor starts by START/STOP command

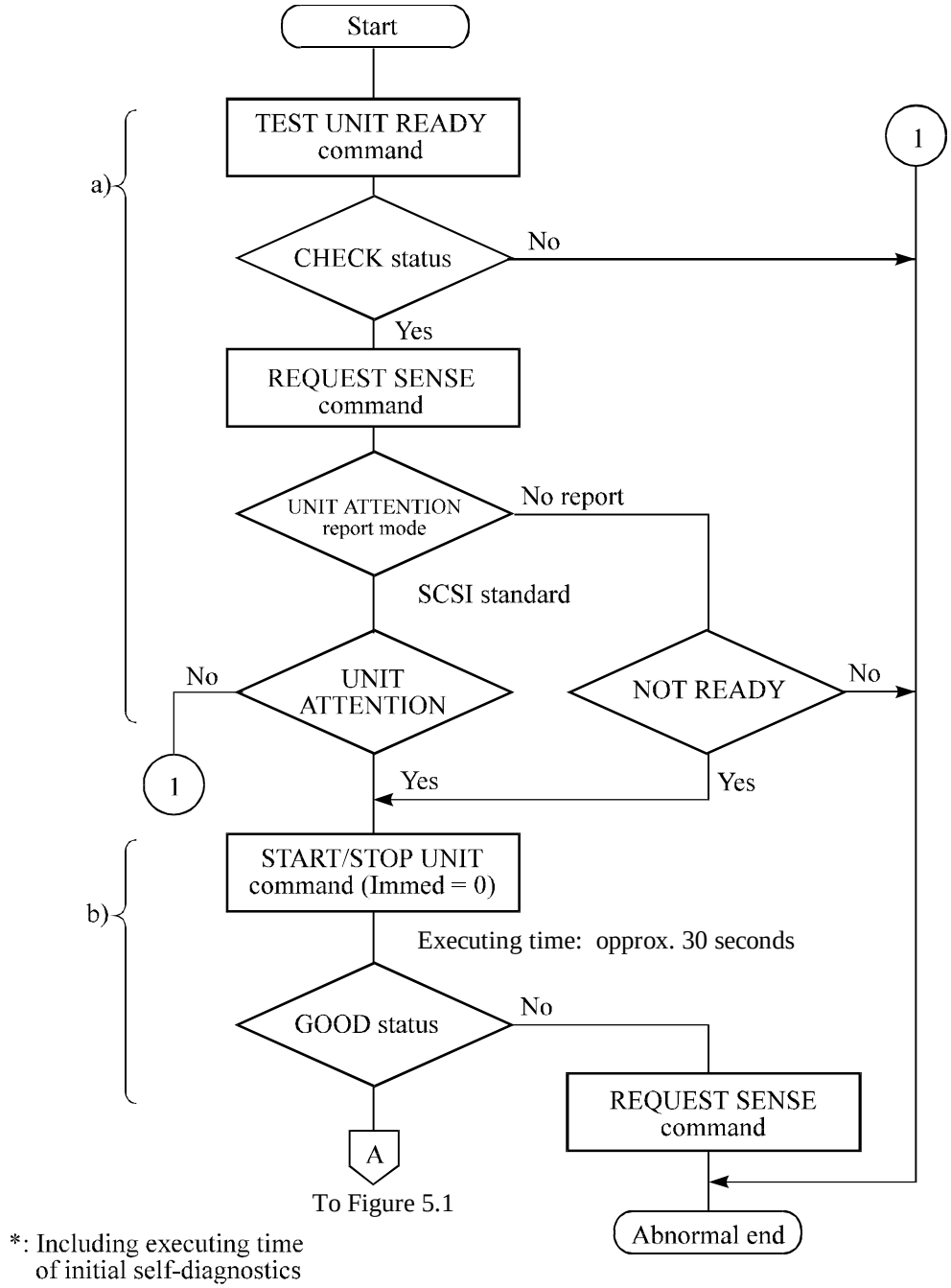


Figure 5.2 Checking the IDD connection (B)

(2) Checking at abnormal end

a) When sense data can be obtained with the REQUEST SENSE command, analyze the sense data and retry recovery for a recoverable error. Refer to Chapter 5 of Fibre Channel Interface Specifications for further details.

b) Check the setting of the terminals. Note that the checking procedure of loop connection differs depending on the setting of the motor start mode and unit attention report mode.

5.4.3 Formatting

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

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

The user can change the following data attributes at initialization:

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

This section outlines the formatting at installation. Refer to Chapters 4 and 6 of Fibre Channel Interface Specifications for further details.

(1) MODE SELECT/MODE SELECT EXTENDED command

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

a. Block descriptor

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

b. Format parameter (page code = 3)

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

c. Drive parameter (page code = 4)

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

(2) FORMAT UNIT command

Initialize all sides of the disk with the FORMAT UNIT command. The FORMAT UNIT command initializes all sides of the disk using the P lists, verifies data blocks after initialization, and allocates an alternate block for a defect block detected with verification. With initialization, the value "00" is written into all bytes of all logical data blocks. Only the position information of defect blocks detected with verification is registered in the G list. The specifications are as follows:

a. Specifying CDB

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

b. Format parameter

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

5.4.4 Setting parameters

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

- Error recovery parameter
- Disconnection/reconnection parameter
- Caching parameter
- Control mode parameter

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

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

This section outlines the parameter setting procedures. Refer to Chapter 4 of Fibre Channel Interface Specifications for further details of the MODE SELECT and MODE SELECT EXTENDED commands and specifying the parameters.

IMPORTANT

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

2. *The model select parameter is not saved for each SCSI ID of but as the common parameter for all IDs. In the multi-INIT System, parameter setting cannot be changed for each INIT.*

3. *Once parameters are saved, the saved value is effective as long as next saving operation is executed from the INIT. For example, even if the initialization of the disk is performed by the FORMAT UNIT command, the saved value of parameters described in this section is not affected.*

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

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

(1) Error recovery parameter

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

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

Parameter		Default value
• ARRE:	Automatic alternate block allocation at read operation	1 (enabled)
• TB:	Uncorrectable data transfer to the INIT	1 (enabled)
• EER:	Immediate correction of correctable error	1 (enabled)
• PER:	Report of recovered error	0 (disabled)
• DCR:	Suppression of ECC error correction	0 (Correction is enabled.)
• Retry count at read operation		63
• Retry count at write operation		0

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

Parameter		Default value
• ERR:	Immediate correction of recoverable error	1 (enabled)
• PER:	Report of recovered error	0 (disabled)
• DTE:	Stop of command processing at successful error recovery	0 (Processing is continued.)
• DCR:	Suppression of ECC error correction	0 (Correction is enabled.)
• Retry count at verification		63

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

Parameter		Default value
• RPR:	Report on parameter rounding by mode select command	0 (disabled)
• Retry count at seek error		15

IMPORTANT

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

   - *ARRE*
   - *TB*
   - *PER*

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

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

The following parameters are used to optimize the start timing of reconnection processing to transfer data on the loop at a read (READ or READ EXTENDED command) or write operation (WRITE, WRITE EXTENDED, or WRITE AND VERIFY command) of the disk. Refer to Chapter 3 of Fibre Channel Interface Specifications for further details.

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

Parameter	Default value
• Buffer full ratio	20 (HEX)
• Buffer empty ratio	20 (HEX)

IMPORTANT

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

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

   - *Time required for reconnection processing*
   - *Average amount of processing data specified with a command*

   Refer to Chapter 3 of Fibre Channel Interface Specifications for how to obtain the rough calculation values for the parameter values to be set. It is recommended to evaluate the validity of the specified values by measuring performance in an operation status under the average system load requirements.

(3) Caching parameters

The following parameters are used to optimize IDD Read-Ahead caching operations under the system environments. Refer to Chapter 3 of Fibre Channel Interface Specifications for further details.

a. Read caching parameters

Parameter		Default value
• RCD:	Disabling Read-Ahead caching operations	0 (enabled)
• WCE:	Write Cache Enable	0 (disabled)
• MS:	Specifying the multipliers of "minimum prefetch" and "maximum prefetch" parameters	0 (Specifying absolute value)
• DISC:	Prefetch operation after track switching during prefetching	0 (inhibit)
• Number of blocks for which prefetch is suppressed		X'FFFF'
• Minimum prefetch		X'0000'
• Maximum prefetch		X'0XXX' (1 cache segment)
• Number of blocks with maximum prefetch restrictions		X'FFFF'
• Number of segments		X'4'

IMPORTANT

1. *When Read-Ahead caching operations are disabled by the caching parameter, these parameter settings have no meaning except write cache feature.*

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

3. *For sequential access, the effective access rate can be increased by enabling Read-Ahead caching operations and Write Cache feature.*

(4) Control mode parameters

The following parameters are used to control the tagged queuing and error logging.

a. Control mode parameters

Parameter		Default value
• RLEC:	Specification of operation when cumulative value parameter reaches maximum value 0	0 (Does not report error)
• Queue algorithm modifier		0 (Ordering is executed by read command only.)
• QErr:	Resume or abort remaining suspended commands after sense pending state	0 (After release of sense retention status, executes queued command.)

5.5 Dismounting Drive

Since the method and procedure for dismounting the disk drive for replacement of the drive, etc. depends on the locker structure of the system, etc., the work procedure must be determined in consideration of the requirements specific to the system. This section describes the general procedure and notes on dismounting the drive.

⚠CAUTION

Damage

1. *When dismounting the drive which is mounted on the system while power is supplied to it.*
   - *The drive to be dismounted must be separated from the loop. Dismounting the drive which is not separated from the loop may cause an unexpected error.*
   - *If the drive is not separated from the loop, issue an LPB to the drive from the initiator in a primitive sequence of the order set.*
   - *It is recommended to stop the spindle motor prior to this loop separation operation. The spindle motor can be stopped by a START/STOP command. It takes about 30 seconds for the spindle motor to stop completely.*
   - *Then, dismount the drive using the drive mounting/dismounting mechanism, etc. of the system. If the drive is dismounted while the spindle motor is running, special care is required to avoid excessive vibration or shock to the drive. It is recommended to stop the operation once the SCA connector breaks off contact and wait until the spindle motor stops (about 30 seconds) before dismount the drive.*
   - *When storing or transporting the drive, put it in an antistatic bag. (Shown in Section 5.1).*

2. *When dismounting the drive which is mounted on the system while power is not supplied to it.*
   - *Do not move the drive until the drive stops completely (about 30 seconds if the spindle motor was stopped by a START/STOP UNIT command, and about 30 seconds after powering-off when the power was simply turned off).*
   - *Then, dismount the drive using the drive mounting/dismounting mechanism, etc. of the system.*
   - *When storing or transporting the drive, put it in an antistatic bag. (Shown in Section 5.1).*

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CHAPTER 6 DIAGNOSTICS AND MAINTENANCE

This chapter describes diagnostics and maintenance information.

6.1 Diagnostics

6.1.1 Self-diagnostics

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

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

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

Table 6.1 Self-diagnostic functions

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

Note:

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

Brief test contents of self-diagnostics are as follows.

a. Hardware function test

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

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

b. Seek test

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

c. Write/read test

This test check the write/read function by using the Internal test space of the disk drive.

(1) Initial self-diagnostics

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

If an error is detected in initial self-diagnosis, the Fault LED lights up. In this status, the IDD reports the CHECK CONDITION status to all input/output operation requests other than the REQUEST SENSE command. When the CHECK CONDITION status is posted, the INIT should issue the REQUEST SENSE command. The sense data obtained with the REQUEST SENSE command details the error information detected with the initial self-diagnostics.

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

The IDD does not reply to the loop for up to 2 seconds after the initial self-diagnostics is started. After that, the IDD can accept the I/O operation request correctly, but the received command, except the executable commands under the not ready state (such as INQUIRY, START/STOP UNIT), is terminated with the CHECK CONDITION status (NOT READY [=2]/logical unit not ready [=04-00]) during the interval from the spindle motor becomes stable to the IDD becomes ready. The executable command under the not ready state is executed in parallel with the initial self-diagnostics, or is queued by the command queuing feature and is executed after completion of the initial self-diagnostics. When the command that comes under the exception condition of the command queuing is issued at that time, the IDD posts the BUSY status for the command. When the error is detected during the initial self-diagnostics, the CHECK CONDITION status is posted for all commands that were stacked during the initial self-diagnostics. For the command execution condition, refer to Section 2.4 and Subsection 2.7.4 in Fibre Channel Interface Specifications.

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

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

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

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

a. Error recovery during self-diagnostics

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

PER	Operation of self-diagnostics
0	The self-diagnostics continues when the error is recovered. The self-diagnostics terminates normally so far as the unrecoverable error is not detected.
1	The self-diagnostics continues when the error is recovered. If the unrecoverable error is not detected, the consecutive tests are executed till last test but the self-diagnostics terminates with error. The error information indicates that of the last recovered error.

b. Reporting result of self-diagnostics and error indication

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

When an error is detected in the self-diagnostics, the IDD terminates the SEND DIAGNOSTIC command with the CHECK CONDITION status. If an error is detected by a hardware function test at this time, the Fault LED lights up.

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

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

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

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

Refer to Chapter 4 of Fibre Channel Interface Specifications for further details of the command specifications.

⚠CAUTION

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

6.1.2 Test programs

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

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

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

(1) Interface test

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

(2) Basic operation test

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

(3) Random/sequential read test

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

(4) Write/read test

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

6.2 Maintenance Information

6.2.1 Maintenance requirements

(1) Preventive maintenance

Preventive maintenance such as replacing air filters is not required.

⚠CAUTION

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

(2) Service life

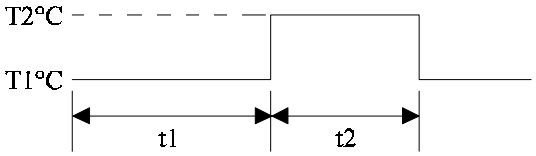
The service life under suitable conditions and treatment is as follows. The service life is depending on the environment temperature. Therefore, the user must design the system cabinet so that the average DE surface temperature is as possible as low.

- DE surface temperature: 45°C or less — 5 years
- DE surface temperature: 46°C to 50°C — 4 years
- DE surface temperature: 51°C to 55°C — 3 years
- DE surface temperature: 56°C and more — Strengthen cooling power so that DE surface temperature is 55°C or less.

Even if the IDD is used intermittently, the longest service life is 5 years.

Note:

The "average DE surface temperature" means the average temperature at the DE surface throughout the year when the IDD is operating.



$$\text{Average DE surface temperature} = \frac{T1 \times t1 + T2 \times t2}{t1 + t2}$$

(3) Parts that can be replaced in the field

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

(4) Service system and repairs

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

a) IDD model, part number (P/N), revision number, serial number (S/N), and date of manufacturing

b) Error status

- Date when the error occurred
- System configuration
- Environmental conditions (temperature, humidity, and voltage)

c) Error history

d) Error contents

- Outline of inconvenience
- Issued commands and specified parameters
- Sense data
- Other error analysis information

⚠CAUTION

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

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

6.2.2 Revision numbers

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

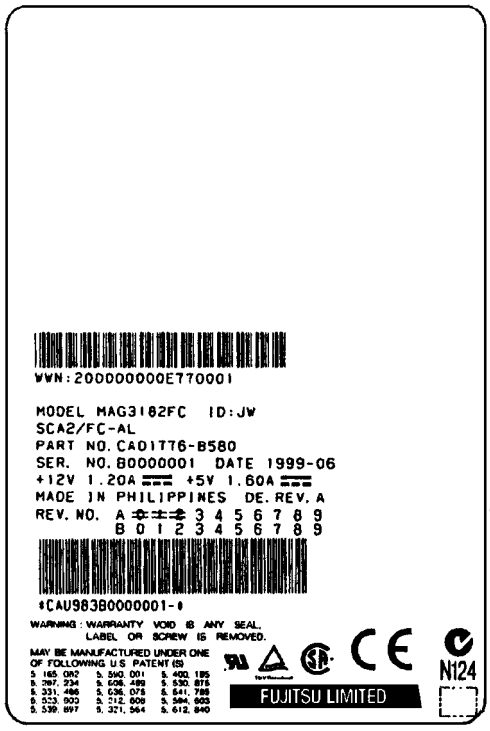


Figure 6.1 Revision label

(1) Indicating revision number at factory shipment

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

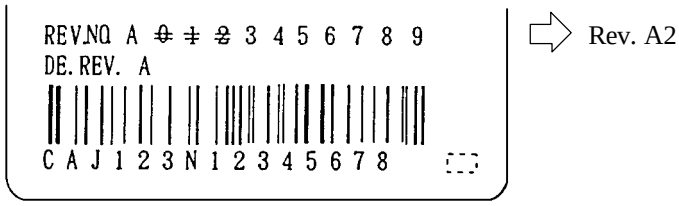
(2) Changing revision number in the field

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

IMPORTANT

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

At shipment



Revising at field

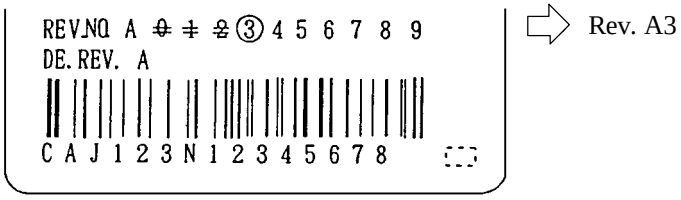


Figure 6.2 Indicating revision numbers

APPENDIX A LOCATIONS OF CONNECTORS

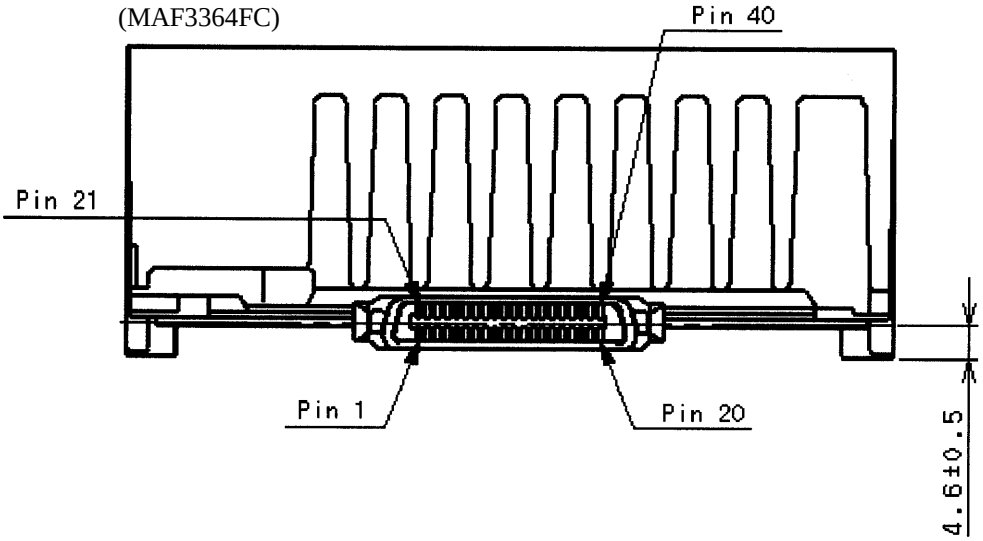
A.1 Locations of Connectors

This appendix shows the locations of connectors for 8- and 16-bit SCSIs.

A.1 Locations of Connectors

(Rear view)

(MAF3364FC)



(Rear view)

(MAG series)

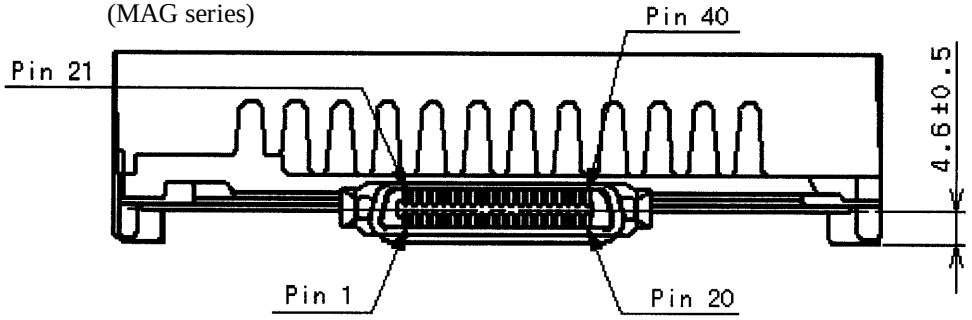


Figure A.1 Locations of connectors

APPENDIX B CONNECTOR SIGNAL ALLOCATION

B.1 Interface (FC-SCA) Connector Signal Allocation

This appendix describes the connector signal allocation.

B.1 Interface (FC-SCA) Connector Signal Allocation

Table B.1 FC-SCA connector: CN1

Pin No.	Signal		Signal		Pin No.
01	–EN bypass port A		+12V charge		21
02	+12V		GND		22
03	+12V		GND		23
04	+12V		+PortA_in		24
05	–Parallel ESI		–PortA_in		25
06	–Drive present		GND		26
07	Active LED out		+PortB_in		27
08	–Spindle sync		–PortB_in		28
09	Start_1/Mated		GND		29
10	Start_2/Mated		+PortA_out		30
11	–EN bypass port B		–PortA_out		31
12*	SEL-6	–DSK_WR	GND		32
13*	SEL-5	–DSK_RD	+PortB-out		33
14*	SEL-4	–ENCL_ACK	–PortB-out		34
15*	SEL-3	D(3)	GND		35
16	Fault LED out		SEL-2	D(2)	36*
17	N.C		SEL-1	D(1)	37*
18	N.C		SEL-0	D(0)	38*
19	+5V		N.C		39
20	+5V		+5V charge		40

Note: *1) Signal names in the right column of the table are those in parallel ESI operation.

APPENDIX C MODEL NAMES AND PRODUCT NUMBERS

C.1 Model Names and Product Numbers

This appendix lists model names (types) and product numbers.

C.1 Model Names and Product Numbers

Table C.1 MAF and MAG series model names and product numbers

Model name (type)	Data block length (at factory shipment)	Total storage capacity (user area)	Mounting screw	Part number	Remarks
MAF3364FC	512B	36.4 GB	#6-32UNC	CA01776-B980	1.6-inch height 10,025 rpm 10 disks 19 heads
MAG3182FC	512B	18.2 GB	#6-32UNC	CA01776-B580	1-inch height 10,025 rpm 5 disks 10 heads
MAG3091FC	512B	9.1 GB	#6-32UNC	CA01776-B380	1-inch height 10,025 rpm 3 disks 5 heads

APPENDIX D FIBRE CHANNEL INTERFACE FUNCTIONS

D.1 Fibre Channel Interface Function Specifications

This appendix lists the fibre channel interface functions provided for the IDD. Refer to the Fibre Channel Logical Interface Specifications for details of each functions.

D.1 Fibre Channel Interface Function Specifications

Table D.1 Fibre channel interface function specifications (1 of 8)

O: Provided ×: Not provided

Item			Specification
Task attribute message	SIMPLE QUEUE TYPE		O
	HEAD OF QUEUE TYPE		O
	ORDERED QUEUE TYPE		O
	ACA TYPE		O
	UNTAGGED		×
Task manage-ment flag message	TERMINATE TASK		×
	CLEAR ACA		O
	TARGET RESET		O
	CLEAR TASK SET		O
	ABORT TASK SET		O
Command (Group 0)	TEST UNIT READY	(00)	O
	REZERO UNIT	(01)	O
	REQUEST SENSE	(03)	O
	FORMAT UNIT	(04)	O
	FmtData (format data)	=0	O
	Interleave factor		O (No interleave)
	Block address format defect listing	=0	×
	Block address format defect listing	≠0	×
	Byte-distance-from-index format defect listing	=0	O
	Byte-distance-from-index format defect listing	≠0	O
	Physical sector address format defecting listing	=0	O
	Physical sector address format defecting listing	≠0	O
	CmpLst (complete list)		O
	FOV (Format Options Valid)		O
	DPRY (Disable Primary)		O
	DCRT (Disable Certification)		O
	STPF (Stop Format)		×
	IP (Initialization Pattern)		×
	DSP (Disable Saving Parameters)		×
	Immed (Immediate)		O
	REASSIGN BLOCKS	(07)	O
	READ	(08)	O
	WRITE	(0A)	O
	SEEK	(0B)	O

Table D.1 Fibre channel interface function specifications (2 of 8)

O: Provided ×: Not provided

Item			Specification
Command (Group 0)	INQUIRY (12)		O
	EVPD (Enable Vital Product Data)		O
	Typical INQUIRY data		O (64 byte long)
	VPD Page 0: VPD page code listing		O
	VPD Page 80: Device serial number		O
	VPD Page C0: Operation mode		O
	READ DEVICE CHARACTERISTICS [VU] *(13)		×
	PRIORITY RESERVE [VU] *(14)		×
	MODE SELECT (15)		O
	PF=(page format)		O (Specified value ignored)
	Page 1: Read/write error recovery		O (12 B: Savable)
		AWRE (Automatic Write Reallocation Enabled)	× (Specified value ignored)
		ARRE (Automatic Read Reallocation Enabled)	O (Changeable)
		TB (Transfer Block)	O (Changeable)
		RC (Read Continuous)	×
		EER (Enable Early Recovery)	×
		PER (Post Error)	O (Changeable)
		DTE (Disable Transfer on Error)	× (Specified value ignored)
		DCR (Disable Correction)	×
		Retry count at read	O (Changeable)
		Correctable bit length	O (Not changeable)
		Head offset count	×
		Data strobe offset count	×
		Retry count at write	O (Changeable)
		Recovery processing time restriction	×
	Page 2: Disconnection/reconnection		O (16 B: Savable)
		Buffer-full ratio	O (Changeable)
		Buffer-empty ratio	O (Changeable)
		Bus inactivity restriction	×
		Disconnection time restriction	×
		Connection time restriction	×
		Maximum burst length	O
		DTDC (data transfer disconnect control)	×
		EMDP (Enable Modify Data Pointer)	×
		FARd, FAWrt, FAStat (Tair Arbitoration READ/Write/Status)	O (Not changeable)
		DImm (Disconnect Immediate)	×

*1 Fujitsu-specific function

Table D.1 Fibre channel interface function specifications (3 of 8)

O: Provided ×: Not provided

Item			Specification
Command (Group 0)	MODE SELECT (continued) (15)		
	Page 3: Format parameter		O (24 B: Savable)
		Number of tracks/zone	O (Not changeable)
		Number of alternate sectors/zone	O (Changeable)
		Number of alternate tracks/zone	O (Not changeable)
		Number of alternate tracks/drive	O (Not changeable)
		Number of alternate sectors/track	O (Not changeable)
		Data byte length/physical sector	O (Changeable)
		Interleave factor	O (No interleave)
		Track skew factor	O (Not changeable)
		Cylinder skew factor	O (Not changeable)
		SSEC/HSEC (Soft Sector/Head Sector)	O (Not changeable)
		RMB (Removable)	O (Not changeable)
		SURF (Surface)	O (Not changeable)
	Page 4: Drive parameter		O (24 B: Savable)
		Number of cylinders	O (Changeable)
		Number of heads	O (Not changeable)
		“Write Precompensation” start cylinder	×
		“Reduced Write Current” start cylinder	×
		Drive step rate	×
		Landing zone cylinder	×
		RPL (Rotational Position Locking)	×
		Rotational synchronization offset	×
		Medium rotational speed	O (Not changeable)
	Page 7: Verify error recovery		O (12 B: Savable)
		EER (Enable Early Recovery)	O (Changeable)
		PER (Post Error)	O (Changeable)
		DTE (Disable Transfer on Error)	× (Specified value ignored)
		DCR (Disable Correction)	O (Changeable)
		Retry count at verification	O (Changeable)
		Correctable bit length	O (Not changeable)
		Recovery processing time restriction	O (Not changeable)

Table D.1 Fibre channel interface function specifications (4 of 8)

O: Provided ×: Not provided

Item				Specification
Command (Group 0)	MODE SELECT (continued) (15)			
		Page 8: Caching parameter		O (20 B: Savable)
			DISC (discontinuity)	O (Not changeable)
			MS (Multiple Select)	×
			WCE (Write Cache Enable)	O (Changeable)
			RCD (Read Cache Disable)	O (Changeable)
			Demand Read Retention Priority	×
			Write Retention Priority	×
			Prefetch suppression block count	×
			Minimum prefetch	×
			Maximum prefetch	O (Not changeable)
			Maximum prefetch restriction block count	O (Not changeable)
			Number of segments	O (Changeable)
			Buffer segment size	×
		Page A: Control mode page		O (12 B: Savable)
			RLEC (Report Log Exception Condition)	× (Specified value ignored)
			Queue Algorithm modifier	O (Changeable)
			QErr (Queue Error management)	O (Changeable)
			RAC (Report a Check)	×
			SWP (Software Write Protect)	×
			DQue (Disable Queuing)	×
			RAEN	×
			UAEN	×
			EAEN	×
			Ready AEN Holdoff period	×

Table D.1 Fibre channel interface function specifications (5 of 8)

O: Provided ×: Not provided

Item			Specification
		Page C: Notch parameter	O
		Page 19: Fibre channel control parameter	O (8 B)
		DTOLI (Disable Target Originated Loop Initialization)	O (Not Changeable)
		DTIPE (Disable Target Initiated Port Enable)	O (Not changeable)
		ALWLI (Allow Login Without Loop Initialization)	O (Not changeable)
		DSA (Disable Soft Address	O (Not changeable)
		DLM (Disable Loop Master)	O (Not changeable)
		DDIS (Disable Discovery)	O (Not changeable)
		Page 21: Additional error recovery [VU] (*1)	O (4 B: Savable)
		RPR (Rounded Parameter Report)	×
		Retry count at seek error	O (Changeable)
	RESERVE (16)		×
	RELEASE (17)		×
	COPY (18)		×
Command (Group 0)	MODE SENSE (1A)		O
		DBD (Disable Block Descriptor)	O
		Page 0 (Non-Parameter Transfer)	O
	START/STOP UNIT (1B)		O
		Immed (Immediate)	O
	RECEIVE DIAGNOSTIC RESULTS (1C)		O
		Page 00: Specifiable page code list	O
		Page 01: Configuration	O
		Page 02: Enclosure status	O
		Page 03: Help text	O
		Page 04: String in	O
		Page 05: Threshold in	O
		Page 06: Array status	O
		Page 07: Element descriptor	O
		Page 08: Short enclosure status	O
		Page 40: Logical/physical address conversion	O

*1 Fujitsu-specific function

Table D.1 Fibre channel interface function specifications (6 of 8)

O: Provided ×: Not provided

Item			Specification
Command (Group 0)	SEND DIAGNOSTIC	(1D)	O
	PF (Page Format)		O (Specified value ignored)
	Self Test (Self Test)		O
	Dev Ofl (Device Offline)		×
	Unit Ofl (Unit Offline)		O
	Page 0: Specifiable page code listing		O
	Page 02: Enclosure control		O
	Page 04: String out		O
	Page 05: Threshold out		O
	Page 06: Array control		O
	Page 40: Logical/physical address conversion		O
	Page 80: Mode setup state report	[VU]*1	×
	Page 81: Device-specific information	[VU]*1	×
	PREVENT/ALLOW MEDIUM REMOVAL	(1E)	×
Command (Group 1)	SEARCH BLOCK HIGH	[VU]*1 (20)	×
	SEARCH BLOCK EQUAL	[VU]*1 (21)	×
	SEARCH BLOCK LOW	[VU]*1 (22)	×
	READ CAPACITY	(25)	O
	PMI (Parial Medium Indicator)		O
	READ EXTENDED	(28)	O
	WRITE EXTENDED	(2A)	O
	SEEK EXTENDED	(2B)	O
	WRITE & VERIFY	(2E)	O
	BytChk (Byte Check)		×
	VERIFY	(2F)	O
	By+Chk (Byte Check)		O
	SEARCH DATA HIGH	(30)	×
	SEARCH DATA EQUAL	(31)	×
	SEARCH DATA LOW	(32)	×
	SET LIMITS	(33)	×
	PRE-FETCH	(34)	×
	SYNCHRONIZE CACHE	(35)	O
	LOCK/UNLOCK CACHE	(36)	O

*1 Fujitsu-specific function

Table D.1 Fibre channel interface function specifications (7 of 8)

O: Provided ×: Not provided

Item			Specification
Command (Group 1)	READ DEFECT DATA	(37)	O
	Block address format		O
	Byte-distance-from-index format		O
	Physical sector address format		O
	COMPARE	(39)	×
	COPY & VERIFY	(3A)	×
	WRITE BUFFER	(3B)	O
	Mode='000' (Header & Data Mode)		O
	Mode='001' (Header & Data Mode with Address)		O
	Mode='010' (Data Mode)		O
	Mode='100' (Download Microcode)		O
	Mode='101' (Download Microcode and Save)		O
	READ BUFFER	(3C)	O
	Mode='000' (Header & Data Mode)		O
	Mode='001' (Header & Data Mode with Address)		O
	Mode='010' (Data Mode)		O
	Mode='011' (Descriptor Mode)		O
	READ LONG	(3E)	O
	CORRCT (Corrected)		×
	WRITE LONG	(3F)	O
Command (Group 2)	CHANGE DEFINITION	(40)	O
	WRITE SAME	(41)	O
	LBdata (Logical Block Data)		O
	PBdata (Physical Block Data)		×
	LOG SELECT	(4C)	×
	LOG SENSE	(4D)	×
	MODE SELECT EXTENDED	(55)	O
	RESERVE EXTENDED	(56)	O
	RESERVE EXTENDED	(57)	O
	MODE SENSE EXTENDED	(5A)	O
Command (Group 6)	DIAGNOSTIC WRITE DATA	[VU] (*1) (C1)	×
	DIAGNOSTIC READ DATA	[VU] (*1) (C2)	×
	FORMAT ID	[VU] (*1) (C4)	×
	SPACE ID & READ DATA	[VU] (*1) (C6)	×
	DISPLACED ID	[VU] (*1) (C8)	×
	READ ID	[VU] (*1) (CA)	×

*1 Fujitsu-specific function

Table D.1 Fibre channel interface function specifications (8 of 8)

O: Provided ×: Not provided

Item			Specification
Command (Group 6)	DIAGNOSTIC FORMAT ID	[VU] (*1) (CD)	×
	DIAGNOSTIC READ ID	[VU] (*1) (CE)	×
	WRITE RAM	[VU] (*1) (D1)	×
	READ RAM	[VU] (*1) (D2)	×
	RECOVER DATA	[VU] (*1) (D8)	×
	RECOVER ID	[VU] (*1) (DA)	×
Command Processing	Defective sector slip processing function		O
	Command link function		×
	Relative block addressing function		×
	Untagged queuing function		×
	Tagged command queuing function		O
	Contingent Allegiance (CA)		×
	Extended Contingent Allegiance (ECA)		×
	Asynchronous condition notification feature (AEN: async. event notification)		×
	Read-ahead cache feature		O
	Cache control feature		×
	DPO (disable page out)		×
	FUA (force unit access)		×
	Write cache feature		O
Status	GOOD	(00)	O
	CHECK CONDITION	(02)	O
	CONDITION MET	(04)	O
	BUSY	(08)	O
	INTERMEDIATE	(10)	O
	INTERMEDIATE CONDITION MET	(14)	O
	RESERVATION CONFLICT	(18)	O
	COMMAND TERMINATED	(22)	O
	QUEUE FULL	(28)	O
Sense data	Non-extended format		×
	Extended format		O (48 bytes long)
CCS (common command set) conformity			O (Rev. 4.b)

*1 Fujitsu-specific function

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Glossary

Bus condition:	Asynchronous condition for causing SCSI bus status transition. There are two types of bus conditions, ATTENTION and RESET.
Bus phase:	An SCSI bus state. The SCSI bus is in one of the following phases: BUS FREE, ARBITRATION, SELECTION, RESELECTION, or INFORMATION TRANSFER. The INFORMATION TRANSFER phase is divided into DATA IN, DATA OUT, COMMAND, STATUS, MESSAGE IN, and MESSAGE OUT phases depending on the type of information being transferred.
CCS:	Common Command Set. The standard SCSI logical specification stipulated by a working committee of ANSI. Functions necessary for direct access devices are defined.
CDB:	Command Descriptor Block. A group of data that describes the command for I/O and is transferred from an initiator to a target.
Command:	Issued to a target to direct an input/output operation and written as CDB.
Disconnect:	Operation performed by the target to free itself from the SCSI bus and the initiator temporarily when SCSI bus operation becomes unnecessary during command processing.
Initiator:	SCSI device that has initiated an input/output operation on the SCSI device. This is abbreviated as INIT.
Logical unit:	Simple unit of equipment that can be directed to perform one I/O operation on the SCSI bus.
LUN:	Logical unit number used to identify a logical unit.
Message:	Information that controls a series of bus phases and I/O sequence between the initiator and the target on the SCSI bus.
Reconnect:	Operation performed by the target to reconnect itself with the initiator when operation on the SCSI bus becomes necessary after disconnection.
SCSI:	Small computer system interface. An input/output interface standardized by the American National Standards Institute (ANSI). [Standard number: ANSI X3.131-1986]
SCSI device:	General term for a device (Input/output device, I/O controller, and host adapter, etc.) connected to an SCSI bus.
SCSI ID:	Physical device address used to identify an SCSI device on the SCSI bus. This number is specific to each SCSI device. SCSI IDs are #0 to #7, each referenced by a unique bit on the data bus.
Sense code:	One byte of code added to the sense data to identify the type of detected error.

Sense data:	Detailed information created by the target when any error is involved in the command termination status. This information is transferred to report the error.
Sense key:	Four-bit code added to the sense data to identify the class of detected error.
Status:	One byte of information that is transferred from a target to an initiator on termination of each command to indicate the command termination status.
Target:	SCSI device which performs I/O initiated by an initiator. It is abbreviated as TARG.

Abbreviations

A

ACK	ACKnowledge
AEN	Asynchoronous Event Notification
ALT	ALTernated (block)
ARRE	Automatic Read Reallocation Enabled
ASCII	American Standard Code for Information Interchange
ASG	ASiGned block
ATN	ATTeNtion
AWG	American Wire Gauge
AWRE	Automatic Write Reallocation Enabled

B

bpi	bits per inch
BSY	BuSY
BytChk	Byte Check

C

C list	Target Certification list
C/D	Control/data
CCS	Common command set
CDB	Common descriptor block
CE	Customer Engineer
CmpLst	Complete List
CRC	Cyclic Redundancy Check
CSS	Contact Start Stop
CYL	CYLinder

D

D	Depth
D list	Data Defect List
DBD	Disable Block Descriptor
DC	Direct Current
DCR	Disable Correction
DCRT	Disable CeRtificaTion
DE	Disk Enclosure
DEF	DEFective block
DevOfl	Device Offline
DPO	Disable Page Out
DPRY	Disable PRimarY
DSP	Disable Saving Parameters
DTDC	Data Transfer Disconnect Control
DTE	Disable Transfer on Error

E

ECC	Error Correction Code
EER	Enable Early Recovery
EVPD	Enable Vital Product Data

F

FG	Frame Ground
FIFO	First In First Out
FmtData	Format Data
FOV	Format Options Valid
FUA	Force Unit Access

G

G	Gap
G list	Grown defect list

H

H	Height
HSEC	Hard SECtor

I

I/O	Input/Output
ID	IDentifier
IDD	Intelligent Disk Drive
ILBN	Ideal Logical Block Number
Immed	Immediate
INDX/SCT	INDeX/SeCTor
IP	Initialization Pattern
ISG	InterSector Gap

L

LBdata	Logical Block data
LBN	Logical Block Number
LED	Light Emitting Diode
LUN	Logical Unit Number

M

MR	Magnetro Resistive
MS	Multiple Select

MSG	MeSsaGe

O

OEM	Original Equipment Manufacturer

P

P list	Primary defect list
P/N	Parts/Number
PBdata	Physical Block data
PC board	Printed Circuit board
PCA	Printed Circuit Assembly
PER	Post ERror
PF	Page Format
PLOSync	Phase Lock Oscillator Syncronous
PMI	Partial Medium Indicator
PR4ML	Partial Response class 4 Maximum Likelihood

R

RC	Read Continuous
RCD	Read Cache Disable
REQ	Request
RH	Relative Humidity
RMB	ReMovaBle
RST	ReSeT
RSV	ReSerVed

S

S/N	Serial/Number
SBd	Synchronized Byte data area
SBi	Synchronized Byte identifier area
SCSI	Small Computer System Interface
SCT	SeCTor
SEL	SELect
SelfTest	Self Test
SG	Signal Ground
SP	Save Page
SPR	SPaRe block
SR	Servo
SSEC	Soft SECtor
STPF	SToP Format
SURF	SURFace

T

TB	Transfer Block
TPI	Tracks Per Inch
TRM	TeRMinator

U

UnitOfl	Unit Offline

V

VCM	Voice Coil Motor
VPD	Vital Product Data
VU	Vendor Unique

W

W	Width
WCE	Write Cache Enable
WP	Write Protect

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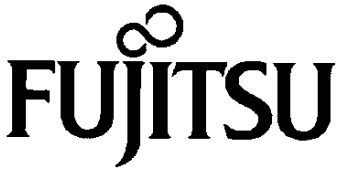
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