C141-C008-01EN

MAT3073FC, MAT3147FC, MAT3300FC SERIES
MAU3036FC, MAU3073FC, MAU3147FC SERIES

DISK DRIVES

FIBRE CHANNEL INTERFACE SPECIFICATIONS

FUJITSU

FOR SAFE OPERATION

Handling of This Manual

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

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

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

First Edition July 2004

Revision History

(1/1)

Edition	Date	Revised section (*1) (Added/Deleted/Altered)	Details
01	2004.07.28	—	—

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

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Preface

This manual explains concerning the MAT3073FC, MAT3147FC, MAT3300FC, MAU3036FC, MAU3073FC, MAU3147FC series 3.5 inch hard disk drives with internal Fibre channel controller.

The purpose of this manual is to provide the specifications and functions of Fibre channel (FC) for use of these magnetic disk drives incorporated into user systems, and to present the information necessary for creating host system software. This manual is written for users who have a basic knowledge of hard disk drives and their use in computer systems.

The composition of manuals related to these disk drives and the range of subjects covered in this manual are shown in "Manual Organization," provided on a subsequent page. Please use these other manuals along with this manual as necessary.

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

Overview of Manual

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

Chapter 1 Fibre Channel Interface

This chapter describes the topology, physical and electrical requirements, interface protocol, and other operations of the Fibre channel (FC) interface which connects the MAT3073FC, MAT3147FC, MAT3300FC, MAU3036FC, MAU3073FC, MAU3147FC.

Chapter 2 Command Processing

This chapter describes the basic logical specifications related to Fibre channel processing.

Chapter 3 Data Buffer Management

This chapter describes the data buffer configuration, data transfer processing functions and cache operations.

Chapter 4 Command Specifications

This chapter describes detailed command specifications and how to use them.

Chapter 5 Sense Data and Error Recovery Methods

This chapter describes the configuration and contents of sense data which report to the host system when an error occurs, etc., key information necessary for error recovery, recommended procedures for error recovery to be executed through host system software and retry processing.

Chapter 6 Disk Media Management

This chapter describes the procedure for initializing the disk media, methods of treating media defects and data recovery methods.

Glossary

The glossary explains technical terms which are necessary to the reader’s understanding when reading this manual.

Acronyms and Abbreviations

This list shows the full spelling of abbreviations used in this manual.

Index

CONVENTIONS USED IN THIS MANUAL

The model name of disk drives covered by this manual differs in its ending suffix (Note 1) depending on its device type (three types), the electrical conditions of the Fibre channel interface used to connect the disk drive to the host system and its capacity and data format at the time it was shipped, but in this manual, except in cases where models need to be especially distinguished, a representative model name (Note 2) is used. In addition, these disk drives are called Intelligent Disk Drive (IDD), “drive” or “device” in this manual.

Note 1: Model Name

M AT 3 300 FC

FC	Interface type	FC: Fibre Channel
300	Formatted capacity	(1,000MB units) * 1MB=1,000,000bytes
3	Disk size	3: 3.5 inch
AT	Type	AT: 1 inch height, 10,025 rpm AU: 1 inch height, 15,000 rpm

Note 2: Typical model name

Type model name	Model name
MAT3300	MAT3300FC
MAT3147	MAT3147FC
MAT3073	MAT3073FC
MAU3147	MAU3147FC
MAU3073	MAU3073FC
MAU3036	MAU3036FC

Conventions for Alert Messages

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

The following are the alert signals and their meanings:

⚠DANGER	This indicates a hazardous situation *likely* to result in *serious personal injury* if the user does not perform the procedure correctly.
⚠WARNING	This indicates a hazardous situation *could* result in *serious personal injury* if the user does not perform the procedure correctly.
⚠CAUTION	This indicates a hazardous situation *could* result in *minor* or *moderate personal injury* if the user does not perform the procedure correctly. This alert signal also indicates that damages to the product or other property, *may* occur if the user does not perform the product correctly.
IMPORTANT	This indicates information that could help the user use the product more efficiently.

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

(Example)

IMPORTANT

It is possible to use bit 7 and bit 6 of the control byte as an inherent control field in future product specifications. It is recommended that the INIT specify zero in this field.

Attention

Please forward any comments you may have regarding this manual.

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

MANUAL ORGANIZATION

Product Manual	1. Outline 2. Specifications 3. Data Format 4. Installation Conditions 5. Installation Procedure 6. Diagnosis and Maintenance
Interface Specifications (This Manual)	1. Fibre Channel Interface 2. Command Processing 3. Data Buffer Management 4. Command Specifications 5. Sense Data and Error Recovery Methods 6. Disk Media Management
Maintenance Manual	1. Specifications and Equipment Configuration 2. Maintenance and Diagnosis 3. Troubleshooting 4. Removal and Replacement Procedures 5. Operating Theory

REFERENCED STANDARDS

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

Specification (document) number	Name	Concerned 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)
NCITS TR-20	FIBRE CHANNEL FABRIC LOOP ATTACHMENT (FC-FLA)	American National Standards Institute (ANSI)
NCITS Project 1133-D, Revision 7.0	FIBRE CHANNEL ARBITRATED LOOP-2 (FC-AL-2)	American National Standards Institute (ANSI)
SFF-8045	Small Form Factor (SFF) document SFF-8045, 40-pin SCA-2 Connector W/Parallel Selection	Small From Factor committe
SFF-8067	Small Form Factor (SFF) document SFF-8067, 40-pin SCA-2 Connector W/Bi-directional ESI	Small From Factor committe

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CHAPTER 1 Fibre Channel Interface

This chapter describes the topology, physical and electrical requirements, interface protocol and operation of the fibre channel interface.

1.1 Topologies in Fibre Channel Interface

Three kind of topologies are defined in ANSI standards. (Arbitrated Loop, Fabric and Point-to-Point)

The drive supports Arbitrated Loop and Fabric as the primary topologies for the drive connections.

Figure 1.1 shows the example of connection for disk drives in FC-AL.

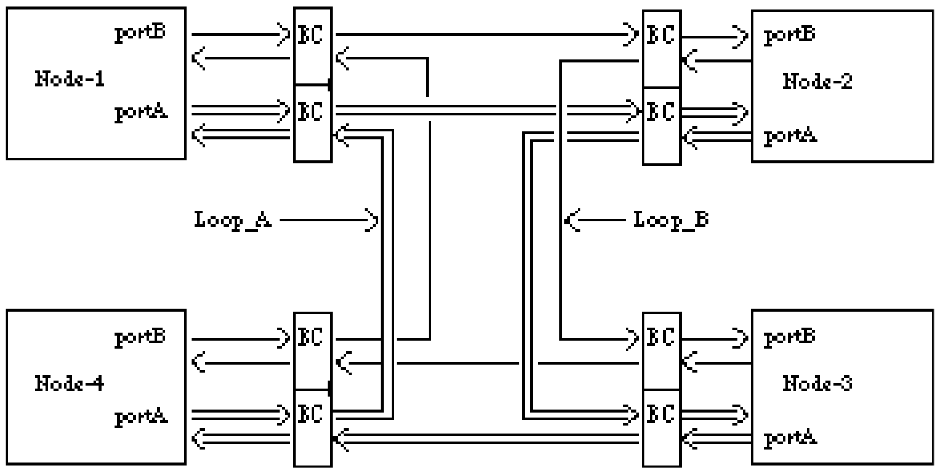


Figure 1.1 Example of FC-AL connection

BC are port bypass circuits on the back plane commonly, where Node mean the Target or initiator.

Each Loop signal is transmitted by one-way direction and made of electrical wires called “link”.

Each node is connected to the loop vial the port which the node owns. Each port consists of the receiver which receives information from the loop and the transmitter which sends information.

In this example, each node has two ports building two independent loops. Information is propagated between the nodes on the loop through serial signals.

This section describes the Node, Port, BC and link forming the above diagram and the signals propagated on the link.

1.1.1 Node/port

Any device connected to Fibre Channel topology is called “node”.

In the application of this drive, the drive itself and the initiator are the nodes.

Each node has at least one port to connect other nodes and the port is called N_port.

Especially, in FC-AL, the port is called “NL_Port” where “NL” stands for node loop.

The drive provides two ports and each port is connected to each FC-AL.

See Figure 1.1.

1.1.2 Link

Each port provides both Receiver and Transmitter.

The drive uses electrical wires (differential signal) to receive or transmit the information.

This pair of wires is called a “link”.

See Figure 1.1.

The drive Link Rate is selectable either 2 Gbps or 1 Gbps by DEV_CTL signals on the Back Plane via SCA-2 Connector.

It is commonly use for both Ports.

See Table 1.12.

1.1.3 Arbitrated loop

Arbitrated loops are defined as “private loop” or “public loop”.

Private loop has no FL_port (for fabric loop) and all nodes are NL_ports.

If there is a FL_port which is managing the loop, the loop is called a public.

This can connect up to 126 active NL_port and one FL_port to the same loop.

And the NL_ports use arbitration to establish an Initiator-Target connections.

See Figure 1.1.

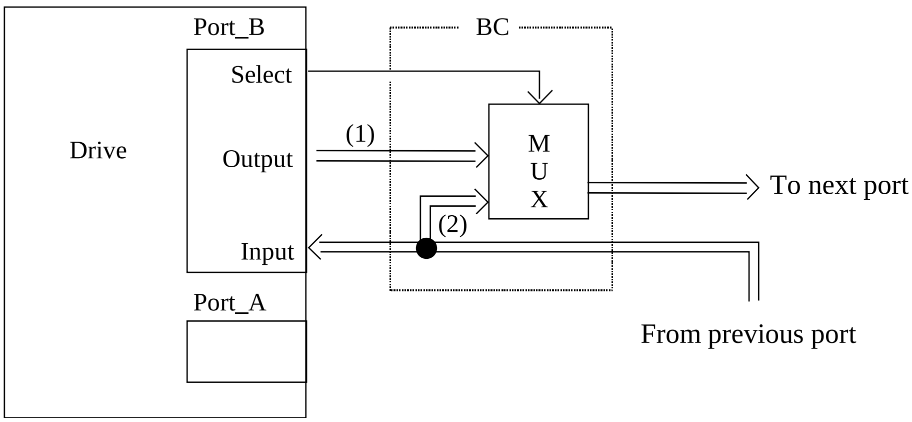
1.1.4 Port bypass circuit (BC)

Port bypass circuit is to bypass the drive if it cannot provide loop services.

For example, by removing the drive, unable to obtain valid data, or by any special condition.

The port bypass circuit is located external to the drive. (for example, on the back plane)

Figure 1.2 shows the relationship between the drive and the circuit.



(1) Regular route (Bypass circuit off)   (2) Via bypass (Bypass circuit on)

Figure 1.2 Port bypass circuit

1.1.5 Encoding & decoding

On FC-AL, the data is encoded prior to transmission and should be decoded when receiving.

The 10-bit character consists of 1,024 data space with 13-bit data mapped 1 control character.

This method is called 8B/10B encoding.

And to prevent too many same signal (ones or zeros), 10-bit character has an option to balance total numbers of ones or zeros.

This balancing is called “running disparity”.

1.1.6 Buffer-to-buffer frame transfer

As shown in Figure 1.3, data transmission occurs from an output buffer in the node part to an input buffer in the node port.

The basic unit of buffer-to-buffer transfer is the frame.

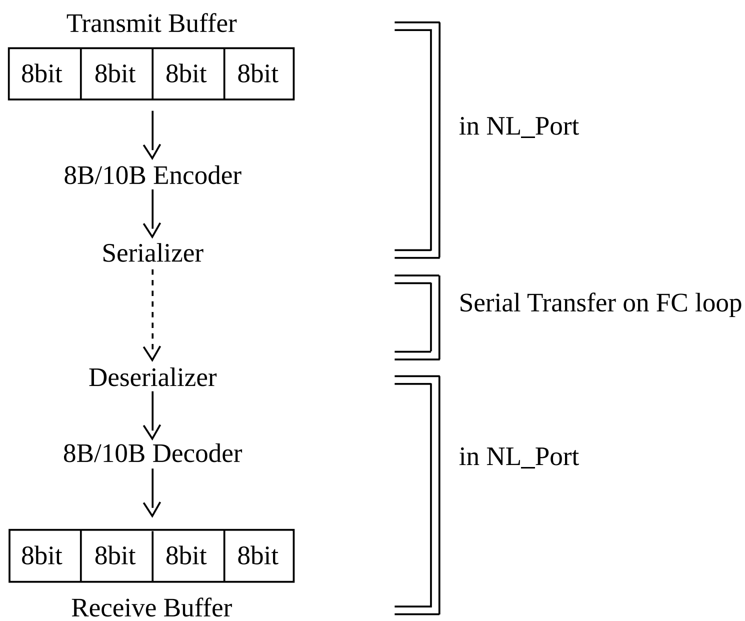


Figure 1.3 Buffer-to-buffer frame transfer

1.2 Information Transmitted on the Loop

This section explains the “Ordered Sets” and “Frame” propagated on the loop.

Since information is exchanged between the ports through serial signals, both loop control information and information at user level are defined in frame format.

The information on the loop is categorized into two groups.

One is “ordered sets” and the other is called “frame”.

Ordered sets consist of four 10-bit character to control port circuit mainly.

And the frame consists of FC-4 Device Data for SCSI protocol and Link Data to control Fibre Channel layer.

The communication between the ports is done by using the frame defined in FC-PH.

The frame has the port address of source and destination, frame control information and user protocol (SCSI-Command, data and etc.) information.

Figure 1.4 shows category of the data on the loop.

```
                 Data                                  Example

Ordered Sets
 ├─ Frame Delimiters                     –SOF, EOF
 ├─ Primitive Signals                    –Idle, R_RDY, OPN, CLS
 └─ Primitive Sequence                   –LIP, LPE, LPB
Frame
 ├─ Link Data
 │   ├─ Basic Link Service               –ABTS, BA_ACC, BA_RJT
 │   └─ Extended Link Service            –PLOGI, PRLI, PDISC, LISM
 │
 └─ FC-4 Device Data
     ├─ Command Frame                    –FCP_CMND_IU
     ├─ Data Frame                       –FCP_DATA_IU
     ├─ Transfer-ready Frame             –FCP_XFER_RDY_IU
     └─ Response Frame                   –FCP_RSP_IU
```

Notes:

a) Ordered Sets is mainly used for control of port circuit.

b) FC-4 Device Data is used for implementation SCSI protocol.

c) Link Data is used for transmission and response for port control data.

Figure 1.4 Data category on the loop

1.2.1 Ordered sets (refer to FC-PH, section 11.4)

There are three kind of Ordered Sets.

(1) –Primitive signals

(2) –Frame delimiters

(3) –Primitive sequence

which consist of four 10 bit character combination.

Each ordered set has string of data shown in Figure 1.5.

The K28.5 special character is always used as the first character of all ordered sets.

K28.5	Dxx.y	Dxx.y	Dxx.y

Figure 1.5 Format of ordered sets

1.2.1.1 Primitive signals

Primitive Signals have a control function to indicate status of the drive or to perform some operation to the port being connected.

Primitive Signals are recognized when one ordered set is detected.

A minimum of six Primitive Signals must be transmitted between each frame.

The name and the function of Primitive Signals is below.

a) Idle; to indicate the port can transmit or receive the frame

b) R_RDY; to indicate the port has an area for receiving the frame

c) ARBx; to request the right to use the loop. x = AL_PA of the requesting port

d) ARB (FO); to request the right (= lowest priority) to use the loop

e) OPN; to inform the transmission of the frame to the destination port

f) CLS: to inform the release of the loop

1.2.1.2 Frame delimiters

Frame Delimiters mark the beginning and end of frames.

They are called Start-of-frame (SOF) delimiters and End-of-frame (EOF) delimiters.

1.2.1.3 Primitive sequence

Primitive Sequence is a control function and requires to be detected.

The name and the function of Primitive sequence is below.

a) LPB; When received, the drive enables the port bypass circuit and bypasses the loop.

b) LPE; When received, the drive disables the port bypass circuit and connects to the loop.

1.2.2 Frame structure (refer to FC-PH, chapter 17)

A frame format is shown in Figure 1.6.

byte count	4	24	0-2048+64 (optional header)	4	4	min24
fill words	SOF	Frame Header	Payload	CRC	EOF	fill words
word count	1	6	0-528	1	1	min6

Figure 1.6 Frame format

a) SOF; Start of frame indicates the beginning of the frame.

b) Frame Header; Used as link control, drive protocol transfer and detect error condition.
The frame header format is listed in Table 1.1.

Table 1.1 Frame header format

word/byte	0 (bits 31 – 24)	1 (bits 23 – 16)	2 (bits 15 – 08)	3 (bits 07 – 00)
0	R_CTL	D_ID		
1	reserved	S_ID		
2	TYPE	F_CTL		
3	SEQ_ID	DF_CTL	SEQ_CNT	
4	OX_ID		RX_ID	
5	OFFSET			

*1 R_CTL; Routing Control to categorize the frame.

D_ID; Destination Identifier, N_port address to which the frame is being sent.

S_ID; Source Identifier, N_port address originating the frame.

*2 TYPE; Data Structure Type, identifies the frame protocol.

*3 F_CTL; Frame Control information

SEQ_ID; Sequence Identifier, uniquely identifies frames in a non-streamed sequence.

DF_CTL; Data Field Control, specifies the optional headers in the payload. This field is not supported by the drive and used as 00h.

SEQ_CNT; Sequence Count, identifies the order of the frames.

OX_ID; Originator Exchange Identifier, assigned by the originator of an exchange. This value is similar to Queue Tag in SCSI and must be unique for a pair between the initiator and the drive.

RX_ID; Responder Exchange Identifier, generated by the responder for an exchange.

OFFSET; Defines the relative displacement of the first byte of the payload from the base address of the command.

c) Payload; Data field, must be multiple of four bytes.

- If the frame is FC-4 Device Data, the payload has SCSI CDB, Read/Write Data or status/sense information.
- If the frame is Link Data, the payload has control information for the drive or the response data to the initiator.

d) CRC; Calculates without including SOF and EOF delimiters.

e) EOF; End of frame indicates the end of a frame.

*1: R_CTL (Routing Control)

The high order bits (bits 31-28) specify the frame type as follows.

0000 = FC-4 Device_Data frame

0010 = Extended Link_Data frame

0011 = FC-4 Link_ Data frame

0100 = Video_ Data frame

1000 = Basic Link_ Data frame

1100 = Link_ Control frame

Others = Reserved

The low order bits (bits 27-24) specify the Information field values.

Those values have the meaning with combination with the value of the high order bits (31-28).

Table 1.2 R_CTL

	High order bits	low order bits	Use
Type=0x08	0000	0000 Uncategorized 0001 Solicited Data 0010 Unsolicited Control 0011 Solicited control 0100 Unsolicited data 0101 Data descriptor 0110 Unsolicited 0111 Command status	Not supported Read and write data Not supported Not supported Not supported Transfer ready Command Response
Type=0x01	0010	0000 Uncategorized 0001 Solicited data 0010 Unsolicited control 0011 Solicited control 0100 Unsolicited data 0101 Data descriptor 0110 Unsolicited command 0111 Command status	Not supported Not supported Request Reply Not supported Not supported Not supported Not supported
Type=0x00	1000	0000 No operation 0001 Abort sequence 0010 Remove connection 0011 Reserved 0100 Basic_Accept 0101 Basic_Reject 0110 Dedicated connecton Preempted 0111 Reserved	Not supported Request Not supported Reply Reply Not supported

*2: Type (Data Structure Type)

Table 1.3 Type

R_CTL (4 highest order bit)	Type Code	Use
1000	00	Basic Link Service
0010	01	Extended Link Service
0000	08	SCSI FCP

*3: F_CTL (Frame Control)

Table 1.4 F_CTL

Bit	Definition	Description
23	Exchange context	0 = Frame is from the exchange originator 1 = Frame is from the exchange responder
22	Sequence context	0 = Initiator 1 = Recipient
21	First sequence	0 = Not the first sequence of the exchange 1 = First sequence of the exchange
20	Last sequence	0 = Not the last sequence of the exchange 1 = Last sequence of the exchange
19	End of sequence	0 = Not the last frame of the sequence 1 = Last frame of the sequence
18	End connection	Not supported
17	Chained sequence	Not supported
16	Sequence initiative	0 = Hold sequence initiative 1 = Transfer sequence initiative
15	X_ID reassigned	Not supported
14	Invalid X_ID	Not supported
13 12 11 10	Reserved	
9	Retransmitted Sequence	Not supported
8	Unidirectional transmit	Not supported
7 6	Continue sequence condition	Not supported
5 4	Abort sequence condition	Not supported
3	Relative offset present	0 = Parameter field not meaningful 1 = Parameter field equals relative offset
2	Reserved	
1 0	Fill data bytes End of data field fill bytes	00 = 0 byte of fill 01 = 1 byte of fill 02 = 2 bytes of fill 03 = 3 bytes of fill

(1) Link Data

Link Data is used when the initiator transmit control code to the target or when the target responses to the initiator.

Link Data supported by the drive are listed below.

Link Service

(1) BASIC LINK SERVICES

Table 1.5 BASIC LINK SERVICES

Basic Link Service Request Frames	Abbr.	Support
Abort Sequence	ABTS	Yes

Basic Link Service Request Frames	Abbr.	Support
Basic_Accept	BA_ACC	Yes
Basic_Reject	BA_RJT	Yes
No Operation	NOP	No
Remove Connection (class1 only)	RMC	No

(2) EXTENDED LINK SERVICES

Table 1.6 EXTENDED LINK SERVICES (1/2)

Extended Link Service Request Frames	Abbr.	Support
Address Discovery	ADISC	Yes
Fabric Login	FLOGI	Yes
Logout	LOGO	Yes
Port Discovery	PDISC	Yes
Port Login	PLOGI	Yes
Process Login	PRLI	Yes
Process Logout	PRLO	Yes
Read Link Status	RLS	Yes
Report Node Capabilities	RNC	Yes
Reinstate Recovery Qualifier	RRQ	Yes
Register FC-4 Types Name Service	RFC-4	Yes
Third-party Process Logout	TRPLO	Yes

Table 1.6 EXTENDED LINK SERVICES (2/2)

Extended Link Service Request Frames	Abbr.	Support
Read Exchange Status Block	RES	No
Request Sequence Initiative	RSI	No
Read Sequence Status Block	RSS	No

Extended Link Service Request Frames	Abbr.	Support
Accept	ACC	Yes
Link Service Reject	LS_RJT	Yes

- Extended Link Services-Loop Initialization

Table 1.7 Extended Link Services-Loop Initialization

Extended Link Service Request Frames LOOP INITIALIZATION	Abbr.	Support
Select Master	LISM	Yes
Fabric Assign AL_PA	LIFA	Yes
Previously Acquired AL_PA	LIPA	Yes
Hard Assigned AL_PA	LIHA	Yes
Soft Assigned AL_PA	LISA	Yes
Report AL_PA Position Map	LIRP	Yes
Loop AL_PA Position Map	LILP	Yes

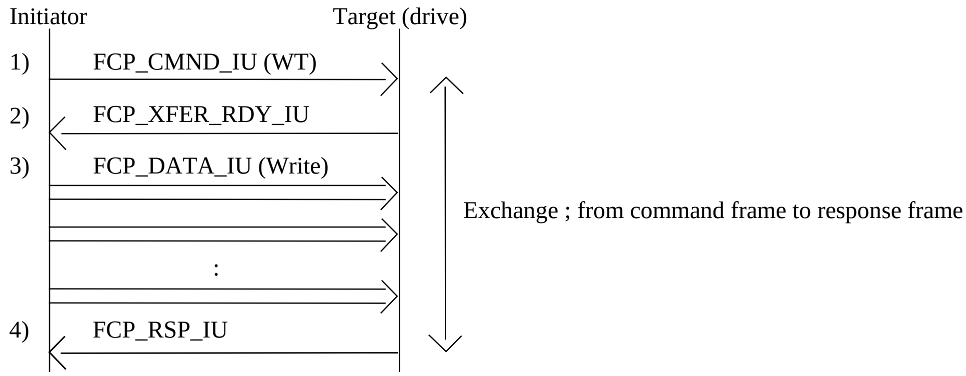
(2) FC-4 Device Data

Exchanges consist of two or more frame sequences between the initiator and the target.

Exchanges starts from command frame by the initiator and ends at response frame by the target.

Four FC-4 Device Data (FCP_CMND_IU, FCP_DATA_RDY_IU, FCP_DATA_IU, FCP_RSP_IU) are used to implement SCSI protocol. Figure 1.7 explains the examples of Exchanges in case of SCSI write/read operation.

a) SCSI write operation



b) SCSI read operation

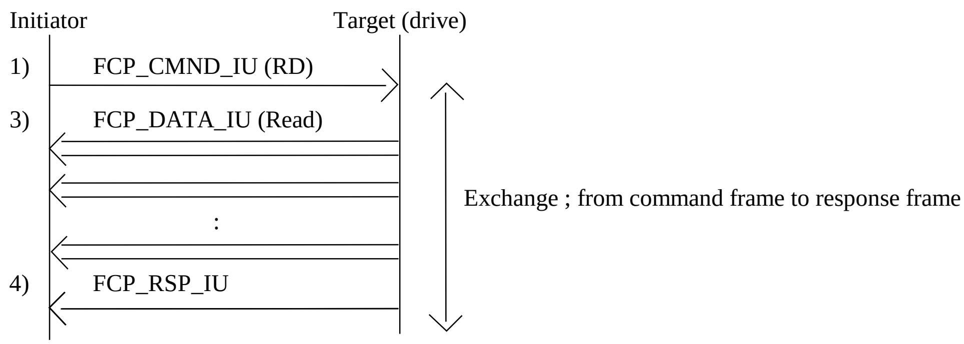


Figure 1.7 Examples of exchange

1) FCP_CMND_IU; includes SCSI command and the control information

2) FCP_DATA_RDY_IU; permits the data transmission from the initiator to the drive

3) FCP_Data_IU; Read or Write data between the initiator and the drive

4) FCP_RSP_IU; Used by the drive to report status/sense data to the initiator

1.3 Physical Requirements, Electrical Requirements

1.3.1 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 1.8 shows the fibre channel connector. See Section 1.3.2, 1.3.3 for signal assignments on the connector.

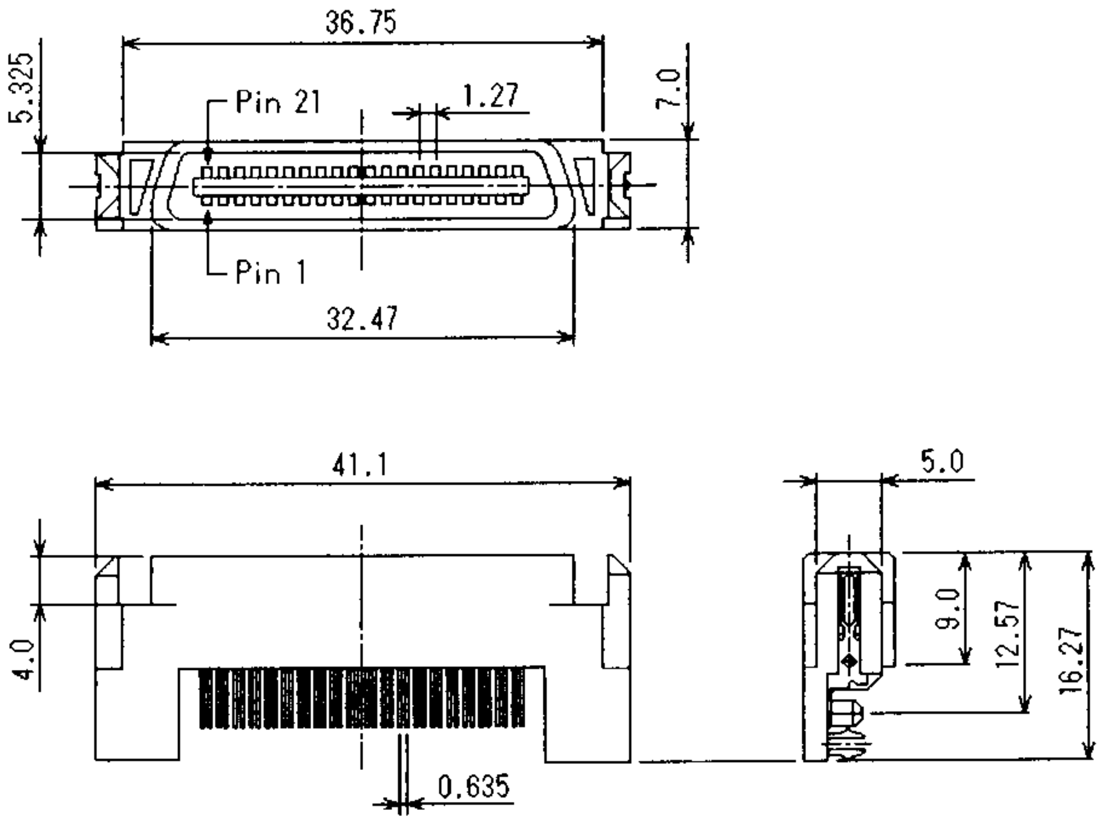


Figure 1.8 SCA2 type interface connector (IDD)

Table 1.8 lists signal assignments on the connector.

Table 1.8 FC-SCA connector: CN1

<table>
<tr><th>Pin No.</th><th colspan="2">Signal</th><th colspan="2">Signal</th><th>Pin No.</th></tr>
<tr><td>01</td><td colspan="2">–EN bypass port A</td><td colspan="2">+12V charge</td><td>21</td></tr>
<tr><td>02</td><td colspan="2">+12V</td><td colspan="2">GND</td><td>22</td></tr>
<tr><td>03</td><td colspan="2">+12V</td><td colspan="2">GND</td><td>23</td></tr>
<tr><td>04</td><td colspan="2">+12V</td><td colspan="2">+PortA_in</td><td>24</td></tr>
<tr><td>05</td><td colspan="2">–Parallel ESI</td><td colspan="2">–PortA_in</td><td>25</td></tr>
<tr><td>06</td><td colspan="2">–Drive present</td><td colspan="2">GND</td><td>26</td></tr>
<tr><td>07</td><td colspan="2">Active LED out</td><td colspan="2">+PortB_in</td><td>27</td></tr>
<tr><td>08</td><td colspan="2">Power_Control</td><td colspan="2">–PortB_in</td><td>28</td></tr>
<tr><td>09</td><td colspan="2">Start_1/Mated</td><td colspan="2">GND</td><td>29</td></tr>
<tr><td>10</td><td colspan="2">Start_2/Mated</td><td colspan="2">+PortA_out</td><td>30</td></tr>
<tr><td>11</td><td colspan="2">–EN bypass port B</td><td colspan="2">–PortA_out</td><td>31</td></tr>
<tr><td>12*</td><td>SEL_6</td><td>–DSK_WR</td><td colspan="2">GND</td><td>32</td></tr>
<tr><td>13*</td><td>SEL_5</td><td>–DSK_RD</td><td colspan="2">+PortB-out</td><td>33</td></tr>
<tr><td>14*</td><td>SEL_4</td><td>–ENCL_ACK</td><td colspan="2">–PortB-out</td><td>34</td></tr>
<tr><td>15*</td><td>SEL_3</td><td>D(3)</td><td colspan="2">GND</td><td>35</td></tr>
<tr><td>16</td><td colspan="2">Fault LED out</td><td>SEL_2</td><td>D(2)</td><td>36*</td></tr>
<tr><td>17</td><td colspan="2">DEV_CTRL_CODE_2</td><td>SEL_1</td><td>D(1)</td><td>37*</td></tr>
<tr><td>18</td><td colspan="2">DEV_CTRL_CODE_1</td><td>SEL_0</td><td>D(0)</td><td>38*</td></tr>
<tr><td>19</td><td colspan="2">+5V</td><td colspan="2">DEV_CTRL_CODE_0</td><td>39</td></tr>
<tr><td>20</td><td colspan="2">+5V</td><td colspan="2">+5V charge</td><td>40</td></tr>
</table>

* Signal names in the right column of the table are those in parallel ESI operation.

1.3.2 Signal function in SFF8045 mode

(1) +12V charge, +5V charge

These signals are used to precharge of the internal circuits to avoid excessive surge current while hot plugging is being operated.

Before power voltage pins (+12V and +5V) make contact, these precharge pins mate early.

Precharge control circuits are external to the drive.

The voltage provided to the precharge signals are defined in Table 1.9.

Table 1.9 Charge supply to the drive

Charge Signal	Range of power supply after charge complete	Max Surge to the drive	Max Continuous required the drive
+12V charge	12V +5%, –12%	6 Amps	1 Amps
+5V charge	5V +5%, –17%	6 Amps	1 Amps

(2) Fault LED out

The drive starts, and this signal lights when it detects internal failure.

1) Fault LED is turned on when asserting Enable Bypass signals for both ports.

2) Fault LED is turned on when the internal failure is detected.

   a) When losing synchronization on both ports

   b) When detecting hardware error in the HDC chip

3) Fault LED is turned on when the host issues the corresponding command.

Note: The Fault LED will not be turned on if only one port loses synchronization.

The Fault LED out signal is an open-collector output. The LED and the current limiting register are external to the drive. See Table 1.10.

Table 1.10 Characteristics of Fault LED out signal

State	Current	Output Voltage
LED off	–100µA <IOH < 100µA	
LED on	IOL > 30mA	0 < VOL <0.5V

(3) Active LED out

The signal indicates that the drive starts and is active.

Two alternative indication pattern is defined in SFF-8045 Specification Rev 4.2.

One is “hot plug implementation” for the drives in hot plugged environments.

The other is “legacy implementation” where the compatibility with previous SCSI indication system is required.

The drive supports hot plug implementation described below.

a) The Active LED out signal does not light if the drive is not connected.

b) The Active LED out signal blinks for approximately 0.5 sec. intervals when the drive is spinning. It turns to light when the drive is ready.

c) The Active LED out signal blinks for approximately 0.5 sec. intervals when the drive is spin-down. It is turned off when the drive is not ready.

d) The Active LED out signal is turned off when the SCSI command is received by the drive and during processing. And it changed to blink when the command processing is completed.

e) The Active LED out signal blinks for approximately 1.0 sec. intervals during being processed Format Command.

(4) Start_1/Mated, Start_2/Mated

These signals controls the method to start the drive’s motor as described Table 1.11.

Also the signals are used to indicate to the drive that the drive has been mated to a backplane.

Table 1.11 Definition of motor start/mated control

Case	Start_2/ Mated	Start_1/ Mated	Function
1	open	open	Drive is not mated to a backplane. The drive’s motor does NOT spin up.
2	open	ground	Drive is mated to a backplane. The drive’s motor spins up when the drive receives SCSI start command after a mating deskew time has passed.
3	ground	open	Drive is mated to a backplane. The drive’s motor spins up after a delay after a mating deskew time has passed.
4	ground	ground	Drive is mated to a backplane. The drive’s motor spins up immediately after a mating deskew time has passed.

The mating deskew time is minimum 250 msec.

A 10 KΩ pull up register to 5V for each signal is asserted on the drive.

The open and ground states should be controlled as in Table 1.12.

Table 1.12 Electric requirement for input control

State	Current	Voltage
open	20 μA <IIH < 20 μA	2.2V <VIH < 5.25V
ground	0 <IIL <–20 mA	–0.5V <VIL <0.7V

(5) Parallel ESI

This signal is not supported in SFF8045 mode.

When receiving either Receive Diagnostic Result or Send Diagnostic Command, the drive will assert this signal to initiate SFF-8067 Enclosure Discovery Phase and to execute ESI operations.

(6) SEL_0, _1, _2, _3, _4, _5, _6

These seven SEL lines are provided for the binary value of the loop identifier by the backplane.

This identifier is name AL_PA and is used for 126 unique value except 00h.

These ID signals are tested by the drive when powered on.

SEL_6 is the most significant bit and SEL_0 is the least significant bit.

Electric requirement for the signals is listed in Table 1.13.

These signals with high state have approximately 10KΩ register on the backplane.

Table 1.13 Electric requirement for SEL_n inputs

State	Current	Voltage
high	–20 μA <IIH < 20 μA	2.2V <VIH < 5.25V
low	–20 μA <IIL < 20 μA	–0.5V <VIL <0.7V

SEL. ID = (SEL_6, SEL_5, SEL_4, SEL_3, SEL_2, SEL_1, SEL_0)

(7) DEV_CTRL_CODE [2, 1, 0]

DEV_CTRL_CODES Provide Link Rate, and Power Failure Warning (PFW) to the drive.

Table 1.14 Electric requirement for DEV_CTRL_CODE inputs

State	Current	Voltage
high	–20 µA <IIH < 20 µA	2.2V <VIH < 5.25V
low	–20 µA <IIL < 20 µA	–0.5V <VIL <0.7V

Table 1.15 Definition of device control codes

Value	Function	Support
7	1.0625 GHZ - The FC interfaces for both ports of the drive are set to run at a link rate of 1.0625 GHZ.	Yes
6	2.1250 GHZ - The FC interfaces for both ports of the drive are set to run at a link rate of 2.1250 GHZ.	Yes
5	4.250 GHZ - The FC interfaces for both ports of the drive are set to run at a link rate of 4.250 GHZ.	No
4 to 2	Reserved	No
1	Reserved for auto-negotiation of FC interface link rate.	No
0	Power Failure Warning	No

Table 1.16 Arbitrated loop physical address (AL_PA) values

AL_PA (hex)	SEL ID (hex)	AL_PA (hex)	SEL ID (hex)	AL_PA (hex)	SEL ID (hex)
EF	00	A3	2B	4D	56
E8	01	9F	2C	4C	57
E4	02	9E	2D	4B	58
E2	03	9D	2E	4A	59
E1	04	9B	2F	49	5A
E0	05	98	30	47	5B
DC	06	97	31	46	5C
DA	07	90	32	45	5D
D9	08	8F	33	43	5E
D6	09	88	34	3C	5F
D5	0A	84	35	3A	60
D4	0B	82	36	39	61
D3	0C	81	37	36	62
D2	0D	80	38	35	63
D1	0E	7C	39	34	64
CE	0F	7A	3A	33	65
CD	10	79	3B	32	66
CC	11	76	3C	31	67
CB	12	75	3D	2E	68
CA	13	74	3E	2D	69
C9	14	73	3F	2C	6A
C7	15	72	40	2B	6B
C6	16	71	41	2A	6C
C5	17	6E	42	29	6D
C3	18	6D	43	27	6E
BC	19	6C	44	26	6F
BA	1A	6B	45	25	70
B9	1B	6A	46	23	71
B6	1C	69	47	1F	72
B5	1D	67	48	1E	73
B4	1E	66	49	1D	74
B3	1F	65	4A	1B	75
B2	20	63	4B	18	76
B1	21	5C	4C	17	77
AE	22	5A	4D	10	78
AD	23	59	4E	0F	79
AC	24	56	4F	08	7A
AB	25	55	50	04	7B
AA	26	54	51	02	7C
A9	27	53	52	01	7D
A7	28	52	53		
A6	29	51	54		
A5	2A	4E	55		

(8) Port out (+port A_out, +port B_out)

Port out signals are output by the drive.

These signals are differential copper with a termination of 50 Ω embedded in HDC Chip and 100 Ω to output ECL signal label on the loop .

The output circuit is shown in Figure 1.9.

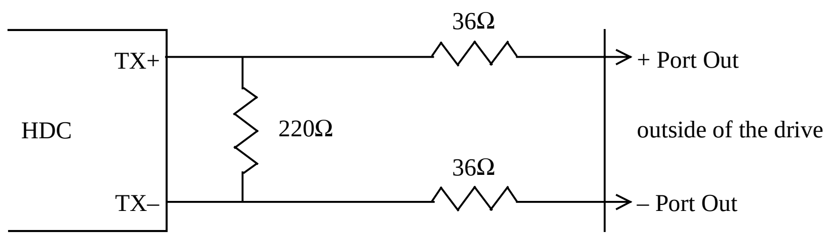


Figure 1.9 Fibre channel output circuit

(9) Port in (+Port A_in, +Port B_in)

These signals are differential copper with 100 Ω termination embedded in HDC chip and are AC coupled with capacitors.

The input circuit is shown in Figure 1.10.

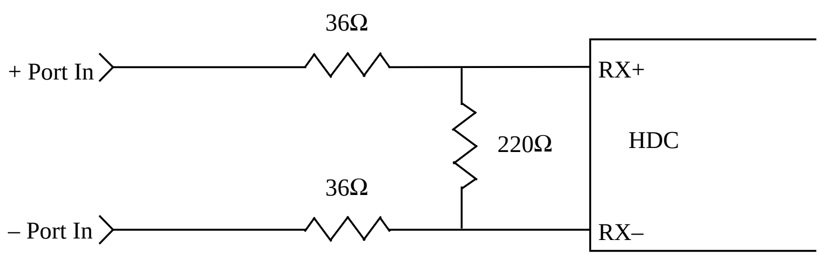


Figure 1.10 Fibre channel input circuit

(10) –EN Bypass Port A/–EN Bypass Port B

These Enable Port Bypass Circuit (PBC) by a bypass signals, which is located external to the drive.

The functional diagram of these signals is described in Section 1.1.4.

When the drive asserts this signal (low), the Port bypass circuit bypasses the drive which is connected.

This signal is asserted when;

a) detecting of the Loop Port Bypass primitive sequence

b) being removed of the drive from the loop

c) loss of receive clock

d) loss of transmission clock

e) detecting hardware error within the drive

This signal is negated when the drive detects a Loop Port Enable primitive sequence.

(11) –Drive present ; This signal connected to the ground.

1.3.3 Signal function in SFF8067 mode

(1) –Parallel ESI

–Parallel ESI signal is used to request the enclosure to provide the SEL_x (x = 0-6) addressing signals and to request ESI block Read/Write operation.

Table 1.13 defines electronic characteristics of this signal.

Table 1.17 Output characteristics of –parallel ESI

State	Current Drive Available	Output Voltage
high	–100 µA <IOH < 100 µA	0< VOH <5.25V
low	IOL >1.6 mA	0< VOL <0.5V

Table 1.17 shows how –Parallel ESI signal is used in the Enclosure Service Interface.

(2) –DSK_WR, DSK_RD, ENCL_ACK, D(3), D(2), D(1), D(0)

The SEL_x (x = 0-6) signals change into communication control signals when –Parallel ESI signal is asserted.

1.4 Drive Operation on the Loop

This section describes the following as the operations which the drive is required to perform at FC level:

- Loop initialization
- Arbitration
- Communication between the initiator and target

1.4.1 Loop initialization

(1) Process Outline

Loop Initialization is a process for the purpose listed below.

- To obtain Arbitrated Loop Physical Address (AL_PA) because the drive has no valid address when powered on.
- To indicate the error on the loop to the other NL_ports.
- To reset particular drive by the initiator.

And the trigger to start Loop Initialization is called LIP.

Loop Initialization is occurred as follows.

a) The drive is powered on.

↓

b) The drive (or all NL_Ports if powered on simultaneously) requests to start Loop Initialization.

↓ ; see 1.4.1(3) (LIP)

c) Select loop master (responsible for processing Loop Initialization)

↓ ; see 1.4.1(4) (LISM)

d) Each NL_ports on the loop starts the process for obtaining AL_PA.

↓ ; see 1.4.1(5) (LIFA/LIPA/LIHA/LISA)

e) Each NL_Ports obtains unique AL_PA and Loop Initialization is terminated.

(2) AL_PA

This sub-section describes the addresses (AL_PA) used on the loop.

AL_PA is an 8-bit character and when encoded to 10 bits, AL_PA has an equal number of ones or zeros to maintain neutral running disparity.

Table 1.18 shows the AL_PA values and the priority used on the loop.

Details of AL_PA is described in Table 1.16.

Table 1.18 AL_PA value/priority

Values (hex)	Priority & Use
00	Highest priority and assigned for FL_port. The drive does not assume the existence of this value on the loop. (because of assuming private loop)
01-EF	126 valid NL_Port address 01 (highest priority) < ===== > EF (Lowest priority)
F0	Has no priority and used for fairness algorithm and for Loop Initialization process
F1-F6	not used
F7, F8	reserved for Loop initialization
FF	vendor Specific reset
others	not used

Most common method for the disk drive will be to have the backpanel provide a hard assigned address.

If the drive failed to obtain a hard assigned address, the drive would obtain the address by soft assigned method. For details, refer to sub-section (5).

(3) LIP (Loop Initialization on Primitive)

Loop Initialization is generated by sending any LIPs in Table 1.19.

The NL_Port which received a LIP then transmit the LIP to the next port on the loop.

This cycle terminates when the NL_Port that started the initialization process receives the LIP.

Table 1.19 LIP sequences

LIP type	Use	Description	
LIP (F7, F7) LIP (F7, AL_PS)	Initializing Loop	A NL_Port requests to obtain AL_PA	*1
LIP (AL_PD, AL_PS)	Reset the port	The source port (AL_PS) requests to reset the destination port (AL_PD). The selected port performs to reset after loop initialization.	*2
LIP (F8, AL_PS)	Loop failure	The NL_Port has detected an input failure AL_PS is the AL_PA of the source port.	*1
LIP (F8, F7)	Loop failure	The NL_Port has detected an input failure and the port could not obtain an AL_PA.	*1
LIP (FF, AL_PS)	Reset ALL port	A Vendor Specific reset executes for both port.	

Note:

*1: The drive can issue the LIP.

*2: The drive receives the LIP but does NOT issue LIP (AL_PD, AL_PS).

(4) LISM (Loop Initialization Select Master)

This sub-section describes a process to select the loop master to which the function for proceeding with each process of Loop Initialization is given.

Selecting the loop master proceeds as follows. (Figure 1.11)

Figure 1.11 shows the example that three ports exist on the loop and each port has an unique Port Name which algebraic relationship is n+2>n+1>n.

Steps [1] through [6] are for selecting a port with the smallest unique port name of those assigned at manufacture, as the loop master.

Steps [8] and [9] are for confirming that the port, which became the loop master by steps [1] through [6], has become the loop master again.

Step	Port Name	n	n+1	n+2
[1] Transmits LISM with its own port name to the next port.		LISM (n) ⇒	LISM (n+1) ⇒	LISM (n+2) ⇒
[2] Receives LISM from the upper loop port.	LISM (n+2) ⇒	LISM (n) ⇒	LISM (n+1) ⇒	
[3] Compares the port name with its own port name and transmits LISM with lower port name.		LISM (n) ⇒	LISM (n) ⇒	LISM (n+1) ⇒
[4] Receives LISM from the upper loop port.	LISM (n+1) ⇒	LISM (n) ⇒	LISM (n) ⇒	
[5] Compares the port name with its own port name and transmits LISM with lower port name.		LISM (n) ⇒	LISM (n) ⇒	LISM (n) ⇒
[6] Receives LISM from the upper loop port.	LISM (n) ⇒	LISM (n) ⇒	LISM (n) ⇒	
[7] Compares the port name with its own port name and if they are the same, the port becomes loop master.		<loop master>	<non loop master>	<non loop master>
[8] Loop master transmits ARB (F0) ans waits for the ARB (F0) comes back.		ARB (F0) ⇒		
[9] Loop master checks ARB (F0)	ARB (F0) ⇒			

Note:

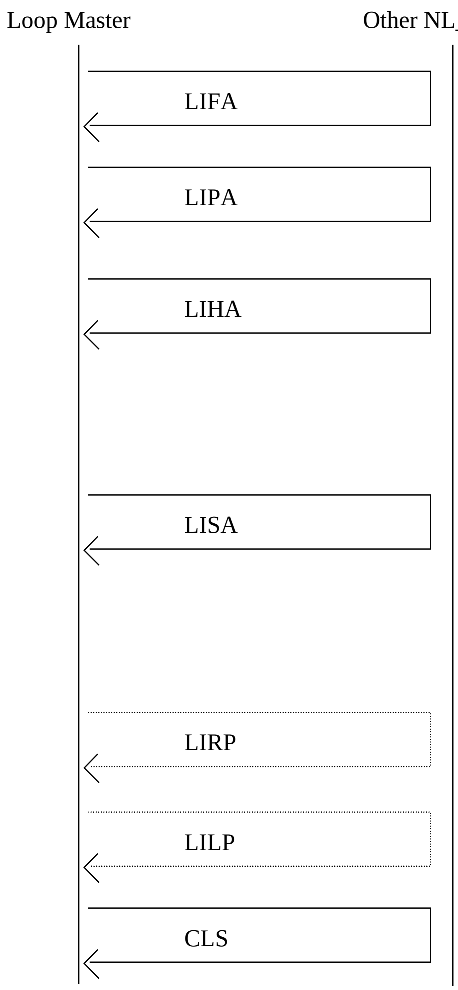
The value is assigned to each port uniquely in production.

Figure 1.11 Process for selecting loop master

(5) LIFA/LIPA/LIHA/LISA

This sub-section describes a process for each port to obtain AL_PA.

Figure 1.12 shows the process for non loop master to obtain unique AL_PA after ending a process for selecting the loop master.



; LIFA is used to gather all fabric-assigned AL_PAs.

; LIPA is used to gather all previously-acquired AL_PAs.
The drive attempts to obtain same AL_PA if the drive obtained the AL_PA in previous initilization.

; LIHA is used to gather all hard assigned AL_PAs.
The drive attempts to obtain AL_PA if it failed to obtain AL_PA in LIPA.
The drive always attempts to obtain AL_PA when
a) powered on or
b) receiving LIP (AL_PD, AL-PS)
The drive always attempts to obtain same AL_PA.

; LISA is used to assign any remaining AL_PA bits.
The drive attempts to obtain AL_PA if it failed up to LIHA.
If the drive fails to obtain AL_PA in LISA, then the drive goes into nonparticipating mode.

<== Each NL_Port obtains unique AL_PA here.

<== LIRP and LILP may be caused by the loop master to confirm the location and address on the loop.

; LIRP is used to record the relative positions on the loop.
; LILP is used to inform all NL_Ports of their relative positions on the loop from the loop master.

Figure 1.12 Loop master operation

The abbreviation in this section is below.

LIFA; Loop Initialization Fabric Assigned

LIPA; Loop Initialization Previously Acquired

LIHA; Loop Initialization Hard Assigned

LISA; Loop Initialization Soft Assigned

LIRP; Loop Initialization Report Position

LILP; Loop Initialization Loop Position

1.4.2 Arbitration

For information to be exchanged between the ports connected to a loop, generally the two ports (send side and receive side) must occupy the loop (placed in point-to-point connection state).

Arbitration is a process to win access right on the loop and must be done before communicating with another port.

When the arbitration is finished, only a pair of a initiator and a target can communicate each other on the loop.

The drive supports the method called “Access fairness”.

The process on the port supporting fairness movement is below.

a) If two or more ports request to arbitrate, the port with the highest priority (the port with smallest AL_PA value) wins the arbitration.

b) The port once won the arbitration cannot participate in the arbitration until other port wins the arbitration and release the loop.

   This method protects that the same port uses the loop consecutively.

1.4.3 Communication between initiator and target

This section shows the figure of the protocol using FC-4 Device Data on Fibre Channel layer.

The following procedures are followed to send FC-4 device data.

- Issue ARB by which the source of FC-4 device data asserts the occupation of the loop.
- After occupying the loop, the source issues “Open” to the destination.
- The receiving station responds by R_RDY by the count by which it can receive FC-4 device data.
- The sending station sends FC-4 device data.
- The sending station sends CLS to terminate the occupation of the loop.

  A description of each FC-4 device data follows.

(1) Command Transfer

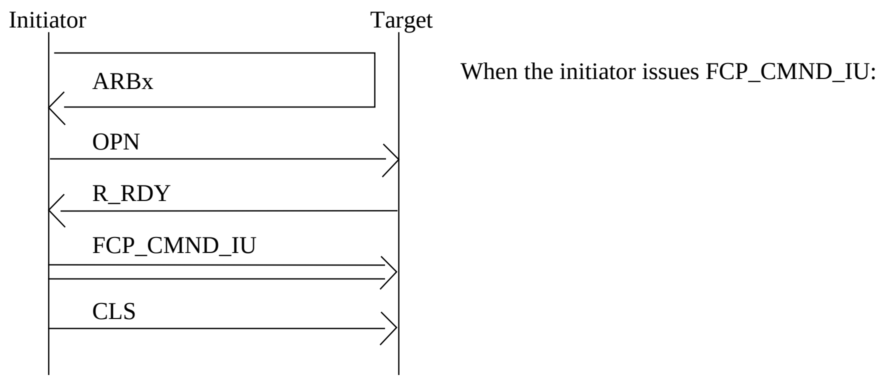


Figure 1.13 Command transfer

(2) Transfer Ready (X_RDY) , Response Transfer (RSP)

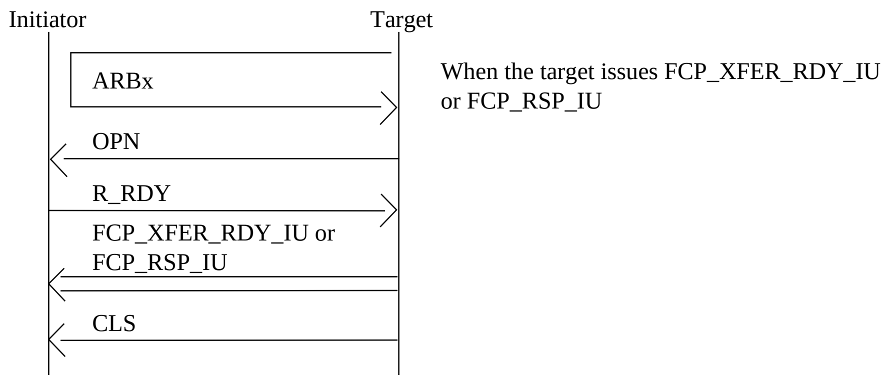


Figure 1.14 Transfer ready (X_RDY) , response transfer (RSP)

(3) Write Data Transfer

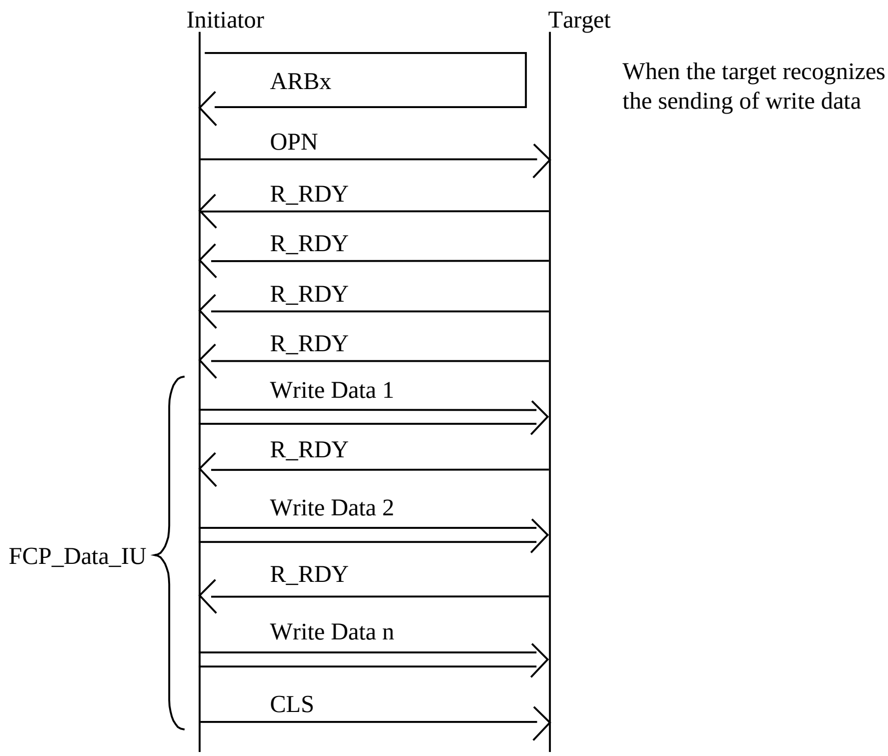


Figure 1.15 Write data transfer

(4) Read Data Transfer

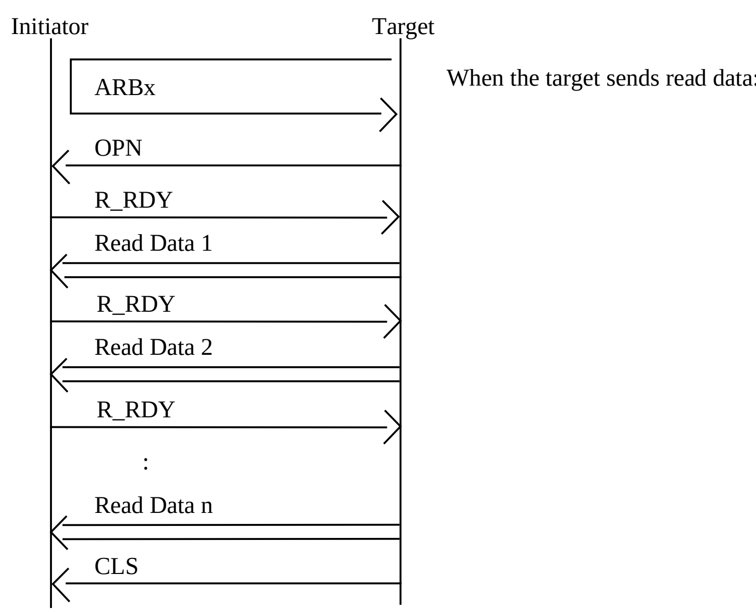


Figure 1.16 Read data transfer

1.5 Ordered Sets (Refer to FC-PH, Section 11.4 and FC-AL, Chapter 6)

Table 1.20 shows the Ordered Sets specification.

This section describes handling of the Ordered Sets of this drive.

Table 1.20 Ordered sets specification (1/2)

No.	Frame Delimiters		Symbol	The drive can;
01	SOF Connect	Class 1	SOFc1	receive only (discard)
02	SOF Initiate	Class 1	SOFi1	receive only (discard)
03	SOF Normal	Class 1	SOFn1	receive only (discard)
04	SOF Initiate	Class 2	SOFi2	receive only (discard)
05	SOF Normal	Class 2	SOFn2	receive only (discard)
06	SOF Initiate	Class 3	SOFi3	receive or transmit
07	SOF Normal	Class 3	SOFn3	receive or transmit
08	SOF Initialize Loop		SOFiL	receive or transmit
09	EOF Terminate		EOFt	receive or transmit
10	EOF Disconnect-Terminate		EOFdt	receive only (discard)
11	EOF Abort		EOFa	receive only (discard)
12	EOF normal		EOFn	receive or transmit
13	EOF Disconnect-Terminate-Invalid		EOFdti	receive only (discard)
14	EOF Normal-Invalid		EOFni	receive only (discard)
No.	Primitive Signals		Symbol	The drive can;
01	Idle		Idle	receive or transmit
02	Receiver_Read		R_RDY	receive or transmit
03	Arbitrate		ARBx	receive or transmit
04	Arbitrate		ARB (F0)	receive or transmit
05	Open full-duplex		OPNyx	receive or transmit
06	Open half-duplex		OPNyy	receive
07	Open broadcast replicate		OPNfr	receive only (discard)
08	Open selective replicate		OPNyr	receive only (discard)
09	Slotted Loop – transfer		SLPyx	receive only (discard)
10	Slotted Loop – isoch		SLPyf	receive only (discard)
11	Slotted Loop – asynch		SLPff	receive only (discard)
12	Close		CLS	receive or transmit
13	Mark		MRKtx	receive only (discard)

Table 1.20 Ordered sets specification (2/2)

No.	Primitive Sequences	Symbol	The drive can;
01	Offline	OLS	receive only (discard)
02	Not_Operational	NOS	receive only (discard)
03	Link_Reset	LR	receive only (discard)
04	Link_Reset_Response	LRR	receive only (discard)
05	Loop Initialization	LIP (F7, F7)	receive or transmit
06	Loop Initialization	LIP (F7, x)	receive or transmit
07	Loop Initialization	LIP (F8, F7)	receive or transmit
08	Loop Initialization	LIP (F8, x)	receive or transmit
09	Loop Initialization	LIPfx	receive only
10	Loop Initialization	LIPyx	receive only
11	Loop Port Enable	LPEyx	receive only
12	Loop Port Enable all	LPEfx	receive only (discard)
13	Loop Port Bypass	LPByx	receive only

1.6 Basic Link Service

This section defines handling of the link service of this drive and handling of each frame.

Table 1.21 shows the basic link service specification

Table 1.21 Basic link service specification

No.	Basic Link Service	Symbol	The drive can;
01	No Operation	NOP	receive only (discard)
02	Abort Sequence	ABTS	receive only
03	Basic Accept	BA_ACC	transmit if only the drive received ABTS
04	Basic Reject	BA_RJT	transmit if only the drive received ABTS

The Basic Link Services supported by this drive are the Abort Sequence (ABTS) and its responses, Basic Accept (BA_ACC) or Basic Reject (BA_RJT). Other Basic Link Services are discarded.

The header field of the basic link service is defined in Figure 1.17.

	0	1	2	3 Byte
Header 0	R_CTL 8x	D_ID xx	xx	xx
1	00	S_ID xx	xx	xx
2	TYPE 00	F_CTL 09	00	00
3	SEQ_ID xx	DF_CTL 00	SEQ_CNT xx	xx
4	OX_ID xx	xx	RX_ID FF	FF
5	PARAMETER xx	xx	xx	xx

Figure 1.17 Header field of the basic link service

(1) R_CTL.. (Routing Control)

The high order four bits (8h) represent Basic Link Service, and the low order four bits each Basic Link Service.

(2) D_ID.. (Destination Identifier)

– Address of the drive which receives ABTS.

– Address of the initiator for a response to ABTS.

(3) S_ID.. (Source Identifier)

– Address of the initiator which sends ABTS.

– Address of the drive for a response to ABTS.

(4) Type

The Basic Link Service uses 00h.

(5) F_CTL.. (Frame Control)

– Set 090000h for the transmission of ABTS.

(Originator of Exchange, Last Data Frame of Sequence, Transfer Sequence Initiative)

– Set 990000h for a response to ABTS.

(Responder of Exchange, Last Sequence of Exchange)

(6) SEQ_ID.. (Sequence Identifier)

The drive does not check this item. For a response to ABTS, respond with the same SEQ_ID as received.

(7) DF_CTL.. (Data Field Control)

Set 00h because no optional header is used.

(8) SEQ_CNT.. (Sequence Count)

Set 0000h to indicate the first frame of a sequence.

(9) OX_ID.. (Originator Exchange Identifier)

– Assigned for the initiator to begin the exchange of ABTS.

– For a response to ABTS, respond with the same OX_ID as received.

(10) RX_ID.. (Responder Identifier)

Set FFFFh to indicate that RX_ID is unused.

(11) Parameter

Unused in the Basic Link Service.

1.6.1 Abort sequence (ABTS)

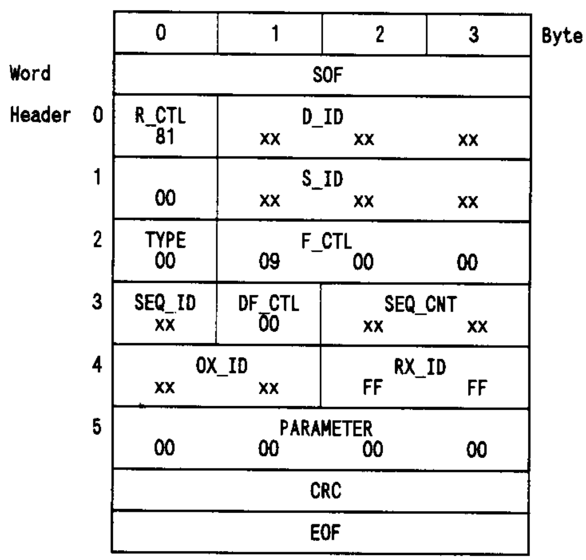


Figure 1.18 Abort sequence (ABTS)

The initiator issues an Abort Sequence (ABTS) to abort one SCSI Exchange (SCSI CMD) or FC Exchange (one link service). For the header field, refer to Section 1.6, "Basic Link Service."

As shown in the figure for the Abort Sequence frame, this ABTS frame has no payload. The ABTS frame has a value of 81h in R_CTL of the header.

1.6.2 Basic accept (BA_ACC)

Word		0	1	2	3
		SOF			
Header	0	R_CTL 84	D_ID xx	xx	xx
	1	00	S_ID xx	xx	xx
	2	TYPE 00	F_CTL D9	00	00
	3	SEQ_ID xx	DF_CTL 00	SEQ_CNT 00	00
	4	OX_ID xx	xx	RX_ID FF	FF
	5	PARAMETER 00	00	00	00
Payload	0	SEQ_ID Valid	Last SEQ_ID	Reserved 00	00
	1	OX_ID Aborted		RX_ID Aborted	
	2	Lowest SEQ_CNT		Highest SEQ_CNT	
		CRC			
		EOF			

Figure 1.19 Basic accept (BA_ACC)

The drive responds with BA_ACC to the initiator when the received ABTS frame is correct.

The payload field of the BA_ACC frame is described below.

For the header fields, refer to Section 1.6, "Basic Link Service."

Word xx/ and byte y of the payload are represented by [PL:Wxx/By].

(1) SEQ_ID Valid.. [PL:W00/B0]

00h: Indicates that last SEQ_ID of word 0/byte 1 is invalid.

80h: Indicates that last SEQ_ID of word 0/byte 1 is valid.

(2) Last SEQ_ID.. [PL:W00/B1]

Indicates that SEQ_ID of last sequence aborted.

(3) OX_ID.. Aborted [PL:W01/B0-1]

Same value as OX_ID received for ABTS.

(4) RX_ID.. Aborted [PL:W01/B2-3]

Same value as RX_ID received for ABTS. (FFFFh)

(5) Lowest SEQ_CNT.. [PL:W02/B0-1] 0000h

(6) Highest SEQ_CNT.. [PL:W02/B2-3] FFFFh

1.6.3 Basic reject (BA_RJT)

Word		0	1	2	3
		SOF			
Header	0	R_CTL 85	D_ID xx	xx	xx
	1	00	S_ID xx	xx	xx
	2	TYPE 00	F_CTL D9	00	00
	3	SEQ_ID xx	DF_CTL 00	SEQ_CNT 00	00
	4	OX_ID xx	xx	RX_ID FF	FF
	5	PARAMETER 00	00	00	00
Payload	0	Reserved 00	Reason Code	Reason Explanation	Vendor Unique
		CRC			
		EOF			

(Byte)

Figure 1.20 Basic reject (BA_RJT)

The drive responds with BA_RJT to the initiator when RX_ID of the received ABTS frame is not FFFFh.

The payload field of the BA_RJT frame is described below. For the header field, refer to Section 1.6, "Basic Link Service."

Word xx/ and byte y of the payload are represented by [PL:Wxx/By].

(1) Reason Code [PL:W00/B1]

03h: Logical error code returned when RX_ID of ABTS is not FFFFh.

(2) Reason Explanation [PL:W00/B2]

03h: Code of invalid OX_ID-RX_ID combination.

(3) Vender Unique (PL:W00/B3]

00h: Not supported by the drive.

1.7 Extended Link Service

Table 1.22 Extended link data specification

No.	Extended Link Service	Symbol	The drive can;
01	N_Port Login	PLOGI	receive or transmit
02	Logout	LOGO	receive or transmit
03	Process Login	PRLI	receive only
04	Process Logout	PRLO	receive or transmit
05	Read Link Status	RLS	receive only
06	Reinstate Recovery Qualifier	RRQ	receive only
07	Port Discovery	PDISC	receive only
08	Address Discovery	ADISC	receive only
09	Third-Party Process Logout	TPRLO	receive only
10	Accept	ACC	transmit if only received Extended Link
11	Link Service Reject	LS_RJT	transmit if only received Extended Link Service was illegal or has fails.
12	Fabric Login	FLOGI	transmit only
13	Report Node Capabilities	RNC	receive only
14	Fabric Address Notification	FAN	receive only

The Extended Link Services supported by this drive are Accept (ACC) and Link Service Reject (LS_RJT).

The header field of the extended link service is defined in Figure 1.21.

Word	0	1	2	3
Header 0	<R_CTL> 2x	<D_ID>		
1		<S_ID>		
2	<TYPE> 01	<F_CTL>		
3	<SEQ_ID>	<DF_CTL>	<SEQ_CNT>	
4	<OX_ID>		<RX_ID>	
5	<Parameter>			

Byte

Figure 1.21 Header field of the extended link service

(1) R_CTL.. (Routing Control)

The high order four bits (2h) represent Extended Link Service, and the low order four bits each Extended Link Service.

(2) D_ID.. (Destination Identifier)

- Destination address for the frame.

(3) S_ID.. (Source Identifier)

- Source address for the frame.

(4) Type

The Extended Link Service uses 01h.

(5) F_CTL.. (Frame Control)

- Set 290000h for the Extended Link Service Command.

  (Originator of Exchange, First Sequence of Exchange, Last Data Frame of Sequence, Transfer Sequence Initiative)

- Set 980000h for a response to the Extended Link Service Command.

  (Responder of Exchange, Last Sequence of Exchange)

(6) SEQ_ID.. (Sequence Identifier)

- The drive does not check this item.
- The drive responds with FFh.

(7) DF_CTL.. (Data Field Control)

Set 00h because no optional header is used.

(8) SEQ_CNT.. (Sequence Count)

- The drive does not check this item.
- The drive responds with 0000h.

(9) OX_ID.. (Originator Exchange Identifier)

- The drive responds with OX_ID received from the initiator.

(10) RX_ID.. (Responder Identifier)

Set FFFFh to indicate that RX_ID is unused.

(11) Parameter

Unused in the Extended Link Service.

1.7.1 N_Port login (PLOGI/PLOGI_ACC)

The initiator issues PLOGI to establish the connection with the drive by notifying the drive of the service parameter. The drive responds with PLOGI_ACC when the frame of the received PLOGI is correct.

The payload field of the PLOGI frame is described in Figure 1.22, and that of the PLOGI_ACC is in Figure 1.23.

For the header field, refer to Section 1.7, "Extended Link Service."

Word xx/ and byte y of the payload are represented by [PL:Wxx/By].

PLOGI

Word	Byte 0	Byte 1	Byte 2	Byte 3
	SOF			
Header 0	R_CTL 22	D_ID xx	xx	xx
1	00	S_ID xx	xx	xx
2	TYPE 01	F_CTL 29	00	00
3	SEQ_ID 00	DF_CTL 00	SEQ_CNT 00	00
4	OX_ID xx	xx	RX_ID FF	FF
5	PARAMETER 00	00	00	00
Payload 0	LS_Command Code 03	00	00	00
1	N_Port Common Service Parameters			
2	N_Port Name			
3	Node Name			
4	Class1 Service Parameter			
5	Class2 Service Parameter			
6	Class3 Service Parameter			
7	Class4 Service Parameter			
8	Vendor Revision Level			
	CRC			
	EOF			

Figure 1.22 Payload field of the PLOGI frame

PLOGI ACC

Word	0	1	2	3
	SOF			
Header 0	R_CTL 23	D_ID xx	xx	xx
1	00	S_ID xx	xx	xx
2	TYPE 01	F_CTL 98	00	00
3	SEQ_ID 00	DF_CTL 00	SEQ_CNT 00	00
4	OX_ID xx	xx	RX_ID FF	FF
5	PARAMETER 00	00	00	00
Payload 0	LS_Command Code 02	00	00	00
1	N_Port Common Service Parameters			
2	N_Port Name			
3	Node Name			
4	Class1 Service Parameter			
5	Class2 Service Parameter			
6	Class3 Service Parameter			
7	Class4 Service Parameter			
8	Vendor Revision Level			
	CRC			
	EOF			

Figure 1.23 Payload field of the PLOGI_ACC frame

(1) LS_Command code [PL:W00/B0]

03h: Indicates PLOGI.

02h: Indicates PLOGI_ACC.

(2) N_port Common Service Parameters [PL:W01-04]

For details, refer to "1.7.1.2 Common Service Parameter."

(3) N_Port Name [PL:W05/-06]

N_Port Name is used to specify two or more ports which a device has. In PLOGI, the N_Port Name of the initiator is entered and the drive saves the N_Port Name of the initiator.

In PLOGI_ACC, the N_Port Name of the drive is entered. For details, refer to "1.7.1.1 Port/Node Name Format."

(4) Node Name [PL:W07-08]

Node Name is used to specify a device. In PLOGI, the N_Port Name of the initiator is entered and the drive saves the N_Port Name of the initiator.

In PLOGI_ACC, the Node Name of the drive is entered. For details, refer to "1.7.1.1 Port/Node Name Format."

(1) Name Address Authority (NAA) [bit63-60]

0x5: Denotes the format of IEEE Registered.

(2) Company_ID [bit59-36]

0x00000E: Value registered in IEEE, denoting the company which has supplied the device.

(3) Product ID [bit35-32]

The value is used either 0x0.

(4) Factory ID [bit31-28]

The value is used either h 0x0 or 0x1.

(5) Vendor Specified Identifier [bit27-4]

Unique value assigned to each device.

(6) Port Number [bit3-0]

0x0: Device Node name

0x1: Port A of the device

0x2: Port B of the device

1.7.1.2 Common service parameter

Table 1.24 Common service parameter

Byte \ Bit	7	6	5	4	3	2	1	0
0	FC-PH Version (High)							
1	FC-PH Version (Low)							
2	(MSB) Buffer to Buffer Credit							
3	Buffer to Buffer Credit (LSB)							
4	Continuos Increase	Random Relative Offset	Valid Vendor Version	F_Port	Alternate Credit Model	E_D_TOV Resolution	0 Reserved	0 Reserved
	Common Features							
5	0	0	0	0	0	Dynamic Half Duplex	Continuous Increase SEQ_CNT	Payload Length
	Reserved							
6	0	0	0	0	(MSB) Receive Data Field Size			
	Reserved							
7	Receive Data Field Size (LSB)							
8	00 Reserved							
9	Total Concurrent Sequence							
10	(MSB) Relative Offset by Information Category							
11	Relative Offset by Information Category (LSB)							
12	(MSB) Point to Point E_D_TOV							
13	Point to Point E_D_TOV							
14	Point to Point E_D_TOV							
15	Point to Point E_D_TOV (LSB)							

(1) Highest version supported [Byte0]

Latest version number of FC-PH supported by the device.

09h: Denotes FC-PH version 4.3.

– For ACC, the drive responds with 20h.

(2) Lowest version supported [Byte1]

Lowest version number of FC-PH supported by the device.

09h: Denotes FC-PH version 4.3.

– For ACC, the drive responds with 20h.

(3) Buffer-to-buffer Credit [Byte2-3]

– The drive does not check this field and operates assuming that Buffer to buffer Credit is one.

– For ACC, the drive responds with 0001h.

(4) Common features [Byte4-5]

a) 1b: Continuously Increasing Offset [bit7]

– The drive responds with LS_RJT (03h, 0Fh) when (this bit) = 0b.

– For ACC, the drive responds with 1b.

b) 0b: Random Relative Offset [bit6]

- The drive does not check this bit and does not support this function.
- For ACC, the drive responds with 0b.

c) 0b: Valid Vendor Version [bit5]

- The drive does not check this bit and does not support this function.
- For ACC, the drive responds with 0b.

d) 0b: N_Port/F_Port [bit4]

- The drive responds with LS_RJT (03h, 0Fh) when (this bit) = 1b.
- For ACC, the drive responds with 0b.

e) 1b: Alternate BB_Credit Management [bit3]

- The drive responds with LS_RJT (03h, 0F) when (this bit) = 0.
- For ACC, the drive responds with 1b.

f) E_D_TOV Resolution [bit2]

- The drive does not check this field.
- For ACC, the drive responds with 0b.

g) Dynamic Half Duplex [bit2]

- The drive does not check this field.
- For ACC, the drive responds with 0b.

h) Continuous Increase SEQ_CNT [bit1]

- The drive does not check this field.
- For ACC, the drive responds with 0b.

i) Payload Length [bit0]

- The drive does not check this field.
- For ACC, the drive responds with 0b.

(5) Receive Data Field Size [Byte6-7]

- The drive responds with LS_RJT (03h, 07h) when 256 = < (this field) = < 2112 not a multiple of 4.
- The drive responds with the value of the receive data field size of class 3 parameter of PLOG1 by ACC. (2048)

(6) Total Concurrent Sequence [Byte9]

- The drive does not check this field.
- For ACC, the drive responds with FFh.

(7) Relative Offset by category [Byte10-11]

- The drive does not check this field.
- For ACC, the drive responds with 0002h.

  (This indicates that Information Category is Solicited data when bit 1 = 1b.)

(8) Point-to-point E_D_TOV value [Byte12-15]

This field is significant for point-to-point connection and invalid for loop connection.

- The drive does not check this field.
- For ACC, the drive responds with 0x000007d0 in this fields.

1.7.1.3 Class 3 service parameter

Table 1.25 Class 3 service parameter

Bit / Byte	7	6	5	4	3	2	1	0
0	Class Valid	Intermix Mode	Stacked Connect Request		Sequence Delivery	Dedicated Simplex	Camp-on	Buffered Class 1
	Service Options							
1	0 priority	Reserved						
2	X_ID Reassignment		Initiator Process Associator		ACK_0 Capable	ACK_N Capable	0 Reserved	0 Reserved
	Initiator Control							
3	Reserved							
4	ACK_0 Capable	ACK_N Capable	X_ID Interlock	Error Policy		0 Reserved	Categories per Sequence	
	Recipient Control							
5	Reserved							
6	0	0	0	0	(MSB) Receive Data Field Size			
	Reserved							
	Receive Data Field Size (LSB)							
	Reserved							
9	Concurrent Sequences							
10	0	(MSB) N_Port End to End Credit						
11	N_Port End to End Credit (LSB)							
12	Reserved							
13	Open Sequence Per Exchange							
14	Reserved							
15	Reserved							

(1) Service Options [Byte0]

a) Class Valid [Byte0/bit7]

- The drive responds with LS_RJT(03h, 01h) when (this bit) = 0.
- For ACC, the drive responds with 1.

b) Intermix Mode [Byte0/bit6]

- This field is invalid for Class 3 and the drive ignores it.

c) Stacked Connect Request [Byte0/bit5-4]

- This field is invalid for Class 3 and the drive ignores it.

d) Sequential Delivery [Byte0/bit3]

- This field is invalid for Class 3 and the drive ignores it.

e) Dedicated Simplex [Byte0/bit2]

- This field is invalid for Class 3 and the drive ignores it.

f) Camp-On [Byte0/bit1]

- This field is invalid for Class 3 and the drive ignores it.

g) Buffered Class 1 [Byte0/bit0]

- This field is invalid for Class 3 and the drive ignores it.

(2) Priority [Byte1, Bit7]

This field is invalid in class 3 and the drive ignore it.

(3) Initiator Control [Byte2]

a) 00: X_ID Reassignment [Byte2/bit7-6]

- The drive does not check this field.

b) 00: Initial Process Associator [Byte2/bit5-4]

- The drive responds with LS_RJT(03h, 03h) when (this bit) ≠ 00.
- The drive responds with 00 in this field.

c) Sequence Initiator ACK_O/ACK_N capable [Byte2/bit3-2]

- This field is invalid for Class 3 and the drive ignores it.

(4) Recipient Control [Byte4]

a) ACK_O/ACK_N capable [Byte4/bit7-6]

- This field is invalid for Class 3 and the drive ignores them.

b) X_ID interlock [Byte4/bit5]

- This field is invalid for Class 3 and the drive ignores it.

c) 00: Error Policy [Byte4/bit4-3]

- The drive supports Discard Policy only and responds with LS_RJT(03h, 05h) when (this bit) ≠,00b.
- Drive responds with 00b in this field.

d) 00: Categories per Sequence [Byte4/bit1-0]

- The drive does not check this field but supports only one category per sequence.
- Drive responds with 00b in this field.

(5) Receive data field Size [Byte6-7]

- The drive responds with LS_RJT (03h, 07h) when 256 = < (this field) = < 2112 not a multiple of 4.
- The drive responds with the value of the receive data field size of class 3 parameter of PLOG1 by ACC.

(6) Concurrent Sequence [Byte9]

- The drive ignores this field.
- Drive responds with FFh in this field.

(7) N_Port End-to-end Credit [Byte10-11]

- This field is invalid for Class 3 and the drive ignores it.

(8) Open Sequence per Exchange [Byte13]

- The drive responds with LS_RJT (03h, 01h) when (this field) = 0.
- For ACC, the drive responds with 01.

1.7.2 Port logout (LOGO/LOGO_ACC)

LOGO

Word	Byte 0	Byte 1	Byte 2	Byte 3
	SOF			
Header 0	R_CTL 22	D_ID xx	xx	xx
1	00	S_ID xx	xx	xx
2	TYPE 01	F_CTL 29	00	00
3	SEQ_ID 00	DF_CTL 00	SEQ_CNT 00	00
4	0X_ID xx	xx	RX_ID FF	FF
5	PARAMETER 00	00	00	00
Payload 0	LS_Command Code 05	00	00	00
1	Reserved	N Port Identifier		
2	Port_Name			
3				
	CRC			
	EOF			

LOGO_ACC

Word	Byte 0	Byte 1	Byte 2	Byte 3
	SOF			
Header 0	R_CTL 23	D_ID xx	xx	xx
1	00	S_ID xx	xx	xx
2	TYPE 01	F_CTL 98	00	00
3	SEQ_ID FF	DF_CTL 00	SEQ_CNT 00	00
4	0X_ID xx	xx	RX_ID FF	FF
5	PARAMETER 00	00	00	00
Payload 0	LS_Command Code 02	00	00	00
	CRC			
	EOF			

Figure 1.24 Port logout (LOGO/LOGO_ACC)

The initiator issues LOGO to establish the connection with the drive by notifying the drive of the service parameter. The drive responds with LOGO_ACC when the frame of the received LOGO is correct.

The drive responds with LOGO when notifying the initiator that login has not been completed.

The payload field of the LOGO/LOGO_ACC frame is described below.

Word xx and byte y of the payload are represented by [PL:Wxx/By].

(1) LS_Command code [PL:W00/B0]

05h: Indicates LOGO.

02h: Indicates LOGO_ACC.

(2) N_Port Identifier [PL:W01/B1-3]

The value of S_ID of the frame header is used.

(3) Port Name [PL:W02W03]

Unique 8-byte value for the port which has issued LOGO.

1.7.3 Process login (PRLI/PRLI_ACC)

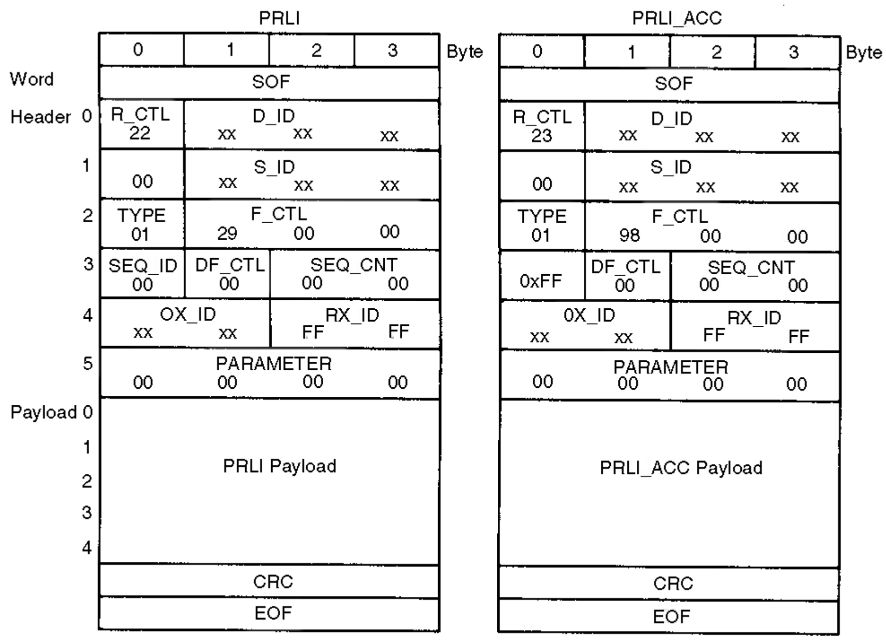


Figure 1.25 Process login (PRLI/PRLI_ACC)

The initiator issues PRLI to the drive to establish an operating environment. The drive responds with PRLI_ACC when the frame of the received PRLI is correct.

The payload field of the PRLI/PRLI_ACC frame is described below. For the header field, refer to Section 1.7, "Extended Link Service."

Word xx and byte y of the payload are represented by [PL:Wxx/By].

(1) LS_Command code [PL:Byte0]

20h: Indicates PRLI.

02h: Indicates PRLI_ACC.

(2) Page Length [PL:Byte1]

10h: Service Parameter page length (in bytes) of PRLI or Service Parameter Response page length (in bytes) of PRLI_ACC.

– The drive responds with LS_RJT(03h, 00h) when (this field) ≠,10h.

– For ACC, the drive responds with 10h.

(3) Payload Length [PL:Byte2-3]

14h: Payload length (20 bytes) of PRLI or Payload length (20 bytes) of PRLI_ACC.

– The drive responds with LS_RJT(03h, 00h) when (this field) ≠,14h.

– For ACC, the drive responds with 14h.

1.7.3.1 Service parameter pages

PRLI Payload (Service Parameter Page)

Bit / Byte	7	6	5	4	3	2	1	0
0	LS_Command = 0x20							
1	Page Length = 0x10							
2 3	Payload Length = 0x0014							
4	Type Code = 0x00							
5	Type Code Extention = 0x00							
6	Originator Process Associator Valid	Responder Process Associator Validity	Establish Image Pair	0	0	0 Reserved	0	0
7	Reserved							
8 9 10 11	(MSB) Originator Process Associator (LSB)							
12	(MSB) Responder Process Associator (LSB)							
16	Reserved							
17	Reserved							
18	Reserved							
19	0 Reserver	Data Overlay Allow	Initiator Function	Target Function	Command Data Mix	Data Response Mix	RD XFR RDV Disable	WT XFR RDV Disable

Figure 1.26 Service parameter pages

These pages are used by PRLI.

(1) Type Code [PL:Byte4]

08h: Denotes SCSI FCP process.

– The drive responds with LS_RJT(03h, 00h) when this field is not 08h.

(2) Type Code Extension [PL:Byte5]

00h: Not used by SCSI FCP.

– The drive responds with LS_RJT(03h, 00h) when this field is not 00h.

(3) Originator Process Associator Validity [PL:Byte6/bit7]

0b: The drive neither supports nor checks this bit.

(4) Responder Process Asscociator Validity [PL:Byte6/bit6]

0b: The drive neither supports nor checks this bit.

(5) Establish Image Pair [PL:Byte6/bit5]

1b: The drive establish connection with the initiator.

0b: The drive responds with ACC but does not establish connection with the initiator.

(6) Originator Process Associator [PL:Byte8-11]

00000000h: The drive neither supports nor checks this field.

(7) Responder Process Associator [PL:Byte12-15]

00000000h: The drive neither supports nor checks this field.

(8) Service Parameters [PL:Byte19]

a) 0b: Data Overlay Allow [bit6]

– The drive neither supports nor checks this field.

b) 1b: Initiator Function [bit5]

– The drive does not check this bit and operates assuming that 1b has been specified.

c) 0b: Target Function [bit4]

– The drive does not check this bit.

d) 0b: Command/Data Mix Allowed [bit3]

– The drive neither supports nor checks this bit.

e) 0b: Data/Response Mix Allowed [bit2]

– The drive neither supports nor checks this bit.

f) 1b: Read Transfer Ready Disable [bit1]

– The drive does not check this bit and operates assuming that 1b has been specified.

g) 0b: Write Transfer Ready Disable [bit0]

– The drive does not check this bit and operates assuming that 0b has been specified.

1.7.3.2 Service parameter response pages

PRLI Payload (Service Parameter Responce Page)

Bit / Byte	7	6	5	4	3	2	1	0
0	LS_Command = 0x02							
1	Page Length = 0x10							
2 3	Payload Length = 0x0014							
4	Type Code = 0x08							
5	Type Code Extention = 0x00							
6	Originator Process Associator Valid = 0	Responder Process Associator Valid = 0	Establish Image Pair	0 Reserved	Responce Code			
7	Reserved							
8 9 10 11	(MSB) Originator Process Associator (LSB)							
12 13 14 15	(MSB) Responder Process Associator (LSB)							
16	Reserved							
17	Reserved							
18	Reserved							
19	Reserved = 0	Data Overlay Allow = 0	Initiator Function = 0	Target Function = 1	Command Data Mix = 0	Data Response Mix = 0	RD XFR RDV Disable = 1	WT XFR RDV Disable = 0

Figure 1.27 Service parameter response pages

These pages are used by PRLI_ACC.

(1) Type Code [Byte4]

08h: Denotes SCSI FCP process.

– The drive responds with 08h by ACC.

(2) Type Code Extension [Byte5]

00h: Not used by SCSI FCP.

– The drive responds with 00h by ACC.

(3) Originator Process Associator Validity [Byte6/bit7]

0b: The drive neither supports nor checks this bit.

(4) Responder Process Asscociator Validity [PL:Byte6/bit6]

0b: The drive does not support this bit and responds with 0b by ACC.

(5) Establish Image Pair [Byte6/bit5]

1b: The drive establish connection with the initiator.

0b: The drive responds with ACC but does not establish connection with the initiator.

– The drive responds with the value specified by PRLI.

(6) Response Code [Byte6/bit3-0]

1h: Request executed.

– The drive responds with 1h by ACC when PRLI is executed.

(7) Originator Process Associator [Byte8-11]

00000000h: The drive does not support this field and responds with 0000h by ACC.

(8) Responder Process Associator [Byte12-15]

00000000h: The drive does not support this field and responds with 0000h by ACC.

(9) Service Parameters [Byte19]

a) 0b: Data Overlay Allow [bit6]

   – The drive does not support this field and responds with 0b by ACC.

b) 0b: Initiator Function [bit5]

   – The drive responds with 0b by ACC.

c) 1b: Target Function [bit4]

   – The drive responds with 1b by ACC.

d) 0b: Command/Data Mix Allowed [bit3]

   – The drive does not support this bit and responds with 0b by ACC.

e) 0b: Data/Response Mix Allowed [bit2]

   – The drive does not support this bit and responds with 0b by ACC.

f) 1b: Read Transfer Ready Disable [bit1]

   – The drive responds with 1b by ACC.

g) 0b: Write Transfer Ready Disable [bit0]

   – The drive responds with 0b by ACC.

1.7.4 Process logout (PRLO/PRLO_ACC)

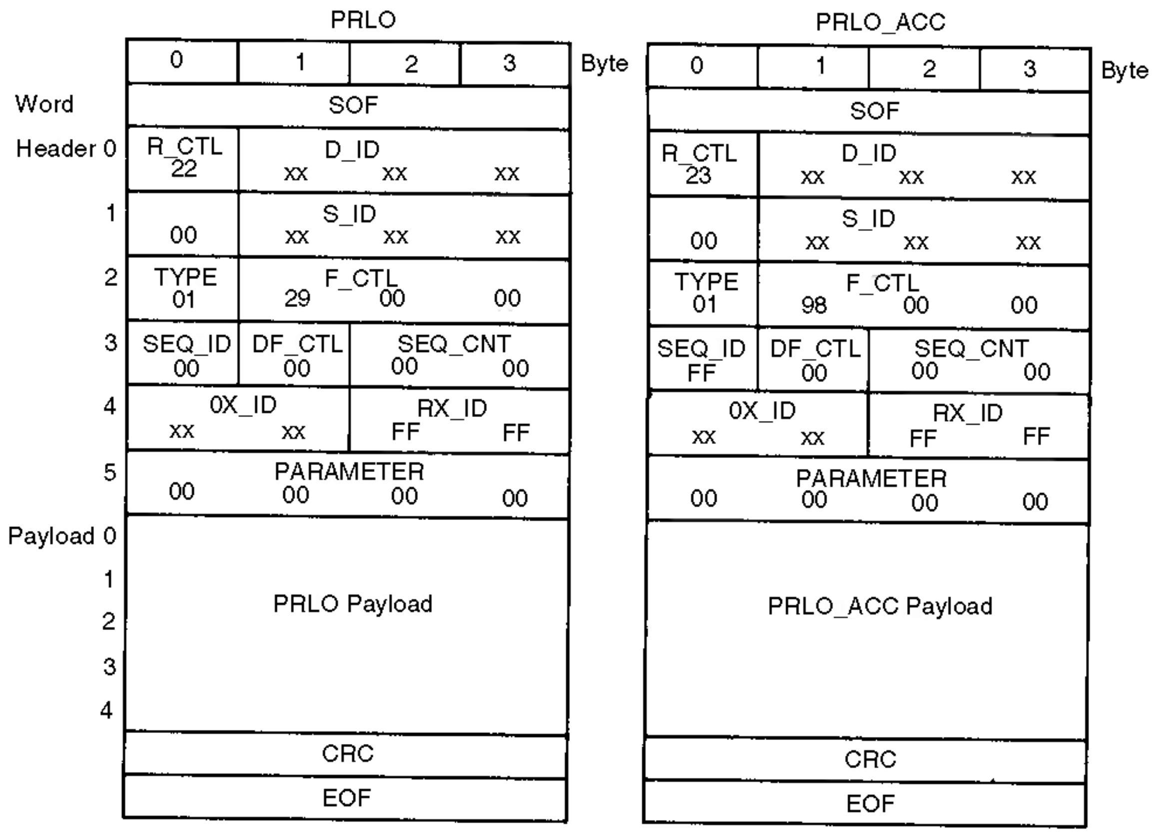


Figure 1.28 Process logout (PRLO/PRLO_ACC)

The initiator issues PRL0 to the drive to cancel the established login. The drive responds with PRLO_ACC when the frame of the received PRLO is correct.

The payload field of the PRLO/PRLO_ACC frame is described below.

PRLO Payload (Logout Parameter Page)

Byte \ Bit	7	6	5	4	3	2	1	0
0	LS_Command = 0x21							
1	Page Length = 0x10							
2 3	Payload Length = 0x0014							
4	Type Code = 0x08							
5	Type Code Extention = 0x00							
6	Originator Process Associator Valid	Responder Process Associator Valid	0	0	0 (Reserved)	0	0	0
7	Reserved							
8 9 10 11	(MSB) Originator Process Associator (LSB)							
12 13 14 15	(MSB) Responder Process Associator (LSB)							
16	Reserved							
17	Reserved							
18	Reserved							
19	Reserved							

Figure 1.29 Payload field of the process logout (PRLO/PRLO_ACC)

Word xx and byte y of the payload are represented by [PL:Wxx/By].

(1) LS_Command code [Byte0]

21h: Indicates PRLO.

02h: Indicates PRLO_ACC.

(2) Page Length [Byte1]

10h: Logout Parameter page length (in bytes) of PRLO or Logout Parameter Response page length (in bytes) of PRLO_ACC.

– The drive responds with LS_RJT(03h, 00h) when (this field) ≠,10h.

– For ACC, the drive responds with 10h.

(3) Payload Length [Byte2, 3]

0014h: Payload length (20 bytes) of PRLO or Payload length (20 bytes) of PRLO_ACC.

– The drive responds with LS_RJT(03h, 00h) when (this field) ≠,0014h.

– For ACC, the drive responds with 0014h.

1.7.4.1 Logout parameter pages

PRLO Payload (Logout Parameter Page)

Bit / Byte	7	6	5	4	3	2	1	0
0	LS_Command = 0x21							
1	Page Length = 0x10							
2 3	Payload Length = 0x0014							
4	Type Code = 0x08							
5	Type Code Extention = 0x00							
6	Originator Process Associator Valid = 0	Responder Process Associator Valid = 0	0	0	0 Reserved	0	0	0
7	Reserved							
8 9 10 11	(MSB) Originator Process Associator (LSB)							
12	(MSB) Responder Process Associator (LSB)							
16	Reserved							
17	Reserved							
18	Reserved							
19	Reserved							

Figure 1.30 Logout parameter pages

These pages are used by PRLO.

(1) Type Code [Byte4]

00h: The drive neither supports nor checks this field.

(2) Type Code Extension [Byte5]

00h: The drive neither supports nor checks this field.

(3) Originator Process Associator Validity [Byte6/bit7]

0b: The drive neither supports nor checks this bit.

(4) Responder Process Asscociator Validity [Byte6/bit6]

0b: The drive neither supports nor checks this bit.

(5) Originator Process Associator [Byte8-11]

0000h: The drive neither supports nor checks this field.

(6) Responder Process Associator [Byte12-15]

0000h: The drive neither supports nor checks this field.

1.7.4.2 Logout parameter response pages

PRLO Payload (Logout Parameter Response Page)

Byte \ Bit	7	6	5	4	3	2	1	0
0	LS_Command = 0x02							
1	Page Length = 0x10							
2 3	Payload Length = 0x0014							
4	Reserved							
5	Reserved							
6	Originator Process Associator Valid = 0	Responder Process Associator Valid = 0	0 Reserved	0	Type Code			
7	Reserved							
8 9 10 11	(MSB) Originator Process Associator (LSB)							
12 13 14 15	(MSB) Responder Process Associator (LSB)							
16	Reserved							
17	Reserved							
18	Reserved							
19	Reserved							

Figure 1.31 Logout parameter response pages

These pages are used by PRLO_ACC.

(1) Originator Process Associator Validity [Byte6/bit 7]

0b: The drive does not support this bit and responds with 0b by ACC.

(2) Responder Process Asscociator Validity [Byte6/bit6]

0b: The drive does not support this bit and responds with 0b by ACC.

(3) Type Code [Byte6/bit3-0]

1h: Request executed.

– The drive responds with 1h by ACC when PRLO is executed.

(4) Originator Process Associator [Byte8-11]

0000h: The drive does not support this field and responds with 0000h by ACC.

(5) Responder Process Associator [Byte12-15]

0000h: The drive does not support this field and responds with 0000h by ACC.

1.7.5 Port discovery (PDISC/PDISC_ACC)

The initiator issues PDISC to the drive to check if the drive address has changed immediately after initialization. The drive responds with PDISC_ACC when the frame of the received PDISC is correct.

The payload field of the PDISC/PDISC_ACC frame is described below. For the header field, refer to Section 1.7, "Extended Link Service."

The PDISC has same information as the PLOGI except LS Command, which is 50000000h.

The PDISC_ACC has same information as the PDISC_ACC, if parameters have not changed from previous login.

1.7.6 Discover address (ADISC/ADISC_ACC)

ADISC

Word \ Byte	0	1	2	3
	SOF			
Header 0	R_CTL 22	D_ID xx	xx	xx
1	00	S_ID xx	xx	xx
2	TYPE 01	F_CTL 29	00	00
3	SEQ_ID 00	DF_CTL 00	SEQ_CNT 00	00
4	0X_ID xx	xx	RX_ID FF	FF
5	PARAMETER 00	00	00	00
Payload 0	LS_Command Code 52	00	00	00
1	Reserved	Hard Address of Originator		
2 - 3	Port Name of Originator			
4 - 5	Node Name of Originator			
6	Reserved	N_Port ID of Originator		
	CRC			
	EOF			

ADISC_ACC

Word \ Byte	0	1	2	3
	SOF			
Header 0	R_CTL 23	D_ID xx	xx	xx
1	00	S_ID xx	xx	xx
2	TYPE 01	F_CTL 98	00	00
3	SEQ_ID FF	DF_CTL 00	SEQ_CNT 00	00
4	0X_ID xx	xx	RX_ID FF	FF
5	PARAMETER 00	00	00	00
Payload 0	LS_Command Code 02	00	00	00
1	Reserved	Hard Address of Originator		
2 - 3	Port Name of Originator			
4 - 5	Node Name of Originator			
6	Reserved	N_Port ID of Originator		
	CRC			
	EOF			

Figure 1.32 Discover address (ADISC/ADISC_ACC)

The initiator issues ADISC to the drive to check if the drive address has changed immediately after initialization. The drive responds with ADISC_ACC when the frame of the received ADISC is correct.

The payload field of the ADISC/ADISC_ACC frame is described below. For the header field, refer to Section 1.7, "Extended Link Service."

Word xx and byte y of the payload are represented by [PL:Wxx/By].

(1) LS_Command code [PL:W00/B0]

52h: Indicates ADISC.

02h: Indicates ADISC_ACC.

(2) Hard Address of Originator [PL:W01/B1-3]

– For ADISC, the initiator sets the address set by the SEL signal in the low order 8 bits.

– For ADISC_ACC, the drive sets the address set by the SEL signal in the low order 8 bits.

(3) Port name [PL:W02-03]

– For ADISC, Port_name of the initiator is set in Port name of Originator.

– For ADISC_ACC, Port_name of the drive is set in Port name of Responder.

(4) Node name [PL:W04-05]

– For ADISC, Node_name of the initiator is set in Node name of Originator.

– For ADISC_ACC, Node_name of the drive is set in Node name of Responder.

(5) N_Port ID [PL:W06]

– For ADISC, Port_ID of the initiator is set in N_Port ID of Originator.

– For ADISC_ACC, Port_ID of the drive is set in N_Port ID of Responder.

1.7.7 Reinstate recovery qualifier (RRQ/RRQ_ACC)

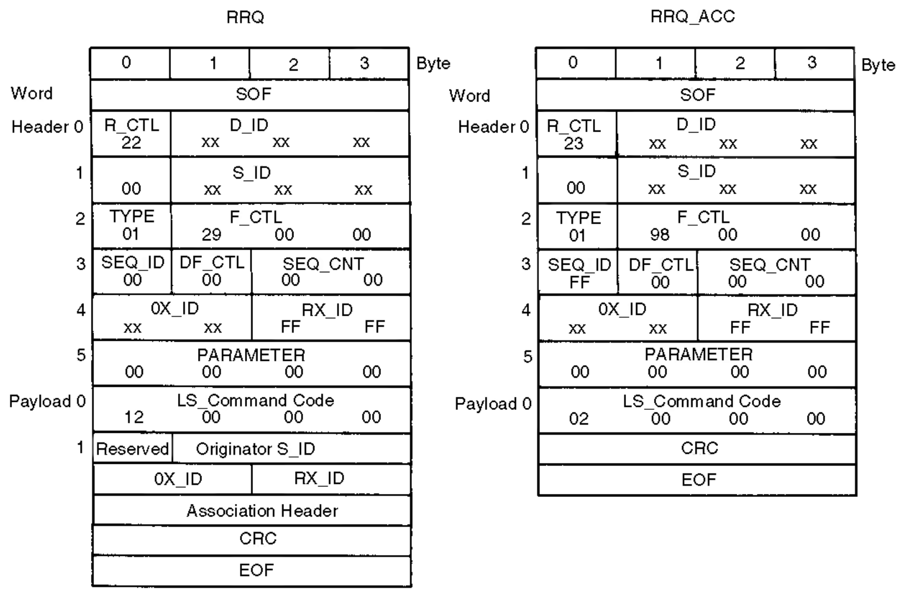


Figure 1.33 Reinstate recovery qualifier (RRQ/RRQ_ACC)

The initiator issues RRQ to the drive to notify the drive of reuse of Recovery Qualifier (S_ID, D_ID, OX_ID, RX_ID, SEQ_CNT) aborted by ABTS. The drive responds with RRQ_ACC when the frame of the received RRQ is correct.

The payload field of the RRQ/RRQ_ACC frame is described below.

Word xx and byte y of the payload are represented by [PL:Wxx/By].

(1) LS_Command code [PL:W00/B0]

12h: Indicates RRQ.

02h: Indicates RRQ_ACC.

(2) Originator S_ID [PL:W01/B1-3]

N_Port_ID of the initiator is set.

(3) OX_ID [PL:W02/B0-1]

OX_ID of Exchange aborted when the initiator previously issued ABTS.

(4) RX_ID [PL:W02/B2-3]

FFFFh: RX_ID of Exchange aborted when the initiator previously issued ABTS.

Drive responds with LS_RJT (03h, 17h) when RX_ID 0xFFFF of RRQ is received.

(5) Association Header [PL:W03-10]

The drive neither supports nor checks this field.

1.7.8 Read link error status block (RLS/RLS_ACC)

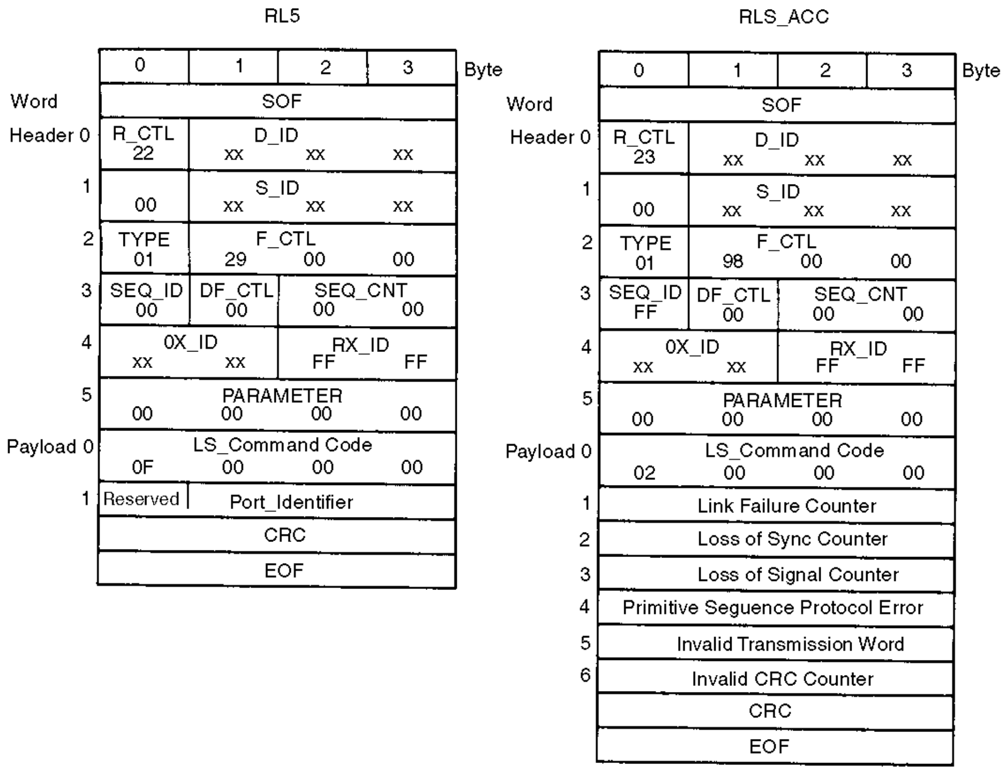


Figure 1.34 Read link error status block (RLS/RLS_ACC)

The initiator issues RLS to the drive when requesting the drive for Fibre Channel link error information. The drive responds with Link Error Status Block by RLS_ACC when the frame of the received RLS is correct.

The payload field of the RLS/RLS_ACC frame is described below.

Word xx and byte y of the payload are represented by [PL:Wxx/By].

(1) LS_Command code [PL:W00/B0]

0Fh: Indicates RLS.

02h: Indicates RLS_ACC.

(2) Port Identifier [PL:W01/B1-3]

Specifies the port of Link Error Status Block which the drive should respond with.

0: Link Error Status Block concerning the port which has received RLS.

1: Link Error Status Block concerning Port A.

2: Link Error Status Block concerning Port B.

The drive responds with LS_RJT(03h, 1Fh) when this field is any value other than the above.

(3) Link Error Status Block [PL:W01-06]

This field is used by ACC of the drive.

Individual ERRORS are counted in each Port respectively.

a) Link Failure Count [PL:W01]

The drive counts the number of times when synchronization is not achieved for a minimum of R_T_TOV (100ms) and enters it in this field.

b) Loss of Synchronization Count [PL:W02]

The drive counts the number of times when loss of synchronization is detected and enters it in this field.

c) Loss of Signal Count (PL:W03)

The drive does not support this field and responds with all zeros.

d) Primitive Sequence Protocol Error (PL:W04)

The drive does not support this field and responds with all zeros.

e) Invalid Transmission Word (PL:W05)

The drive counts the number of times when Invalid transmission word is detected and enters it in this field.

f) Invalid CRC Count [PL:W06]

The drive counts the number of times when Data Frame has CRC ERROR is detected and enters it in this field.

1.7.9 Third party process logout (TPRLO/TPRLO_ACC)

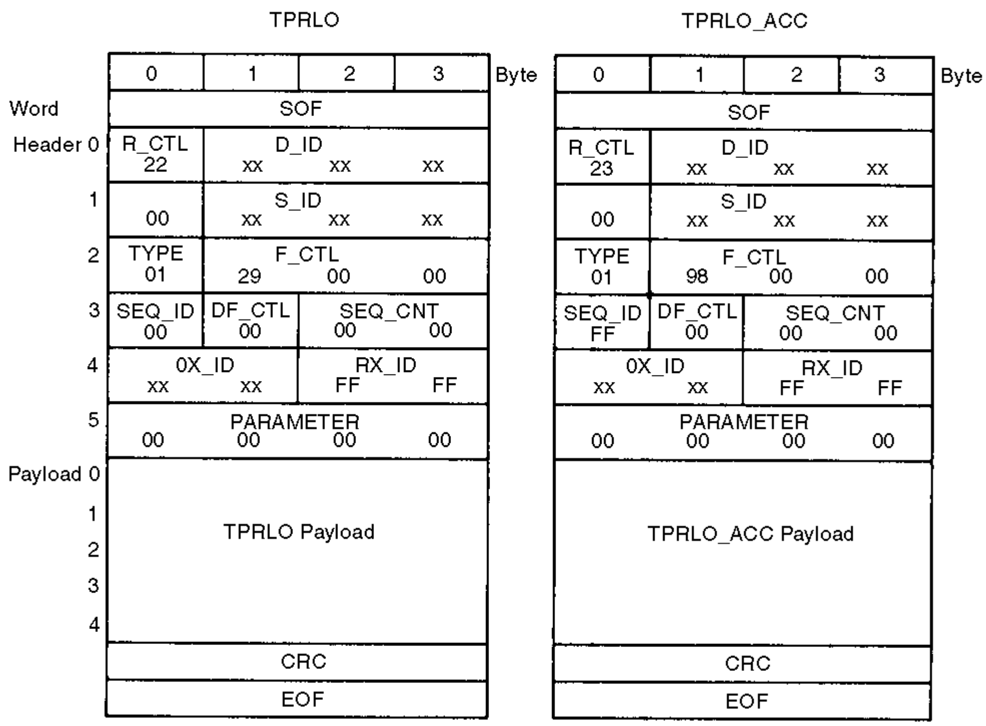


Figure 1.35 Third party process logout (TPRLO/TPRLO_ACC)

The initiator issues TPRLO to the drive to cancel the established login specified by Third Party Originator N_Port ID. The drive responds with TPRLO_ACC when the frame of the received TPRLO is correct.

The payload field of the TPRLO/TPRLO_ACC frame is described below.

Word xx and byte y of the payload are represented by [PL:Wxx/By].

(1) LS_Command code [PL:W00/B0]

24h: Indicates TPRLO.

02h: Indicates TPRLO_ACC.

(2) Page Length [PL:W00/B1]

10h: Logout Parameter page length (in bytes) of TPRLO or Logout Parameter Response page length (in bytes) of TPRLO_ACC.

– The drive responds with LS_RJT(03h, 00h) when (this field) ≠, from 10h to 14h.

– For ACC, the drive responds with 14h.

(3) Payload Length [PL:W00/B2-3]

18h: Payload length (24 bytes) of TPRLO or Payload length (24 bytes) of TPRLO_ACC.

– The drive responds with LS_RJT(03h, 00h) when (this field) ≠, from 14h to 18h.

– For ACC, the drive responds with 18h.

(4) Logout Parameter pages [PL:W01-05]

Forms the payload of TPRLO. For details, refer to "1.7.9.1 Logout Parameter pages."

1.7.9.1 Logout parameter pages

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	1	0	0	1	0	0
	LS_Command							
1	0	0	0	1	0	0	0	0
	Page Length							
2	0	0	0	0	0	0	0	0
3	0	0	0	1	0	1	0	0
	Payload Length							
4	0	0	0	0	1	0	0	0
	Type Code							
5	0	0	0	0	0	0	0	0
	Type Code Extension							
6	Third Party Originator Process Association Valid	Third Party Responder Process Association Valid	Third Party Originator N_Port ID Validity	Global Process Logout	0 Resrved	0 Reserved	0 Reserved	0 Resrved
7	0 Reserved							
8–11	(MSB) Third Party Originator Process Associator (LSB)							
12–15	(MSB) Third Party Responder Process Associator (LSB)							
16	0 Reserved							
17–19	(MSB) Third Party Originator N_Port ID (LSB)							

Figure 1.36 Logout parameter pages

These pages are used by TPRLO/TPRLO_ACC.

(1) Type Code [PL:W01/B0]

08h: Indicates SCSI FCP process.

The drive responds with LS_RJT(03h, 00h) when (this field) ≠,08h, or 00h.

Drive responds with 08h in this field.

(2) Type Code Extension [PL:W01/B1]

00h: Not used by SCSI FCP. (the drive ignores this field)

(3) Third Party Originator Process Association Validity [PL:W01/B2/bit7]

0b: The drive neither supports nor checks this bit.

(4) Third Party Originator Process Association Validity [PL:W01/B2/bit6]

0b: The drive neither supports nor checks this bit.

(5) Third Party Originator N_Port ID Validity [PL:W01/B2/bit5]

(6) Global Process Logout [PL:W01/B2/bit4]

When Global Process Logout bit is 0b, this field is valid.

The value of 0 in this field does not affect to the drive.

If this field is 1, an Initiator which is given into Third Party Originator N_Port ID field is logout.

When Global Process Logout bit is 1b, all of Initiator which has been login are logout.

(7) Third Party Originator Process Associator [PL:W02]

The drive neither supports nor checks this field.

(8) Third Party Originator Process Associator [PL:W03]

The drive neither supports nor checks this field.

(9) Third Party Originator N_Port ID [PL:W04]

This field is valid only when Global bit is 0 and Third Party Originator N_Port ID Validity is 1.

1.7.10 Link service reject (LS_RJT)

LS_RJT

		0	1	2	3	Byte
Word		SOF				
Header	0	R_CTL	D_ID			
		23	xx	xx	xx	
	1		S_ID			
		00	xx	xx	xx	
	2	TYPE	F_CTL			
		01	98	00	00	
	3	SEQ_ID	DF_CTL	SEQ_CNT		
		FF	00	00	00	
	4	OX_ID		RX_ID		
		xx	xx	FF	FF	
	5	PARAMETER				
		00	00	00	00	
Payload	0	LS_Command Code				
		01	00	00	00	
	1	Reserved	Reason Code	Reason Explanation	Vendor Unique= 0x00	
		CRC				
		EOF				

Figure 1.37 Link service reject (LS_RJT)

Responds with LS_RJT when rejecting the received Extended Link Service frame.

The payload field of the LS_RJT frame is described below.

Word xx and byte y of the payload are represented by [PL:Wxx/By].

(1) LS_Command code [PL:W00/B0]

01h: Indicates LS_RJT.

(2) Reason Code [PL:W01/B1]

The Reason Code which the drive responds with is entered.

- 01h: Invalid LS_Command Code
- 03h: Logical Error
- 05h: Logical Busy
- 09h: Unable to Perform Command request
- 07h: Protocol Error
- 0Bh: Command not support

(3) Reason Explanation [PL:W01/B2]

The Reason Explanation Code which the drive responds with is entered.

01h: Service Parameter error- Option.

– Error was detected in Class 3 Service Parameter for PDISC or PLOGI.

03h: Service Parameter error- Initiator Control

– Error was detected in Initiator Control of Class 3 Service Parameter for PLOGI or PDISC.

05h: Service Parameter error- Recipient Control Error was detected in Recipient Control of Class 3 Service Parameter in PDISC or PLOGI.

07h: Service Parameter error- Receive Data Field Size

– Error was detected in Receive Data Field Size of Class 3 Service Parameter in PDISC or PLOGI.

0Fh: Invalid Common Service Parameters Error was detected in Common Service Parameter for PDISC or PLOGI.

1Fh: Invalid N_Port Identifier Error was detected in N_Port Identifier.

29h: Insufficient resources to support Login Drive had not sufficient resources to Login.

2Ah: Unable to supply requested Data Drive could not supply requested Data.

2Ch: Request not Supported.

1.7.11 Fabric login (FLOGI/FLOGI_ACC)

The drive issues FLOGI to Fabric to establish the public loop environment.

The payload field of FLOGI frame is described in Figure 1.38, and that of FLOGI_ACC is in Figure 1.39.

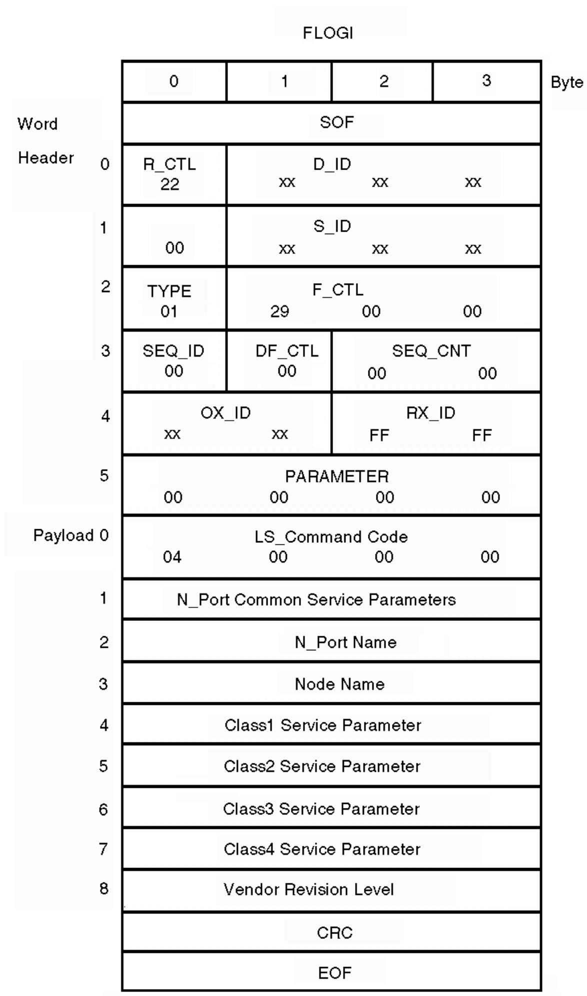


Figure 1.38 Fabric login (FLOGI)

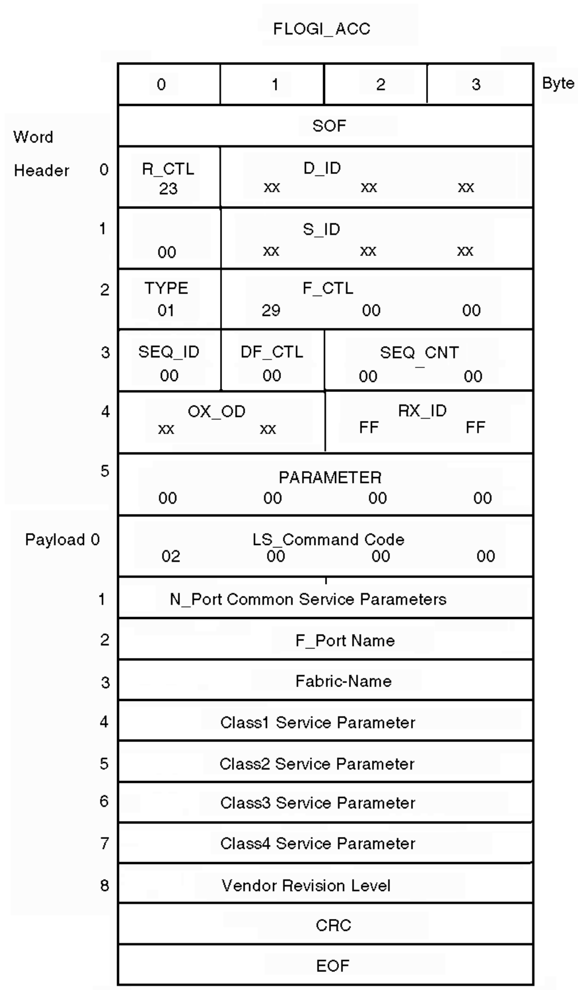


Figure 1.39 Fabric login (FLOGI_ACC)

Word xx/ and byte y of the payload are represented by [PL:Wxx/By].

(1) LS_Command code [PL:W00/B0]

04h: Indicates FLOGI.

02h: Indicates FLOGI_ACC.

– The drive responds with LS_RJT(0Bh, 00h) when this field is an unsupported Link Service code.

(2) Common Service Parameter [PL:W01-04]

For details, refer to "1.7.1.2 Common Service Parameter."

(3) N_Port Name [PL:W05-06]

N_Port Name is used to specify two or more ports which a device has. In FLOGI, the N_Port Name of the drive is entered.

In FLOGI_ACC, the N_Port Name of the initiator is entered. For details, refer to "1.7.1.1 Port/Node Name Format."

(4) Node Name [PL:W07-08]

Node Name is used to specify a device. In FLOGI, the N_Port Name of the drive is entered.

In FLOGI_ACC, the Node Name of the initiator is entered. For details, refer to "1.7.1.1 Port/Node Name Format."

(5) Class 1 Service Parameter [PL:W09-12]

This drive does not Check Class 1 Service Parameter.

(6) Class 2 Service Parameter [PL:W13-16]

This drive does not check Class 2 Service Parameter.

(7) Class 3 Service Parameter [PL:W17-20]

For details, refer to "1.7.1.3 Class 3 Service Parameter."

(8) Vendor Version Level [PL:W25-28]

This field is vendor-unique.

1.7.12 RNC/RNC_ACC

The initiator issues RNC to the drive to know Node Capabilities.

The payload field of RNC/RNC_ACC frame is described in Figure 1.40.

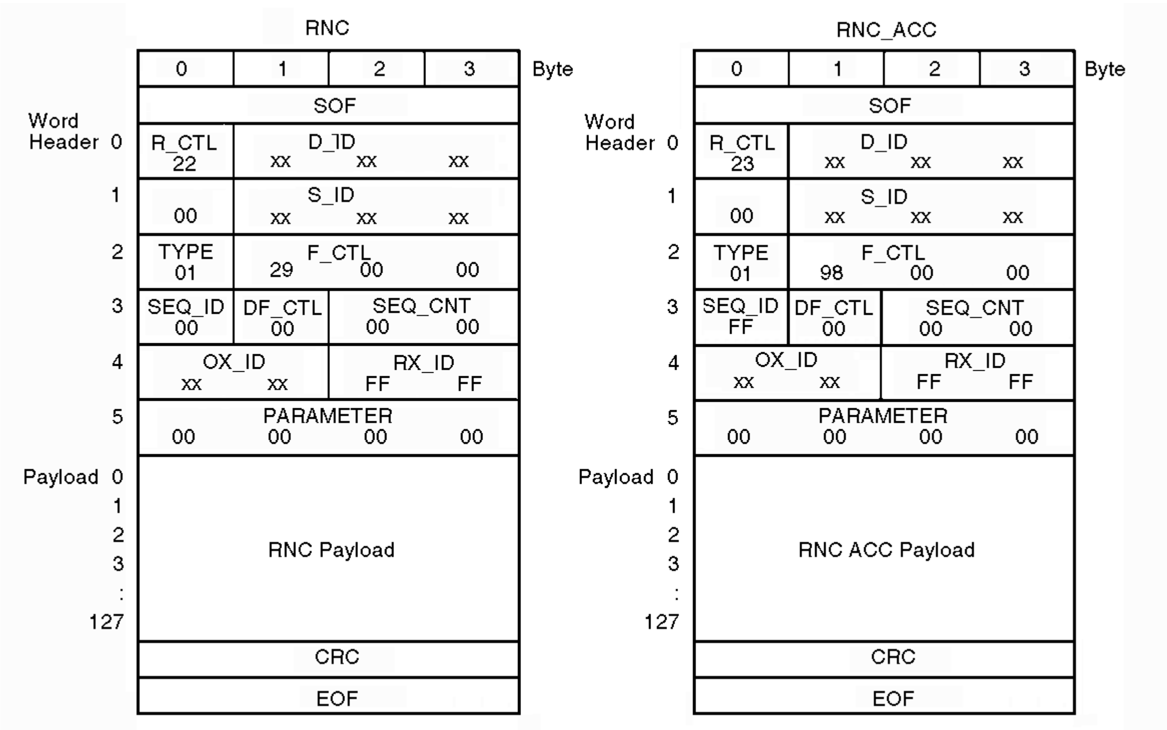


Figure 1.40 RNC/RNC_ACC (1/2)

RNC /RNC_ACC Payload

Byte \ Bit	7	6	5	4	3	2	1	0
0	LS_Command							
1	Reserved							
2 3	Payload Length							
4	RNC Flag	Reserved						
5	Reserved							
6	Reserved							
7	VU Information Length							
8 : 15	(MSB) Vendor Identifier (LSB)							
16 : 255	Capability Entry							

Figure 1.40 RNC/RNC_ACC (2/2)

(1) LS_Command Code [PL:W00/B0]

53h: Indicates RNC

02h: Indicates RNC_ACC

(2) Payload Length [PL:W00/B2-3]

If RNC Flag is "1", drive responds that payload length is 10h in RNC_ACC.

If RNC Flag is "0", drive responds that payload length is 20h in RNC_ACC.

(3) RNC Flag [PL:W01/B0]

1: Select option requested

0: Report all capabilities

(4) VU Information Length [PL:W01/B7]

Drive does not check this field.

(5) Vendor Identifier [PL:W02-03]

Drive does not check this field.

(6) Capability Entry [PL:W04-W127]

Drive does not check this field.

If RNC Flag given from Initiator is "1", drive responds RNC_ACC as follows.

- Payload Length = 10h
- RNC Flag = 1
- VU Information Length = 0
- Vendor Identifier = 'FUJITSU' in ASCII

If RNC Flag given from Initiator is "0", drive responds RNC_ACC as follows.

- Payload Length = 20h
- RNC Flag = 0
- VU Information Length = 0
- Vendor Identifier = 'FUJITSU' in ASCII
- Capability Entry

Byte 16 (Document) = 04h

17 (Low Revision) = 78h

18 (High Revision) = 78h

19 (Flag) = 00h

20 (Document) = 13h

21 (Low Revision) = 2Dh

22 (High Revision) = 2Dh

23 (Flag) = 00h

24 (Document) = 25h

25 (Low Revision) = 15h

26 (High Revision) = 15h

27 (Flag) = 00h

28 (Document) = 26h

29 (Low Revision) = 1Bh

30 (High Revision) = 1Bh

31 (Flag) = 00h

1.7.13 FAN

Fabric F_Port sends FAN to the drive to confirm Loop Fabric Address, Fabric Port Name and Fabric Name.

Payload of FAN frame is described below.

FAN

	Word	0	1	2	3 (Byte)
		SOF			
Header	0	R_CTL 22	D_ID xx	xx	xx
	1	00	S_ID FF	FF	FE
	2	TYPE 01	F_CTL 29	00	00
	3	SEQ_ID 00	DF_CTL 00	SEQ_CNT 00	00
	4	OX_ID xx	xx	RX_ID FF	FF
	5	PARAMETER 00	00	00	00
Payload	0	LS_Command Code 60	00	00	00
	1	Reserved	Loop Fabric Address		
	2	(MSB) Fabric Port Name			
	3				(LSB)
	4	(MSB) Fabric Name			
	5				(LSB)
		CRC			
		EOF			

Figure 1.41 FAN

(1) Loop Fabric Address

Drive responds Domain, Area, 00h.

(2) Fabric Port Name

Drive responds Fabric Port Name.

(3) Fabric Name

Drive responds Fabric Name.

The drive, FAN is received, compares between Fabric Port Name, Fabric Name, Domain, Area and them which is received in FAN, if all of them are not identical, drive issues FLOGI.

1.8 Extended Link Service (Loop Initialization)

Word	0	1	2	3
Header 0	<R_CTL> 22	<D_ID>		
1	Reserve	<S_ID>		
2	<TYPE> 01	<F_CTL>		
3	<SEQ_ID>	<DF_CTL>	<SEQ_CNT>	
4	<OX_ID>		<RX_ID>	
5	<Parameter>			

(Byte)

Note) xxxxxx = ‘000000’···FL_Port or ‘0000EF’···NL_Port

Figure 1.42 Extended link service (loop initialization)

Listed below are the frames used by Loop Initialization in the Extended Link Service supported by this drive.

1. LISM frame: Used for selecting Loop Master.
2. LIFA, LIPA, LIHA, LISA frame: Used to assign AL_PA in Loop Initialization.
3. LIRP, LILP frame: Used for collection and notification of connection information for the initiator and drive connected on the loop.

The header field of Extended Link Service is defined below.

(1) R_CTL.. (Routing Control)

The high order 4 bits (2h) represent Extended Link Service, and the low order 4 bits (2h) Initialization frame.

(2) D_ID.. (Destination Identifier)

0000EFh: In the case of NL_Port

000000h: In the case of FL_Port

(3) S_ID.. (Source Identifier)

0000EFh: In the case of NL_Port

000000h: In the case of FL_Port

(4) Type

01h is used for Extended Link Service.

– F_CTL.. (Frame Control)

– 380000h is set for Initialization frame of Extended Link Service.

(5) SEQ_ID.. (Sequence Identifier)

– The drive does not check this item.

– The drive responds with 00h.

(6) DF_CNTL.. (Data Field Control)

Set 00h because no Optional Header is used.

(7) SEQ_CNT.. (Sequence Count)

– The drive does not check this item.

– The drive responds with 0000h.

(8) OX_ID.. (Originator Exchange Identifier)

FFFFh is set to indicate that OX_ID is unused.

(9) RX_ID.. (Responder Identifier)

FFFFh is set to indicate that RX_ID is unused.

(10) Parameter

Not used by Extended Link Service.

– The drive responds with 0000h.

1.8.1 Loop initialization select master (LISM)

Word	Byte 0	1	2	3
		<SOF>		
Header 0	22	Note) xx	xx	xx
1	00	Note) xx	xx	xx
2	01	38	00	00
3	00	00	00	00
4	FF	FF	FF	FF
5	00	00	00	00
Payload 0	11	01	00	00
1	Port name (8 Byte)			
2				
3	<CRC>			
4		<EOF>		

Figure 1.43 Loop initialization select master (LISM)

Frame sent to determine Loop Master in initialization.

The payload field of the LISM frame is described below. For the header field, refer to Section 1.8, "Extended Link Service (Loop Initialization)."

Word xx and byte y of the payload are represented by [PL:Wxx/By].

(1) Loop Initialization Identifier [W00]

11010000h: Indicates LISM.

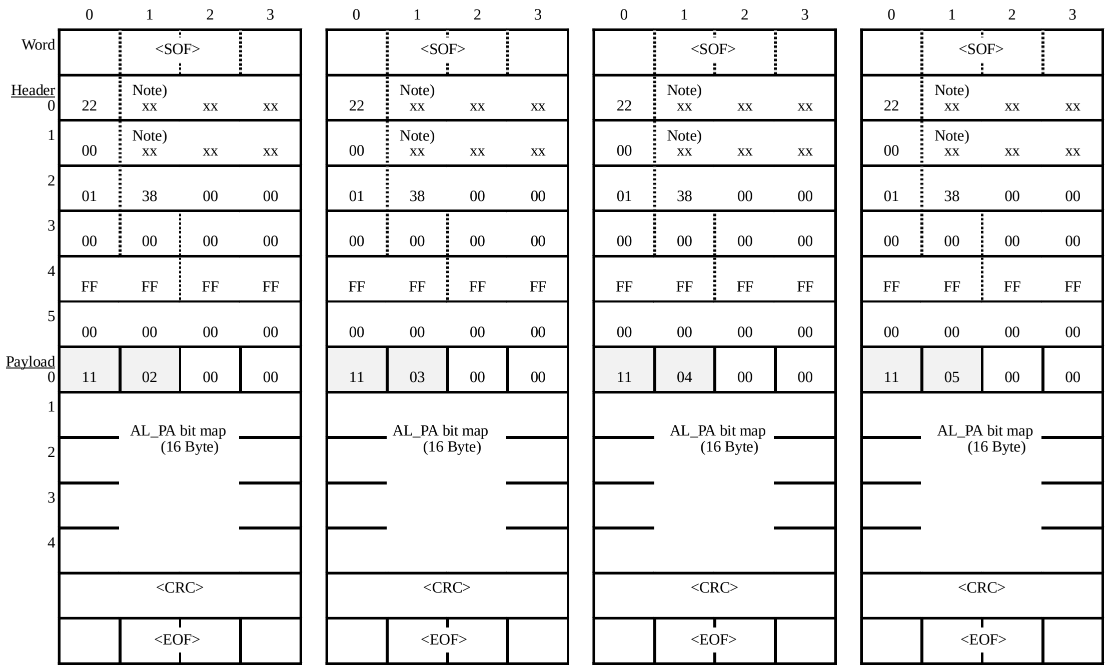
– The received frame will be discarded when this field is an unsupported Link Service code.

(2) Port Name [PL:W01-02]

8-byte Port Name is entered.

See 1.7.1.1.

1.8.2 Assign AL_PA frame (LIFA, LIPA, LIHA, LISA)



Note) xxxxxx = ‘000000’···FL_Port or ‘0000EF’···FL_Port

Figure 1.44 Assign AL_PA frame (LIFA, LIPA, LIHA, LISA)

Frame used to assign AL_PA in initialization.

The payload field of the LIFA/LIPA/LIHA/LISA frame is described below. For the header field, refer to Section 1.8, "Extended Link Service (Loop Initialization)."

Word xx and byte y of the payload are represented by [PL:Wxx/By].

(1) Loop Initialization Identifier [W00]

11020000h: Indicates LIFA.

11030000h: Indicates LIPA.

11040000h: Indicates LIHA.

11050100h: Indicates LISA (LIRP/LILP frame supported).

11050000h: Indicates LISA (LIRP/LILP frame not supported).

– The received frame will be discarded when this field is an unsupported Link Service code.

(2) Port Name [PL:W01-04]

16-byte AL_PA bit map is entered.

1.8.3 Position map information (LIRP, LILP)

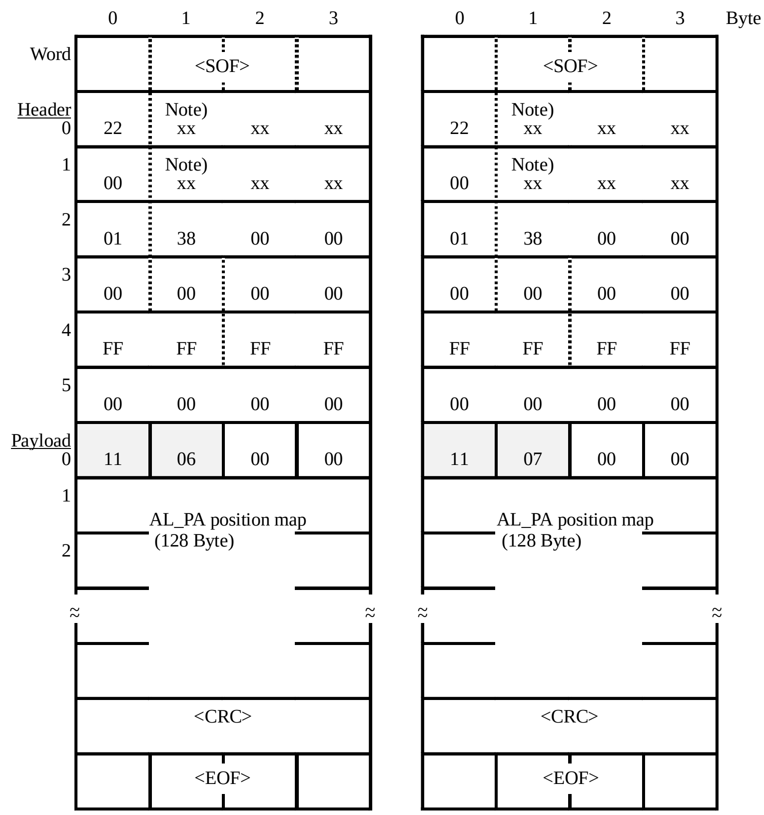


Figure 1.45 Position map information (LIRP, LILP)

Used for collection and notification of connection information for the initiator and drive connected on the loop, in initialization.

The payload field of the LIRP/LILP frame is described below. For the header field, refer to Section 1.8, "Extended Link Service (Loop Initialization)."

Word xx and byte y of the payload are represented by [PL:Wxx/By].

(1) Loop Initialization Identifier [W00]

11060000h: Indicates LIRP.

11070000h: Indicates LILP.

– The received frame will be discarded when this field is an unsupported Link Service code.

(2) Port Name [PL:W01-02]

128-byte Position Map is entered.

1.9 FC-4 Device Data

FC-4 Device Data indicates supported by this drive.

1.9.1 FCP CMND

The initiator issues FCP_CMND frame when it issues SCSI_Command.

The header field of the FCP CMND is defined in Figure 1.46.

Byte		0	1	2	3
		SOF			
Header	0	R_CTL 06	D_ID xx	xx	xx
	1	00	S_ID XX	XX	XX
	2	TYPE 08	F_CTL 29	00	00
	3	SEQ_ID xx	DF_CTL 00	SEQ_CNT 00	00
	4	OX_ID xx	xx	RX_ID FF	FF
	5	PARAMETER 00	00	00	00
Payload	0–1	FCP_LUN			
	2	FCP_CNTL			
	3–6	FCP_CDB			
	7–n	ADDITIONAL_FCP_CDB			
	n+1	FCP_DL			

Figure 1.46 Header field of the FCP CMND

(1) R_CTL.. (Routing Control)

06h: Indicates FCP CMND

(2) D_ID.. (Destination Identifier)

– Destination address for the frame.

(3) S_ID.. (Source Identifier)

– Source address for the frame.

(4) Type

The FCP_CMND frame uses 08h.

(5) F_CTL.. (Frame Control)

– Set 290000h for the FCP_CMD

  (Originator of Exchange, First Sequence of Exchange, Last Data frame of Sequence, Transfer Sequence Initiative.)

(6) SEQ_ID.. (Sequence Identifier)

– Set the optional value

(7) DF_CTL.. (Data Field Control)

Set 00h because no optional header is used.

(8) SEQ_CNT.. (Sequence Count)

– Set 0000h because it is used single frame sequence.

(9) OX_ID.. (Originator Exchange Identifier)

– Assign an unique value from initiator to the drive.

The drive does not check Command Over Lap.

(10) RX_ID.. (Responder Identifier)

Set FFFFh to indicate that RX_ID is unused.

(11) Parameter

Unused the parameter in the FCD_CMD and 00000000h entered.

The payload field of the FCP CMND frame is defined below.

Word xx and byte y of the payload are represented by [PL:Wxx/By].

(1) Logical Unit Number (FCP_LUN) [PL: W00-01]

All zero, this drive supports only LUN=zero

– In case of the drive is specified except for the zero value on FCP_CMND except for Inquiry, Request Sense CMD, the drive responds Check Condition Status in FCP_RSP frame.

(2) Control Field (FCP_CNTL) [PL:W02]

For details, refer to 1.9.1.1 Control Field (FCP_CNTL).

(3) CDB [PL:W03-06]

SCSI CDB is entered in the field.

- The field is 16 byte length any time and the drive does not check an unused area of this field occurred by SCSI Command Type.
- If Task Management Flag set, this field is invalid.

For details of CBD, refer to 1.9.1.2 Command Descriptor Block.

(4) Additinonal_FCP_CDB [PL:W07_n]

The drive ignores this field.

(5) Data length (FCP_DL) [PL:Wn+1]

Descripting the maximum data transfer available value in byte unit defined CDB in this frame.

The drive is compared with the transfer length, this field and data, in FCP_RSP

- FCP_DL > (data transfer length)

  set FCP_RESID_UNDER=1
- FCP_DL > (data transfer length)

  set FCP_RESID_OVER=1
- FCP_DL = (data transfer length)

  set FCP_RESID_UNDER/OVER=0, 0

1.9.1.1 Control field (FCP_CNTL)

<table>
<tr><td colspan="2">bit</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>WD</td><td>Byte</td><td colspan="8"></td></tr>
<tr><td rowspan="4">2</td><td>0</td><td colspan="8">Reserved</td></tr>
<tr><td>1</td><td colspan="5">Reserved</td><td colspan="3">Task Attribute</td></tr>
<tr><td>2</td><td>Obso-lete</td><td>Clear ACA</td><td>Target Reset</td><td>Logical Unit Reset</td><td>Reserv-ed</td><td>Clear Task Set</td><td>Abort Task Set</td><td>Reserv-ed</td></tr>
<tr><td>3</td><td colspan="6">Reserved</td><td>RD Data</td><td>WT Data</td></tr>
</table>

Figure 1.47 Control field (FCP_CNTL)

(1) Task Attribute [PL:W02/B1/bit2-0]

The initiator specifies the Command Queue type.

0h: Simple Queue

1h: Head of Queue

2h: Ordered Queue

4h: ACA Queue

5h: Untagged

– The drive handles ACA Queue as same as Simple Queue.

(2) Task Management flag [PL:W02/B2]

The initiator uses to control the task.

a) Obsolete [B2/bit7]

0b: This drive does not support the bit. If this bit set, the drive respond FCP_RSP with "Task Management Function Not Support" of FCP_CODE.

b) Clear ACA [B2/bit6]

0b: This drive does not support the bit, works as 0.

c) Target Reset [B2/bit5]

- This drive clears all commands queued when this drive receives the Target Reset.
- The drive generates the UNIT ATTENTION condition internally for all of initiators. If the drive receives the command after Target Reset, the drive will respond check condition (SenseKey=UNIT ATTENTION).
- The drive aborts all of "Open Exchange".

d) Logical Unit Reset [B2/bit4]

- This drive clears all commands queued when this drive receives the Target Reset.
- The drive generates the UNIT ATTENTION condition internally for all of initiators. If the drive receives the command after Target Reset, the drive will respond check condition (SenseKey=UNIT ATTENTION).
- The drive aborts all of "Open Exchange".

e) Clear Task Set [B2/bit2]

- This drive clears all commands queued when this drive receives the Target Reset.
- The drive generates the UNIT ATTENTION condition internally for all of initiators except Clear Task Set issue initiator. If the drive receives the command after Clear Task Set, the drive will respond check condition (SenseKey=UNIT ATTENTION).
- The drive aborts all of "Open Exchange".

f) Abort Task Set [B2/bit1]

- This drive clears all Task set issued by the initiator of commands abort-queued when this drive receives the Abort Task Set.
- The drive aborts "Open Exchange".

g) Read Data [B3/bit1]

- In case of the command has the Read data (the data is transferred from drive to initiator), 1 is set.

h) Write data [B3/bit0]

- In case of the command has the Write data (the data is transferred from initiator to drive), 1 is set.

1.9.1.2 Command descriptor block

bit		7	6	5	4	3	2	1	0
WD	Byte								
3	0	Operation Code							
		Group Code			Command Code				
	1	Reserved = h ‘00’							
	2	(MSB)							
	3				Logical Block Address				
4	0								
	1								(LSB)
	2	Reserved = h ‘00’							
	3	(MSB)			Transfer Length				
5	0								
	1	Control Byte							
		Reserved = b ‘000’					NACA	Flag	Link

bit		7	6	5	4	3	2	1	0
WD	Byte								
3	0	Operation Code							
		Group Code			Command Code				
	1	Reserved = b ‘000’			(MSB)				
	2				Logical Block Address				
	3								(LSB)
4	0	Transfer Length							
	1	Control Byte							
		Reserved = b ‘000’					NACA	Flag	Link

Figure 1.48 Command descriptor block

This section indicates the 6 byte and 10 byte CDB.

(1) Operation Code [PL:W03/B0]

For details of Operation Code, refer to Chapter 4.

The Upper 3 bit of Operation Code indicates the Group Code.

0000b, Group-0, 6 byte commands

001b, Group-1, 10 byte commands

010b, Group-2, 10 byte commands

011b, Group-3, received

100b, Group-4, 16 byte commands

101b, Group-5, 12 byte commands

110b, Group-6, Vendor specific

111b, Group-7, Vendor specific

(2) Logical Block Address

It can be specified the logical block address, 21 bit on 6 byte CDB and 32 bit on 10 byte CDB.

The maximum logical block address of drive is described on the Read Capacity Command.

(3) Transfer Length

It can be specified by 255 block using 1 byte (in this field) in 6 byte CDB.

It can be specified by 64K-1 block using 2 byte (in this field) in 10 byte CDB.

(4) Control Byte

This field includes the following informations.

a) NACA
(Normal Auto Contingent Allegiance)

– This drive does not support this bit.

b) Flag

– This drive does not support this bit.

c) Link

– This drive does not support this bit.

1.9.2 FCP XFER RDY

In case of transferring the drive, the drive issues FCP XFER RDY frame to the initiator.

The header field of the FCP XFER RDY is defined in Figure 1.49.

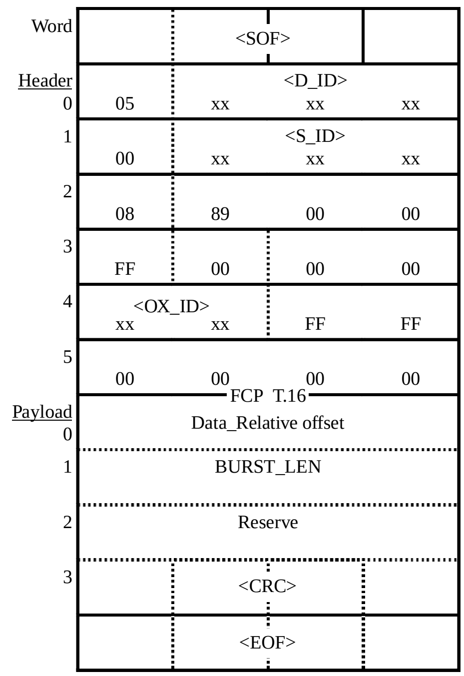


Figure 1.49 Header field of the FCP XFER RDY

(1) R_CTL.. (Routing Control)

05h: Indicates FCP XFER RDY

(2) D_ID.. (Destination Identifier)

– Destination address for the frame.

(3) S_ID.. (Source Identifier)

– Source address for the frame.

(4) Type

SCSI FCP frame uses 08h.

(5) F_CTL.. (Frame Control)

– Set 890000h for the FCP XFER RDY

(Responder of Exchange, Last Data frame of Sequence, Transfer Sequence Initiative)

(6) SEQ_ID.. (Sequence Identifier)

- The drive responds FFh.

(7) DF_CTL.. (Data Field Control)

Set 00h because no optional header is used.

(8) SEQ_CNT.. (Sequence Count)

- It is responded 0000h because it is used single frame sequence.

(9) OX_ID.. (Originator Exchange Identifier)

- The drive responds the OX_ID of FCP CMND received from the initiator.

(10) RX_ID.. (Responder Identifier)

Set FFFFh to indicate that RX_ID is unused.

(11) Parameter

Unused the parameter in the FCP XFER RDY and 00000000h entered.

The payload field of the FCP XFER RDY is defined below.

Word xx and byte y of the payload are represented by [PL:Wxx/By].

(1) Data Relative Offset (Data_R0) [PL:W00]

For this FCP XFER RDY frame, The drive specifies the byte Offset value of the first WT data sending the initiator.

The initiator describes the value of this field in the Relative Offset of the first WT data for this FCP XFER RDY frame.

(2) Burst Length (BURST_LEN) [PL:W01]

The initiator can be transferred number of WT Data Byte for this FCP XFER RDY frame. The BURST_LEN is satisfied with the following the conditions.

BURST_LEN:

(WT Command to transfer data rest of byte velocity)

BURST_LEN:

(Maximum Burst Size of Disconnect/Reconnect SCSI mode page)

BURST_LEN:

(Available transferring maximum byte velocity in FC Sequence)

1.9.3 FCP DATA

The header field of the FCP DATA is defined in Figure 1.50.

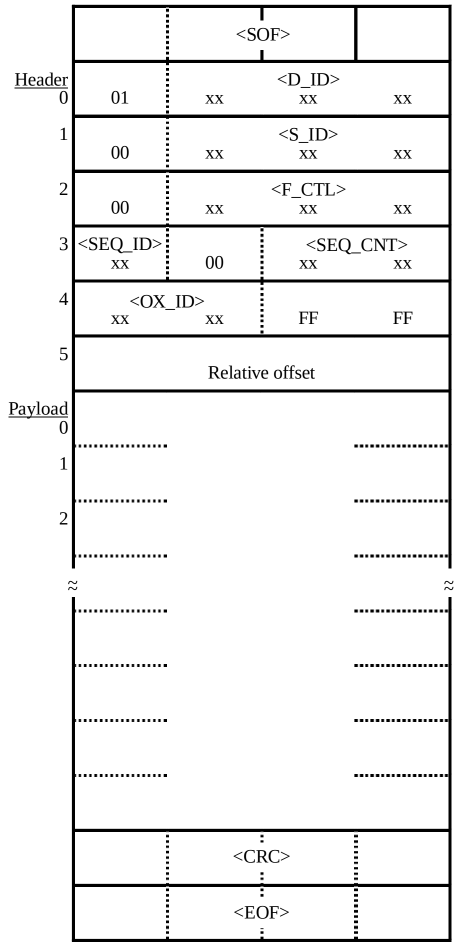


Figure 1.50 Header field of the FCP DATA

This frame is used for transferring between the initiator and the drive.

The header field of the FCP DATA is defined below.

(1) R_CTL.. (Routing Control)

01h: Indicates FCP DATA

(2) D_ID.. (Destination Identifier)

– Destination address for the frame.

(3) S_ID.. (Source Identifier)

– Source address for the frame.

(4) Type

SCSI FCP frame uses 08h.

(5) F_CTL.. (Frame Control)

Table 1.26 F_CTL

Section			F_CTL value
Write data frame (from initiator to drive)			
	a) not last frame of sequence		
		a1) with Relative Offset a2) without Relative Offset	000008h 000000h
	b) last frame of sequence x indicates 4 bit as below.		09000xh
	bit 3	when x is 1: with Relative Offset when x is 0: without Relative Offset	
	bit 2	0, Reserved	
	bit 1-0	Fill Data Byte 0, 0.....0 byte of fill (4 byte valid) 0, 1.....1 byte of fill (3 byte valid) 1, 0.....2 byte of fill (2 byte valid) 1, 1.....3 byte of fill (1 byte valid)	
Read Data frame (from drive to initiator)			
	a) not last frame of sequence		
		a1) with Relative Offset	800008h
	b) last frame of sequence x indicates 4 bit as below.		88000xh
	bit 3	when x is 1: with Relative Offset	
	bit 2	0, Reserved	
	bit 1-0	Fill Data Byte 0, 0.....0 byte of fill (4 byte valid) 0, 1.....1 byte of fill (3 byte valid) 1, 0.....2 byte of fill (2 byte valid) 1, 1.....3 byte of fill (1 byte valid)	

In case of accessing media, buffer, this drive demands that the byte velocity is a multiple of 4 byte.

(6) SEQ_ID.. (Sequence Identifier)

- In case of transferred Data Frame from the initiator to the drive, the drive has the memory of the first frame SEQ_ID of the sequence and checks the frame SEQ_ID belonging to the sequence.
- In case of the drive sends to the initiator the data frame, the drive institutes 00h to SEQ_ID in the first sequence. In case of issuing the sequence on and after twice in the command (exchange), SEQ_ID is used the added value one.

(7) DF_CTL.. (Data Field Control)

Set 00h because no optional header is used.

(8) SEQ_CNT.. (Sequence Count)

- 0000h is instituted in the transferred first data frame by the command. Whatever used multiple sequences by transferring the data on CMD, the drive demands that the SEQ_CNT value is lasted in the whole transferring data.

(9) OX_ID.. (Originator Exchange Identifier)

- The assigned value by the initiator to FCP_CMND.

(10) RX_ID.. (Responder Identifier)

Set FFFFh to indicate that RX_ID is unused.

(11) Parameter (Relative Offset)

It can be used as the Relative Offset in FCP Data

The drive does not check received this field of data frame.

The drive do for the continuous added value in this field of sending data frame.

The header field of the FCP DATA is used for transferring the defined information in the user data, SCSI protocol.

1.9.4 FCP RSP

The header field of the FCP RSP is defined in Figure 1.51.

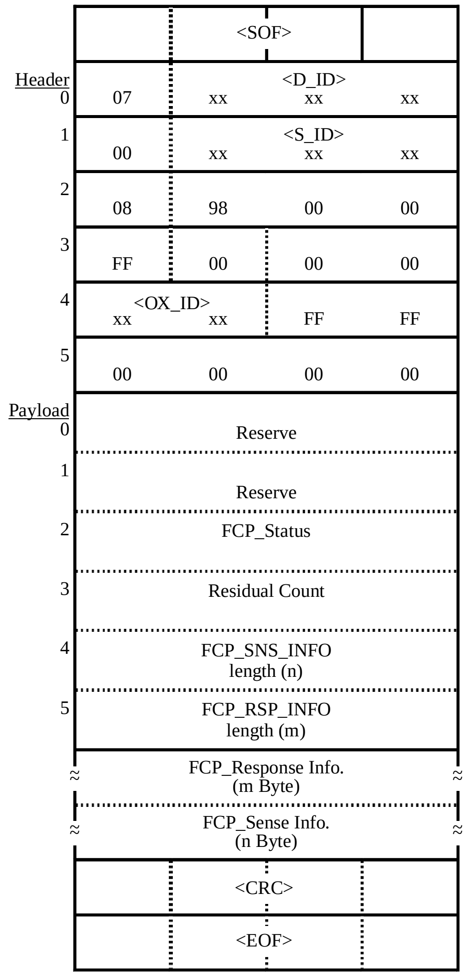


Figure 1.51 Header field of the FCP RSP

The drive reports the operation results of received FCP CMND by using FCP RSP frame.

The header field of the FCP RSP is defined below.

(1) R_CTL.. (Routing Control)

07h: Indicates FCP RSP frame

(2) D_ID.. (Destination Identifier)

– Destination address for the frame.

(3) S_ID.. (Source Identifier)

– Source address for the frame.

(4) Type

SCSI FCP frame uses 08h.

(5) F_CTL.. (Frame Control)

– Set 980000h for the FCP_RSP

  (Responder of Exchange, last sequence of exchange, last data frame of sequence.)

(6) SEQ_ID.. (Sequence Identifier)

– The drive responds by FFh.

(7) DF_CTL.. (Data Field Control)

Set 00h because no optional header is used.

(8) SEQ_CNT.. (Sequence Count)

– It is responded 0000h because it is used single frame sequence.

(9) OX_ID.. (Originator Exchange Identifier)

– The drive responds the OX_ID of FCP CMND received from the initiator.

(10) RX_ID.. (Responder Identifier)

Set FFFFh to indicate that RX_ID is unused.

(11) Parameter

Unused the parameter in the FCP RSP and 00000000h replied.

The payload field of the FCP RSP is defined below.

Word xx and byte y of the payload are represented by [PL:Wxx/By].

(1) FCP CONF REQ [PL:W02/B2/bit4]

The drive ignores this bit.

(2) FCP RESID UNDER [PL:W02/B2/bit3]

In case of

FCP_DL (FCP_CNMD) > (transferred data byte velocity based on CDB)

Residual Counter = FCP_DL – (transferred data byte velocity)

(3) FCP RESID OVER [PL:W02/B2/bit2]

In case of

FCP_DL (FCP_CNMD) < (transferred data byte velocity based on CDB)

Residual Counter = (transferred data byte velocity) – FCP_DL

(4) FCP SNS LEN VALID [PL:W02/B2/bit1]

When this bit is 1, the field of Length of Sense Information (FCP_SNS_INFO) is valid and FCP_RSP frame includes the FCP Sense Information field.

(5) FCP RSP LEN VALID [PL:W02/B2/bit0]

When this bit is 1, the field of Length of Response Information (FCP_RSP_INFO) is valid and FCP_RSP frame includes the FCP Sense Information field.

(6) SCSI Status [PL:W02/B2/bit0]

Refer to Section 2.2 Status Byte.

1.9.4.1 FCP status

bit		7	6	5	4	3	2	1	0
WD	Byte								
2	0	Reserved 00h							
	1	Reserved 00h							
	2	Reserved 00h			FCP CONF REQ	FCP RESID UNDER	FCP RESID OVER	FCP SNS LEN VALID	FCP RSP LEN VALID
	3	SCSI Status							

Figure 1.52 FCP status

(1) FCP RESID UNDER [PL:W02/B2/bit3]

In case of

FCP_DL (FCP_CNMD) > (transferred data byte velocity based on CDB)

Residual Counter = FCP_DL – (transferred data byte velocity)

(2) FCP RESID OVER [PL:W02/B2/bit2]

In case of

FCP_DL (FCP_CNMD) < (transferred data byte velocity based on CDB)

Residual Counter = (transferred data byte velocity) – FCP_DL

(3) FCP SNS LEN VALID [PL:W02/B2/bit1]

When this bit is 1, the field of Length of Sense Information (FCP_SNS_INFO) is valid and FCP_RSP frame includes the FCP Sense Information field.

(4) FCP RSP LEN VALID [PL:W02/B2/bit0]

When this bit is 1, the field of Length of Response Information (FCP_RSP_INFO) is valid and FCP_RSP frame includes the FCP Sense Information field.

(5) SCSI Status [PL:W02/B2/bit0]

Refer to Section 2.2 Status Byte.

1.9.4.2 FCP response information

bit		7	6	5	4	3	2	1	0
WD	Byte								
6	0	Reserved 00h							
	1	Reserved 00h							
	2	Reserved 00h							
	3	Response Code (FCP RSP CODE)							
7	0	Reserved 00h							
	1	Reserved 00h							
	2	Reserved 00h							
	3	Reserved 00h							

Figure 1.53 FCP response information

(1) Response Code (FCP RSP CODE) [PL:W06/B3]

Supporting Response Code below.

00h: Task Management Function Complete or No Failure.

01h: FCP DATA length different than Burst Length.

02h: FCP CMND fields invalid.

03h: RO in the data frame header mismatch with FCP DATA RDY DATA RO.

04h: Task Management Function not support.

05h: Task Management Function failed.

1.9.4.3 FCP sense information

bit		7	6	5	4	3	2	1	0
WD	Byte								
8	0	Validity bit	Error Code = h '70' or h '71'						
	1	= h '00'							
	2	= b '0'	= b '0'	ILI	= b '0'	Sense key			
	3	(MSB)							
9	0	Information							
	1								
	2								(LSB)
	3	Additional Sense Length = h '28'							
10	0	(MSB)							
	1	Command Specific Information							
	2								
	3								(LSB)
11	0	Additional Sense Code (ASC)							
	1	Additional Sense Code Qualifier (ASCQ)							
	2	Reserved = h '00'							
	3	SKSV	Sense key Specific Information						
12	0								
	1								
	2	0	0	0	PORT	0	Link Rate		
	3	CDB Operation Code							
≈	≈	Detailed Information							
19	0								
	1								
	2								
	3								

Refer to Section 5.1 Sense Data.

Figure 1.54 FCP sense information

1.10 Errors on Loop (Refer to FC-PH , Section 29.9)

This section describes errors which may occur on the loop and actions to be taken for them.

Table 1.27, Detail errors and action lists types of errors and actions for them by number. For details of the actions to be taken for errors, refer to Table 1.28, Actions by recipient.

Table 1.27 Detail errors and action (1/2)

Error Category	Specific Error	Seq Recp Action
1) Loop Failure	a) Loss of signal	12
	b) Loss of Sync > timeout period	12
2) Loop Errors	c) Loss of Sync	11
3) Sequence timeout	a) timeout during Sequence	9
	b) timeout at end of Sequence	9
4) Delimiter Errors	a) Class not support	2
	b) Delimiter usage error (SOFc1 while connected)	2
	c) Abnormal frame termination	1
	d) EOFa received	1
	e) Incorrect SOF or EOF	1
5) Address ID Errors	a) incorrect D_ID	2
	b) incorrect S_ID	2
6) Frame_control Errors	a) CRC	1
	d) TYPE not support	2
	e) Invalid Link Control	2
	f) Invalid R_CTL	2
	g) Invalid F_CTL	2
	h) Invalid OX_ID	2
	i) Invalid RX_ID	2
	j) Invalid SEQ_ID	2
	k) Invalid SEQ_CNT	2
	l) Invalid DF_CTL	2
	m) Exchange Error	2

Table 1.27 Detail errors and action (2/2)

Error Category	Specific Error	Seq Recp Action
6) Frame_control Errors	n) Protocol Error	2
	o) Incorrect length	2
	p) Unexpected Link_Continue	2
	q) Unexpected Link_Response	2
	r) Login Required	2
	s) Excessive Sequences attempted	2
	t) Unable to Establish Exchange	2
	u) RO out of bounds	2
7) Data Frame Errors	c) Buffer not available – Class 3	1
	e) missing frame error detected	13

Note:

The contents of Seq. Recp. Action for each error item are described for each item number in Table 1.28, Action by recipient.

Table 1.28 Actions by recipient

No.	Action
1	Discard policy If an invalid frame is detected, the entire invalid frame shall be discarded.
2	If a valid frame is received and a rejectable or busy condition in Class 3 is detected, the entire frame shall be discarded.
9	Abnormally terminate Sequence When a Sequence Recipient detects a Sequence timeout and no Data frames are being received for the Sequence, the Recipient shall terminate the Sequence and update the Exchange Status Block.
11	Update LESB The Link Error Status Block is updated to track errors not directly related to an Exchange.
12	Perform loop failure Protocol If a Loop failure occur, the L_Port which detects the failure shall issue LIP (F8, AL_PS) if it has a valid AL_PA, or LIP (F8, F7) if it doesn't.
13	Error Policy processing When an error is detected within a Sequence, the Sequence is discarded (discard policy)

1.11 Enclosure Service Interface (ESI)

Enclosure Service Interface provides the protocol defining the information between the enclosure and the drive.

The drive starts to execute Enclosure Service when the drive receives “Send Diagnostic” command or “Receive Diagnostic Result” command with Enclosure Service page specified.

a) SFF8045

Two modes in SFF8045 exist, which are Without Parallel ESI and With Parallel ESI.

SFF8045 w/o Parallel ESI only includes the function that the enclosure provides SEL_ID defined in FC-AL to the drive.

On the other hand, SFF8045 with Parallel ESI provides an additional function that the drive can read the status from the enclosure.

b) SFF8067

This mode covers SFF8045 function and has a purpose for diagnostics and receiving the status of the enclosure in the next manner.

The drive receives Send Diagnostic command from the initiator.

Then the drive transmits the page specified in Send Diagnostic command to the enclosure.

The drive receives Receive Diagnostic Result command from the initiator.

Then the drive receives the page specified in Receive Diagnostic Result command from the enclosure.

1.11.1 Data transfer protocol

When powered on, the enclosure operates as SFF8045 w/o Parallel ESI and provides SEL_ID to the drive.

The communication starts upon receiving Send/Receive Diagnostic command as described in Figure 1.55.

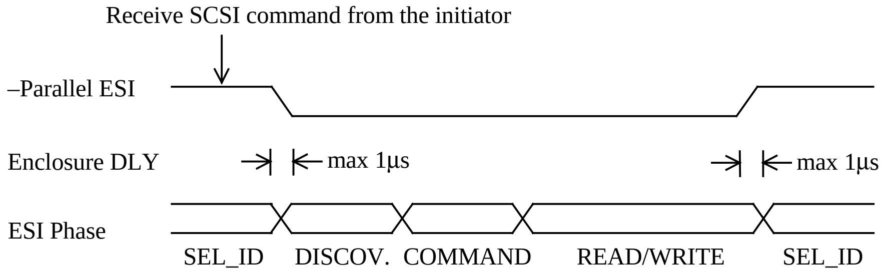


Figure 1.55 Enclosure service data transfer protocol

Detail of DISCOV. (discovery) phase is shown in Figure 1.56.

This process is executed every time when -Parallel ESI signal is asserted.

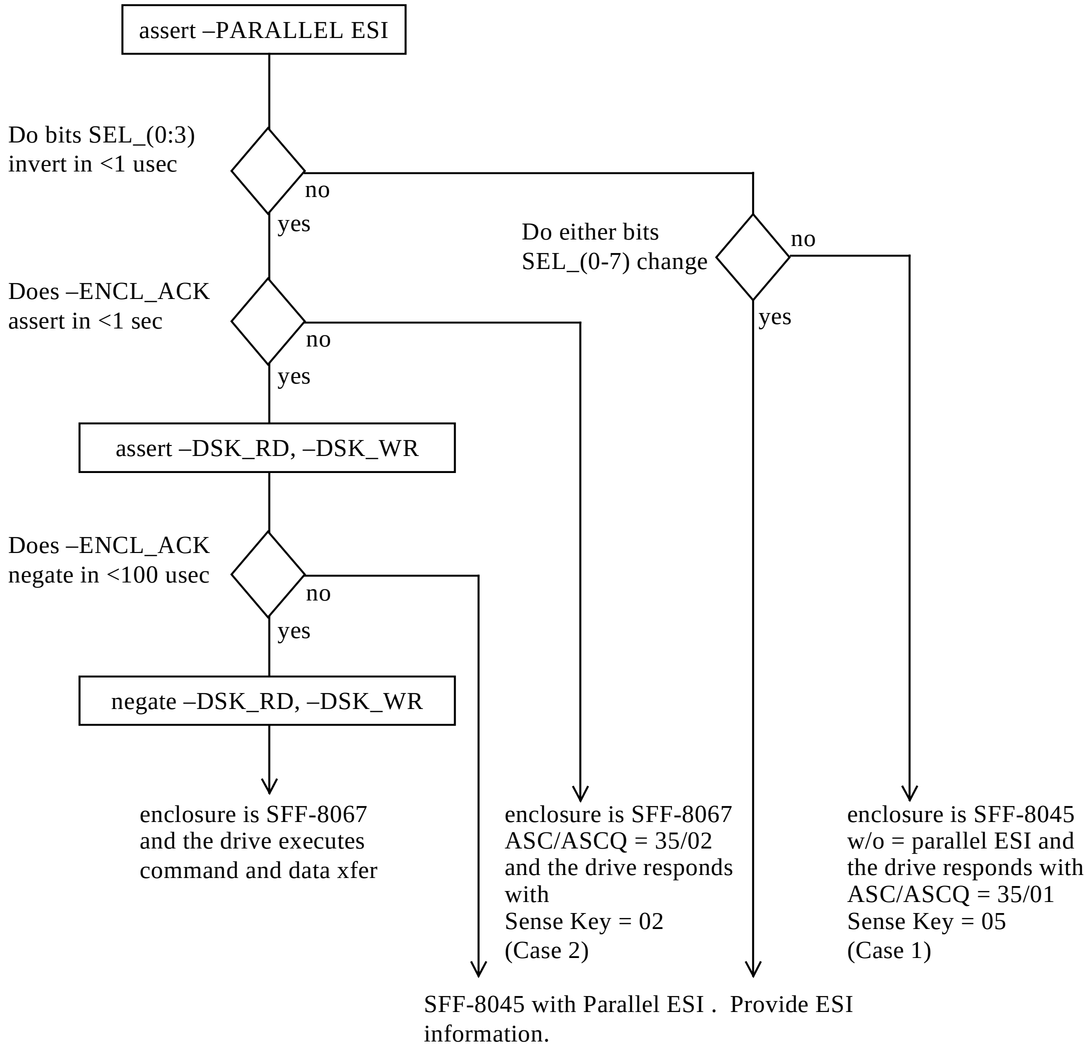
The target of DISCOV. phase is that the drive acknowledges the enclosure can operate as SFF8067 mode.

If the enclosure cannot operate as SFF8067, the drive performs one of the following.

a) assuming that the enclosure can operate as SFF8045 w/o Parallel ESI, then transmits sense data to the initiator. ; case 1 in Figure 1.56.

b) assuming that the enclosure can operate as SFF8067, then transmits sense data to the initiator. ; case 2 in Figure 1.56.

1.11.2 Enclosure discovery phase



Case 1; The drive is SFF8045 w/o Parallel ESI enclosure and transmits sense data (ASC = 35, ASCQ = 01) to the initiator.

Case 2; The drive is SFF8067 enclosure and transmits sense data (ASC = 35, ASCQ = 02) to the initiator.

Figure 1.56 Discovery flow chart

1.11.3 COMMAND phase

In COMMAND phase protocol, the drive transmits the command receiving from the initiator to the enclosure.

Because the data bits are 4 bits width, the drive has to transmit the data even times.

(1) COMMAND phase

The drive communicates with the enclosure as shown in Figure 1.57.

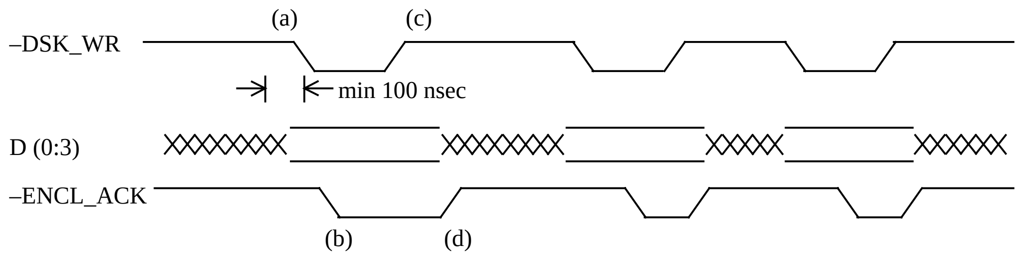


Figure 1.57 COMMAND, WRITE phase

(a) ; The drive asserts –DSK_WR and indicates to the enclosure that the valid data is on D (0:3).

(b) ; The enclosure asserts –ENCL_ACK after receiving the data.

(c) ; The drive negates –DSK_WR and the data by –ENCL_ACK being asserted.

(d) ; The enclosure negates –ENCL_ACK by –DSK_WR being negated.

(2) Definition of COMMAND bytes

If the drive acknowledges the drive should issue COMMAND to the enclosure after receiving SCSI command, then transmits the COMMAND as shown in Table 1.29.

Table 1.29 COMMAND bytes definition

Byte	Definition
byte 0	Page Code
byte 1	Reserved except bit 0 (data transfer direction in SEND DIAG.)
byte 2	Parameter Length high byte in SEND DIAG.
byte 3	Parameter Length low byte in SEND DIAG.

COMMAND bytes length is always four bytes.

- Page code in byte 0 is defined as SES page for communicating with the enclosure.
- Bit 0 in byte 1 defines the direction of the data transfer.

  0 …… from the drive to the enclosure

  1 …… from the enclosure to the drive
- Parameter Length in byte 2 and byte 3 defines data length. The value “0000h” is used when receiving the data (Receive Diagnostic Result command).

(3) Byte/bit alignment

The COMMAND and READ/WRITE data are transferred in the following alignment. (Figure 1.58)

byte number	;	#0	#1	……		#n-1	#n		
byte transfer order in ESI	;	1st	2nd			n-1 th	n th		
bit	;	7	6	5	4	3	2	1	0
transfer order in ESI	;	⇐ 1st nibble ⇒				⇐ 2nd nibble ⇒			
bit alignment	;	D (3)	D (2)	D (1)	D(0)	D (3)	D (2)	D (1)	D (0)

Figure 1.58 Byte/bit alignment in ESI

1.11.4 READ/WRITE phase

(1) READ phase

READ phase is a process that the drive receives the information stored by the enclosure.

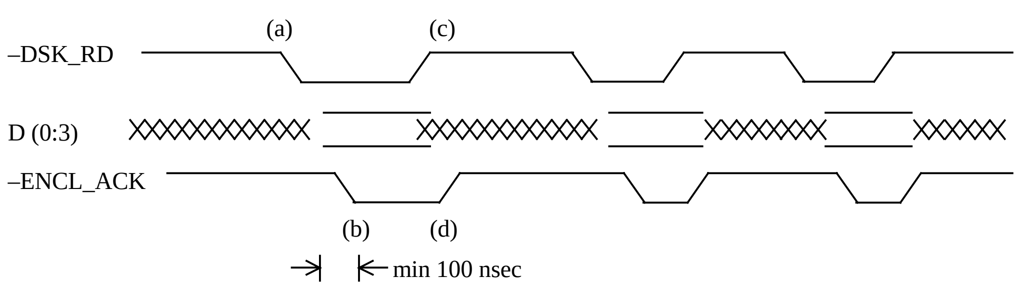


Figure 1.59 READ phase

(a) ; The drive asserts –DSK_RD and requests the data to the enclosure.

(b) ; The enclosure asserts –ENCL_ACK after enabling the data on D (0:3).

(c) ; The drive reads the data and negates –DSK_RD.

(d) ; The enclosure negates –ENCL_ACK by –DSK_RD being negated.

(2) WRITE phase

WRITE phase is the same as COMMAND phase.

The protocol is shown in Figure 1.57.

1.11.5 SES sense codes

Table 1.30 ASC/ASCQ defined for ESI conditions

ASC/ASCQ	Definition
35h/01h	Unsupported Enclosure Function
35h/02h	Enclosure Services Unavailable
35h/03h	Enclosure Transfer Failure
35h/04h	Enclosure Transfer Refused

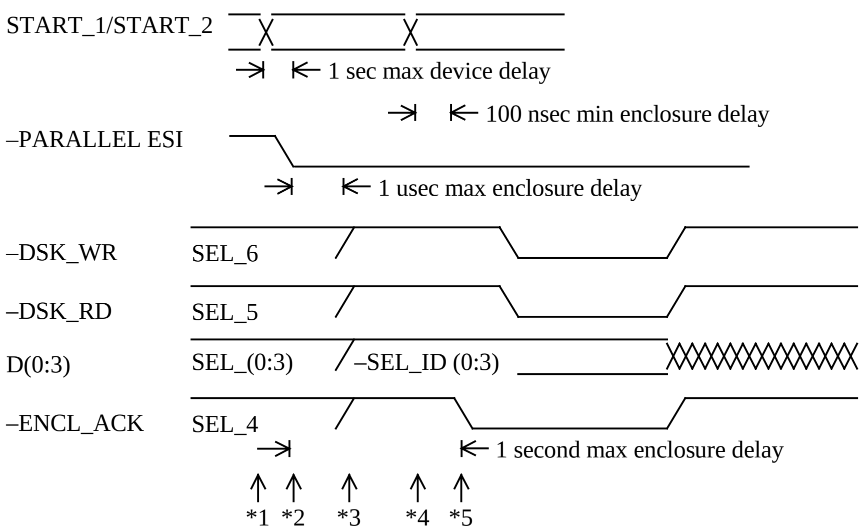
1.11.6 Enclosure Initiated ESI transfer

Enclosure initiated ESI (EIE) provides a means for the enclosure to request information or action from a SCSI device that supports an 8067 ESI interface. The transfer of information is independent of the SCSI interface. The format of the information, however, is similar to the SES information transferred on the SCSI interface for ease of implementation.

1.11.6.1 EIE discovery

A discovery phase is defined to allow the enclosure to initiate an information request and allow the SCSI device to detect the request. If the SCSI device supports detection of the Un-Mated condition of the START_1 and START_2 signals, Case 1, and supports Enclosure Initiated ESI (EIE) transfers, it monitors the START_1 and START_2 signals. On detecting a transition from a valid mated condition, Case 2, 3, or 4, to a different case, the device asserts –PARALLEL ESI. To avoid a false spin-down due to a hand shake timeout, initiating an EIE transfer by changing from a mated condition to the unmated condition is not recommended. If the enclosure is requesting a transfer with a case change, it returns the START_1 and START_2 signals to the original mated condition a minimum of 100 nanoseconds before asserting the –ENCL_ACK signal. Figure 1.60 illustrates a successful discovery of an EIE transfer request.

Table 1.11 shows the detail of “Case”.



*1 Enclosure Services Processor changes START_1 and START_2 to indicate that it is requesting communication with the SCSI device.

*2 SCSI device asserts –PARALLEL ESI to indicate it is ready to begin communication with the Enclosure Services Processor.

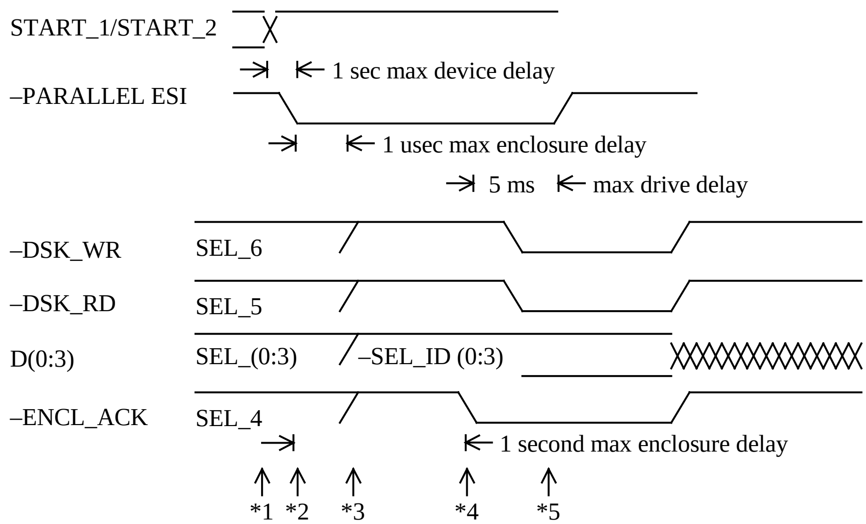
*3 SCSI device determines that enclosure is SFF-8067 compliant by noting that SEL_(0:3) bits have inverted and that SEL_5 and SEL_6 have the value that the device is presenting.

*4 The Enclosure Services Processor returns START_1 and START_2 to Case2, 3, or 4.

*5 The Enclosure Services Processor asserts –ENCL_ACK and discovery continues.

Figure 1.60 Enclosure initiated ESI request

If discovery determines the enclosure does not support an 8067 capable interface or the enclosure has driven the START_1 and START_2 signals to an unmated condition and does not return the START_1 and START_2 signals to a valid mated condition, the device negates –PARALLEL_ESI and prepares for power removal. Figure 1.61 shows a case where the enclosure does support 8067 ESI transfer but the enclosure is requesting the device to prepare for removal. (This drive does not support this function.)



*1 Enclosure Services Processor negates START_1 and START_2 to indicate that it is requesting communication with the SCSI device.

*2 SCSI device asserts –PARALLEL ESI to indicate it is ready to begin communication with the Enclosure Services Processor.

*3 SCSI device determines that enclosure is SFF-8067 compliant by noting that SEL_(0:3) bits have inverted and that SEL_6 and SEL_7 have the value that the device is presenting.

*4 The Enclosure Services Processor asserts –ENCL_ACK to indicate it is ready to begin communication with the SCSI device.

*5 The SCSI device negates –PARALLEL ESI to end the ESI transfer and prepares for power removal. (This drive does not support this function.)

Figure 1.61 Prepare for removal

1.11.6.2 EIE operations

Following successful discovery of an EIE transfer request, the SCSI device transfers an ESI command to the enclosure using the write and command phase procedure. The contents of the command are defined in 1.11.6.3. The device follows the command with a read phase procedure to retrieve the transfer request information from the enclosure. The definition of the enclosure request is in 1.11.6.3.

If the enclosure is requesting information, the SCSI device sends an ESI command with Send = 1 to indicate to the enclosure it is ready to transfer the requested information. The command is followed by a write of the information requested by the enclosure. This information is defined in 1.11.6.3. Following the write, the device negates –Parallel ESI to end the operation. Figure 1.62 is a summary of these operations.

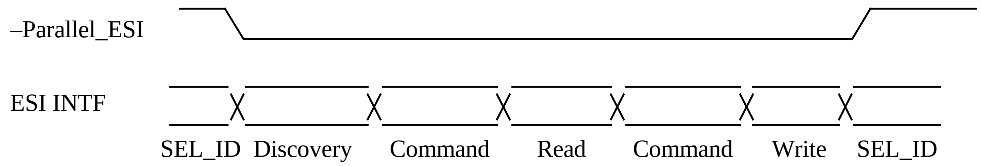


Figure 1.62 EIE operation phases

If any errors or timeouts are detected during the EIE operation, the SCSI device aborts the operation and continues normal operation. Errors are not reported.

1.11.6.3 Enclosure requested information

If the enclosure services interface transfer is initiated by the enclosure, the SCSI device sends ESI Command Phase information to the enclosure following successful discovery. The page code in the ESI command is 00h. This page code is reserved for SCSI diagnostic commands between the host and the SCSI device and will not appear in ESI transfers initiated by SCSI commands. The ESI command is a read operation, SEND = 0, with parameter length of 6h.

The enclosure responds to the ESI command from the SCSI device with an ESI request as defined in Table 1.31. The information requested by the enclosure is identified by the action code. Table 1.32 defines the action codes.

Table 1.31 Enclosure request

Byte \ Bit	7	6	5	4	3	2	1	0
0	Page Code (00h)							
1	0	0	0	0	Action Code			
2	0	0	0	0	0	0	0	0
	Reserved							
3	Action Specific							
4	(MSB) Parameter Length							
5								(LSB)

The parameter length in the enclosure request is set by the enclosure to the number of bytes it is requesting including the four header bytes. The SCSI device sends the actual length of the requested information or the length identified in the request parameter length whichever is less. If the parameter length is equal to 0, the SCSI device ends the ESI transfer by negating Parallel_ESI.

Table 1.32 Action code

Action Code	Description
00h	Device Standard Inquiry Data
01h	Device Addresses
02h	Loop Position Map
03h	Initiate Loop Initialization
04h	Device Identification
05h	Device Temperature
06h	Port Parameters
07h	Link Status
08h	Spin-Down Control
09 to 0Fh	Reserved

* Not supported

If the ESI request contains a valid Action Code and non-zero Parameter Length, the drive responds with a write operation with the requested information. Table 1.33 defines the format of the EIE page. Tables 1.34, 1.35, 1.36, 1.38, and 1.39 define the page contents for the identified action codes.

The Initiate Loop Initialization Action Code (03h) does not include a transfer of information to the enclosure. The Action Specific bits in the Enclosure Request define the operation to be performed. See Table 1.37.

The Action Specific bits for the remaining Action Codes are 0.

Table 1.33 Enclosure initiated ESI page format

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	ESI Page (00h)			
1	0	0	0	0	Action Code			
2 3	(MSB) Page Length (n-3) (LSB)							
4 : n	(MSB) Data (LSB)							

Table 1.34 Device standard inquiry data

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	ESI Page (00h)			
1	0	0	0	0	Action Code (00h)			
2 3	(MSB) Page Length (24h) (LSB)							
4 : 39	(MSB) Inquiry Data (LSB)							

- Inquiry Data - The first 36 bytes of Standard Inquiry data. Reference SCSI Primary Commands - 2 (SPC-2) for a definition of this data.

Note: the vendor specific, VS, bit in byte 6 is not valid.

Table 1.35 Device addresses page

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	ESI Page (00h)			
1	0	0	0	0	Action Code (01h)			
2 3	(MSB) Page Length (24h) (LSB)							
4 : 11	(MSB) Node Name (LSB)							
12	Port A (01h)							
13 : 15	(MSB) Port A Port _Identifier (LSB)							
16	Port A Position							
17	0	0	0	0	0	0	0	0
18 : 25	(MSB) Port A Name (LSB)							
26	Port B (02h)							
27 : 29	(MSB) Port B Port _Identifier (LSB)							
30	Port B Position							
31	0	0	0	0	0	0	0	0
32 : 39	(MSB) Port B Name (LSB)							

- Node Name: A 64-bit Fibre Channel unique Name_Identifier assigned to the drive.
- Port_Identifier: The FC 24-bit address assigned to the port. The lower byte is the current FC-AL AL_PA for this port. If the port does not have a Port_Identifer, a value of FF FF FFh is returned in the Port_Identifier field.
- Port Position: The offset value for this port's AL_PA in the FC-AL AL Loop Initialization Loop Position (LILP) Frame. If the port does not have an AL_PA, a value of FFh is returned in the Port Position field.
- Port Name: A 64-bit Fibre Channel unique Name_Identifier assigned to the Port.

Table 1.36 Loop position map page

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	ESI Page (00h)			
1	0	0	0	0	Action Code (02h)			
2 3	(MSB) Page Length (m-3) (LSB)							
4	Offset Port A (n-4)							
5 : n	(MSB) Loop Map Port A (LSB)							
n + 1	Offset Port B (m–n+1)							
n + 2 : m	(MSB) Loop Map Port B (LSB)							

- Offset: The offset field frorn the FC-AL LILP frame. The offset field indicates the number of bytes in the Loop Map. A value of 00h indicates the Loop Map is not available for the port.
- Loop Map: Valid AL_PA entries from the payload of the FC-AL LILP frame. Only the valid AL_PA entries are transferred to minimize the transfer time on the ESI interface. The maximum Loop Map size is 127 bytes.

Table 1.37 Initiate LIP action specific bits

0	0	0	0	0	0	LIP Loop B	LIP Loop A

- LIP Loop A/B Bits: When set to a l, the drive enters the Loop Initialization Process on either loop A, B, or both as indicated by these bits. The drive originates a LIP (F7, AL_PS) if it has a valid AL_PA. The drive originates a LIP (F7, F7) if it does not have a valid AL_PA.

Table 1.38 Device identification page

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	ESI Page (00h)			
1	0	0	0	0	Action Code (04h)			
2	(MSB)			Page Length (n–3)				
3								(LSB)
4	(MSB)							
:				Device ID Data				
n								(LSB)

- Device ID Data: The device ID data is the contents of the SCSI Vital Product Data Device Identification page (83h). For a definition of this information, see the SPC-2 (SCSI Primary Commands-2) standard.

Table 1.39 Device temperature

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	ESI Page (00h)			
1	0	0	0	0	Action Code (05h)			
2	(MSB)			Page Length (06h)				
3								(LSB)
4	Temperature							
5								
:	Reserved							
9								

- Temperature: The value of the drive temperature sensor in degrees Celsius, offset by +20 degrees. The range expresses a temperature between –19 and +235 degrees Celsius. The value of 0 is reserved.

Table 1.40 Port parameters

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	ESI Page (00h)			
1	0	0	0	0	Action Code (06h)			
2	(MSB)	Page Length (06h)						
3								(LSB)
4	Drive Capabilities							
5	Reserved							LSP CHG
6	0	0	Port A Link Fail	Port A Bypass	0	Port A Link Rate		
7	Reserved							
8	0	0	Port B Link Fail	Port B Bypass	0	Port B Link Rate		
9	Reserved							

- Drive Capabilities - This is a bit significant field that indicates which Device Control Codes as defined in SFF 8045 are supported by the drive. A one in a bit position indicates the corresponding Device Control Code is supported, e.g. a one in bits 7 and 6 indicates that Device Control Codes 7 and 6 are supported. This indicates the drive supports Fibre Channel link rates of 1 and 2 GHz.

- LSP CHG (Link Status Page Change) - A one in this field indicates the data in the Link Status Page has changed since the enclosure last read the Link Status Page. A zero indicates the Link Status Page data has not changed. When the enclosure reads the Link Status Page, this bit is cleared.

- Port Link Fail - A one in this field indicates the drive is currently detecting a Loop Failure condition as defined in FC-AL for the port.

- Port Link Rate - This field is the value defined for the Fibre Channel link rate by the Device Control Code inputs in SFF 8045, i.e., 7 represents 1Ghz.

- Port Bypass - A one in this field indicates the drive is asserting the -ENBL BYPCH signal in the SCA connector for the port. A zero indicates the drive is not requesting bypass.

Table 1.41 Link status page (1/2)

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	ESI Page (00h)			
1	0	0	0	0	Action Code (07h)			
2 3	(MSB) Page Length (60h) (LSB)							
4 : 7	(MSB) Link Failure Count, Port A (LSB)							
8 : 11	(MSB) Loss of Sync Count, Port A (LSB)							
12 : 15	(MSB) Loss of Signal Count, Port A (LSB)							
16 : 19	(MSB) Primitive Sequence Protocol Error, Port A (LSB)							
20 : 23	(MSB) Invalid Transmission Word Count, Port A (LSB)							
24 : 27	(MSB) Invalid CRC Count, Port A (LSB)							
28 : 31	(MSB) LIP F7 Initiated Count, Port A (LSB)							
32 : 35	(MSB) LIP F7 Received Count, Port A (LSB)							
36 : 39	(MSB) LIP F8 Initiated Count, Port A (LSB)							
40 : 43	(MSB) LIP F8 Received Count, Port A (LSB)							
44 : 51	Reserved							

Table 1.41 Link status page (2/2)

Byte \ Bit	7	6	5	4	3	2	1	0
52 : 55	(MSB) Link Failure Count, Port B (LSB)							
56 : 59	(MSB) Loss of Sync Count, Port B (LSB)							
60 : 63	(MSB) Loss of Signal Count, Port B (LSB)							
64 : 67	(MSB) Primitive Sequence Protocol Error, Port B (LSB)							
68 : 71	(MSB) Invalid Transmission Word Count, Port B (LSB)							
72 : 75	(MSB) Invalid CRC Count, Port B (LSB)							
76 : 79	(MSB) LIP F7 Initiated Count, Port B (LSB)							
80 : 83	(MSB) LIP F7 Received Count, Port B (LSB)							
84 : 87	(MSB) LIP F8 Initiated Count, Port B (LSB)							
88 : 91	(MSB) LIP F8 Received Count, Port B (LSB)							
92 : 99	Reserved							

Note: Implementation of the fields in this page is optional. A value of zero either indicates the field is not supported or no count has occurred.

When the drive changes a value in this page, the drive sets the LSP CHG bit in the Port Parameter Page. The enclosure may poll the Port Parameter Page to determine if it needs to read and process the Link Status Page. When the Link Status Page is read by the enclosure the LSP CHG bit is cleared.

The following fields are extracted from the FC-PH defined Link Error Status Block, LESB:

- Link Failure Count - Count of the number of Loss of Sync conditions that have occurred on the port which exceeded 100 mS in duration.
- Loss of Sync Count - Count of the number of short (< 100 mS) Loss of Synchronization conditions that have occurred on the port.
- Loss of Signal Count - Count of the number of Loss of Signal conditions on the port.
- Primitive Sequence Protocol Error - Count of the number of FC-PH defined Primitive Sequence Protocol Errors on the port. This field is not valid in loop mode.
- Invalid Transmission Word Count - Count of the number of invalid transmission words/Running Disparity errors that have been detected on the port.
- Invalid CRC Count - Count of the number of write data frames that have been received with invalid CRC's on the port. These errors are only detected when this drive is the target of the data transfer.

The following fields are unique to loop mode:

LIP F7 Initiated Count - Count of the number of loop initialization processes originated by the port with LIP -F7's (Initialize LIP).

LIP F7 Received Count - Count of the number of loop initialization processes initiated on the port by receiving LIP-F7's (Initialize LIP).

LIP F8 Initiated Count - Count of the number of loop initialization processes originated by the port with LIP -F8's (Failure LIP).

LIP F8 Received Count - Count of the number of loop initialization processes initiated on the port by receiving LIP-F8's (Failure LIP).

1.12 Public Loop

Public loop consists of the private loop through the multiple FL_Port or N_Port device through the multiple F_Port. (Shown as Figure 1.63)

The FL_Port is the gateway to the Fabric for the Public NL_Ports on its Local Loop, allowing NL_Ports to act as if they were N_Ports and interact with other N_Ports and NL_Ports attached to the fabric.

It can be communicated with all devices connected with F_Port/FL_Port. (ex. NFS Client can be communicated with SCSI Device #6 etc.)

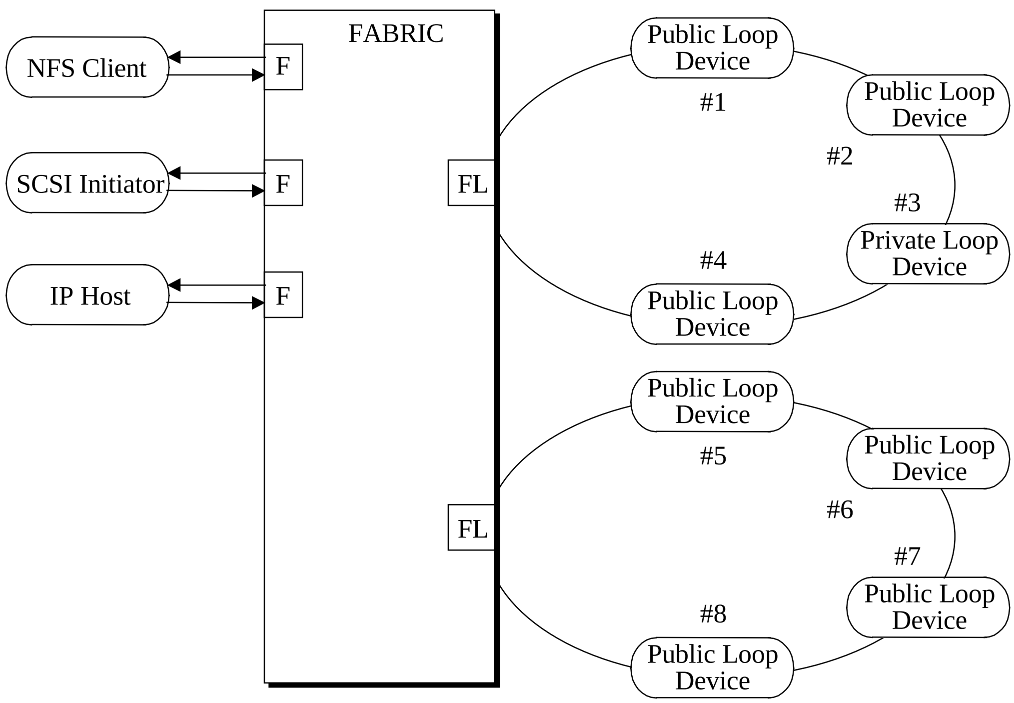


Figure 1.63 Public loop configuration

Example for Establishment

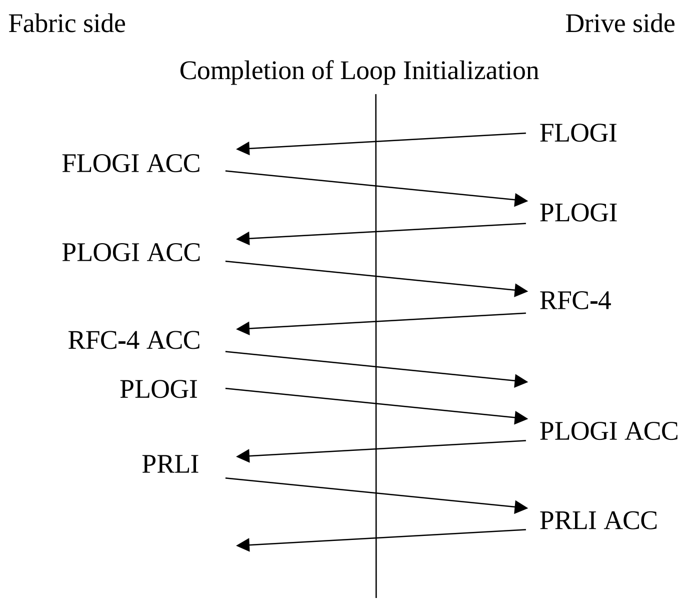


Figure 1.64 General public loop initialization sequence

At this point, Public Loop establishes between Fabric and Drive.

1.13 Dual Loop

This drive has a Dual Port configuration with two ports (A, B). Viewed from the Fibre Channel Interface, these two ports appear to exist as two independent devices.

Even though these two ports are independent to the interface, since they use the storage medium in common, internally, during reading or writing from one of the ports, read or write requests from the other port must wait.

The matrix for transmitting and receiving of frames at the interface is defined as shown in Table 1.42.

Table 1.42 Transmitting and receiving of frames at the interface

	Initializing LISM to LISA	Initializing LIRP and LILP	Receiving FCP_CMD	Receiving FCP_LNK	Executing FCP_DATA	Transmitting FCP_XRDY	Transmitting FCP_RSP
Initializing LISM to LISA	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Initializing LIRP and LILP	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Receiving FCP_CMD	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Receiving FCP_LNK	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Executing FCP_DATA	Yes	Yes	Yes	Yes	Yes *	Yes	Yes
Transmitting FCP_XRDY	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Transmitting FCP_RSP	Yes	Yes	Yes	Yes	Yes	Yes	Yes

* At 2Gbps Link Rate, while the one port is executing FCP_DATA, the alternate port can not be executed FCP_DATA.

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CHAPTER 2 Command Processing

In this chapter, the basic theory and specifications concerning IDD command processing functions are described.

IMPORTANT

The IDD operates as the target (TARG) in the FC LOOP. In the explanations given in this chapter, the IDD is labeled “TARG”, except in cases where a particularly clear distinction is necessary.

2.1 Command Format

Input/Output commands from the INIT (Initiator) to the IDD are executed by the CDB (Command Descriptor Block). The CDB is information which is transmitted from the INIT to the TARG in the FCP_CMND frame. In a number of commands, other than the CDB specifications, parameters which are necessary in executing a command are specified in the DATA frame. Details concerning these commands are described in the specifications for individual commands in Chapter 4.

The CDB used by the IDD has 3 formats, one with a length of 6, 10 bytes and the other with a length 12 bytes. The basic format of each respective CDB is shown in Tables 2.1, 2.2 and 2.3.

Table 2.1 6-Byte CDB basic format

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code							
1	Reserved			Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Transfer Data Length							
5	Control Byte							

Table 2.2 10-Byte CDB basic format

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code							
1	Reserved			0	0	0	0	0
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	0	0	0	0	0	0	0	0
7	Transfer Data Length (MSB)							
8	Transfer Data Length (LSB)							
9	Control Byte							

Table 2.3 12-Byte CDB basic format

Byte \ Bit	7	6	5	4	3	2	1	0
0	Operation Code							
1	Reserved			0	0	0	0	0
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Transfer Data Length (MSB)							
7	Transfer Data Length (LSB)							
8	Transfer Data Length (MSB)							
9	Transfer Data Length (LSB)							
10	0	0	0	0	0	0	0	0
11	Control Byte							

The meanings of each of the fields in the CDB are explained below. Depending on the type of command, the basic format of the CDB and the definition and meaning of a field may differ. Details are described in the specifications for individual commands in Chapter 4.

(1) Operation code

Table 2.4 Operation code

Bit 7	6	5	4	3	2	1	0
Group Code			Command Code				

The top byte of all CDBs shows the format and type of command that is being executed.

a. Group code

The group code decides the number of bytes in the CDB and its format. The IDD uses the commands of the groups shown below.

Group 0 (“000”): 6-byte CDB (Shown in Figure 2.1)

Group 1 (“001”): 10-byte CDB (Shown in Figure 2.2)

Group 2 ("010"): 10-byte CDB (Shown in Figure 2.2)

Group 3 ("011"): Reserved Operation Code (Shown in Section (6))

Group 4 ("100"): 16-byte CDB

Group 5 ("101"): 12-byte CDB (Shown in Section 2.3)

b. Command code

The command code specifies the type of command in each group.

(2) LUN (Logical Unit Number)

This IDD operates only by "0", defined in the FCP_CMND frame. Concerning INQUIRY, this limitation does not apply.

(3) Logical block address

This field shows the top logical data block address of the data block group on the disk medium that is to be processed by the command. In a Group 0 CDB, 21-bit block addressing can be used, and in a Group 1, Group 2 or Group 5 CDB, 32-bit block addressing can be used. Standards for logical data block addressing in the IDD are described in Section 2.8.

(4) Transfer data length

This field specifies the length of data to be transferred between the INIT and the TARG by execution of the command, either as the number of logical data blocks or the number of bytes. In subsequent descriptions, the former is called the "Number of Transfer Blocks" and the latter is called the "Transfer Byte Length" or the "Parameter List Length".

Furthermore, depending on the command, use of this field can have other meanings, or no meaning at all. There are also some commands which allocate 3 or more bytes as the transfer data length field. Detailed standards concerning these commands, are described in the specifications for individual commands in Chapter 4.

a. Transfer block count

When the "Transfer Data Length" field is specified as the "Number of Transfer Blocks", this field specifies the number of logical data blocks transferred between the INIT and IDD.

In a command with a 1-byte length, if the value specified in this field is zero, it is regarded that 256 blocks have been specified, and specification in a range of from 1 to 256 blocks is possible. On the other hand, in a command with a 2-byte length, when the value specified in this field is zero, data transfer is not executed. Specification in a range of from 0 to 65,535 blocks is possible.

b. Transfer byte length or parameter list length

When the transfer data length is specified as the “Transfer Byte Length” or “Parameter List Length”, this field specifies the length of the data transferred between the INIT and IDD by that command in number of bytes. When zero is specified in this field, data transfer is not executed, except in cases where it is particularly stipulated in the specifications for individual commands in Chapter 4.

In commands which send the parameters which are necessary for command execution are sent from the INIT to the IDD, this field is called “Parameter List Length” and specifies the total number of bytes of the parameter list sent by the INIT.

On the other hand, with commands which receive information from the IDD (REQUEST SENSE, INQUIRY, etc.), it is called “Transfer Byte Length” and specifies the maximum number of bytes that can be received from the INIT (the number of bytes in the area secured in the INIT for receiving information). The IDD transfers either the number of effective bytes of information specified by the command or the value specified in the “Transfer Byte Length”, whichever value has the smaller number of bytes.

(5) Control byte

Table 2.5 Control byte

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

a. Bits 7, 6 (vendor unique)

The values specified in these bits have no meaning except in cases where it is specified in individual commands, and the IDD disregards the specified values.

IMPORTANT

It is possible to use bit 7 and bit 6 of the control byte as an inherent control field in future product specifications. It is recommended that the INIT specify zero in this field.

b. Bits 5, 4, 3

These should always be set on “0”.

c. Bit 2 (ACA)

This IDD does not support ACA, so this bit should be set on “0”.

d. Bit 1 (Flag)

This IDD does not support Flag, so this bit should be set on “0”.

e. Bit 0 (Link)

This IDD does not support Link, so this bit should be set on “0”.

(6) Handling an illegal CDB

If there are errors in the contents of a CDB description (specification), or if there is an error in the specification of a parameter transferred from the INIT in accordance with a CDB specification, that command ends with the CHECK CONDITION status. In the case of a command that changes data on the disk medium, when there is an error in the CDB specification, the disk medium is not changed by that command, but when there is an error in a parameter transferred in a DATA frame, the contents of the disk medium in the area specified in that command may be changed. Also, a DATA frame request may be executed after receiving a DATA frame, but those data are not used.

2.2 Status Byte

The format of the status byte and the types of status which the IDD supports are shown in Table 2.6.

The status byte is 1 byte of information in the STATUS frame which notifies the INIT from the TARG after a command is completed, and which shows the results of executing the command. Also, when an Input/Output operation request has been received, even if the TARG cannot execute the command, the status byte is reported. However, by forcibly interrupting execution by an abnormal state such as ABORT TASK SET, ABTS, CLEAR TASK SET, TARGET RESET, LIP (XY) or FC LOOP, if the command is cleared, the status byte for that command is not reported.

Table 2.6 Status

Status code	Status
00h	GOOD Status
02h	CHECK CONDITION Status
04h	CONDITION MET Status
08h	BUSY Status
10h	INTERMEDIATE Status
14h	INTERMEDIATE CONDITION MET Status
18h	RESERVATION CONFLICT Status
22h	COMMAND TERMINATED Status
28h	TASK SET FULL Status

(1) GOOD status

This status indicates that execution of the command ended normally.

(2) CHECK CONDITION status

This status is reported in the case of a)~c) below. The IDD generates sense data when this status is reported and displays the detailed cause. The IDD transfers the generated sense data together with this status report in the same FCP_RSP frame. Therefore, it is unnecessary to gather sense data using the REQUEST SENSE command.

a) If the sense key in the sense data shows RECOVERED ERROR [= 1], it shows that the last command, which resulted in the CHECK CONDITION status, ended normally in conjunction with error recovery processing by the IDD.

b) If the sense key in the sense data shows UNIT ATTENTION [= 6], it shows that the IDD is being kept in the Unit Attention state. For details of the Unit Attention state, see item 2.5.

c) Any cases other than the above indicate that it was impossible to execute the command or the command ended abnormally.

(3) CONDITION MET Status

Not supported.

(4) BUSY status

Not supported.

(5) INTERMEDIATE status

Not supported.

(6) INTERMEDIATE CONDITION MET Status

Not supported.

(7) RESERVATION CONFLICT status

This status indicates that the IDD is currently reserved by another INIT and use is impossible until the reservation status is released. Normally, an INIT that receives this status, reissues the original command after waiting for the appropriate period of time only.

(8) COMMAND TERMINATED status

Not supported.

(9) TASK SET FULL status

This status is reported when there is no empty space in the command queue and the IDD cannot register tagged commands it has received in the command queue.

2.3 Outline of Command Processing

2.3.1 Single commands

A diagram of processing of single commands, which are the most basic operations in the FC LOOP, is shown below.

a. Read processing

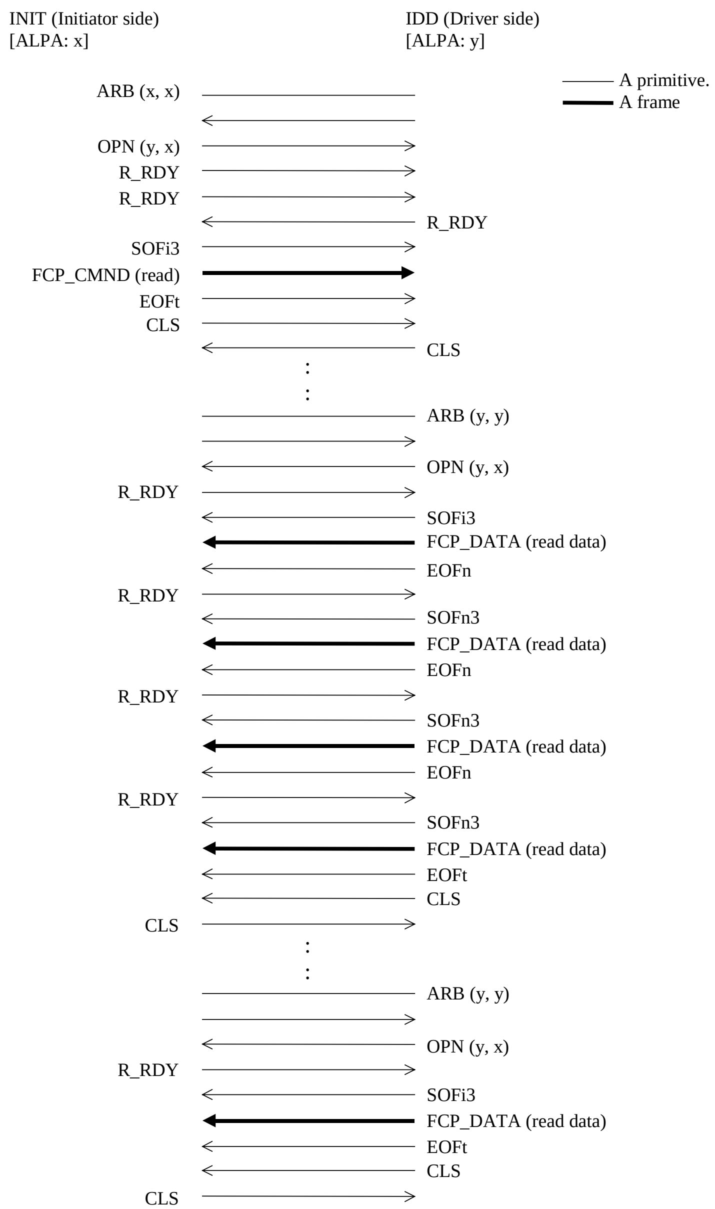


Figure 2.1 General read data transfer sequence

b. Write processing

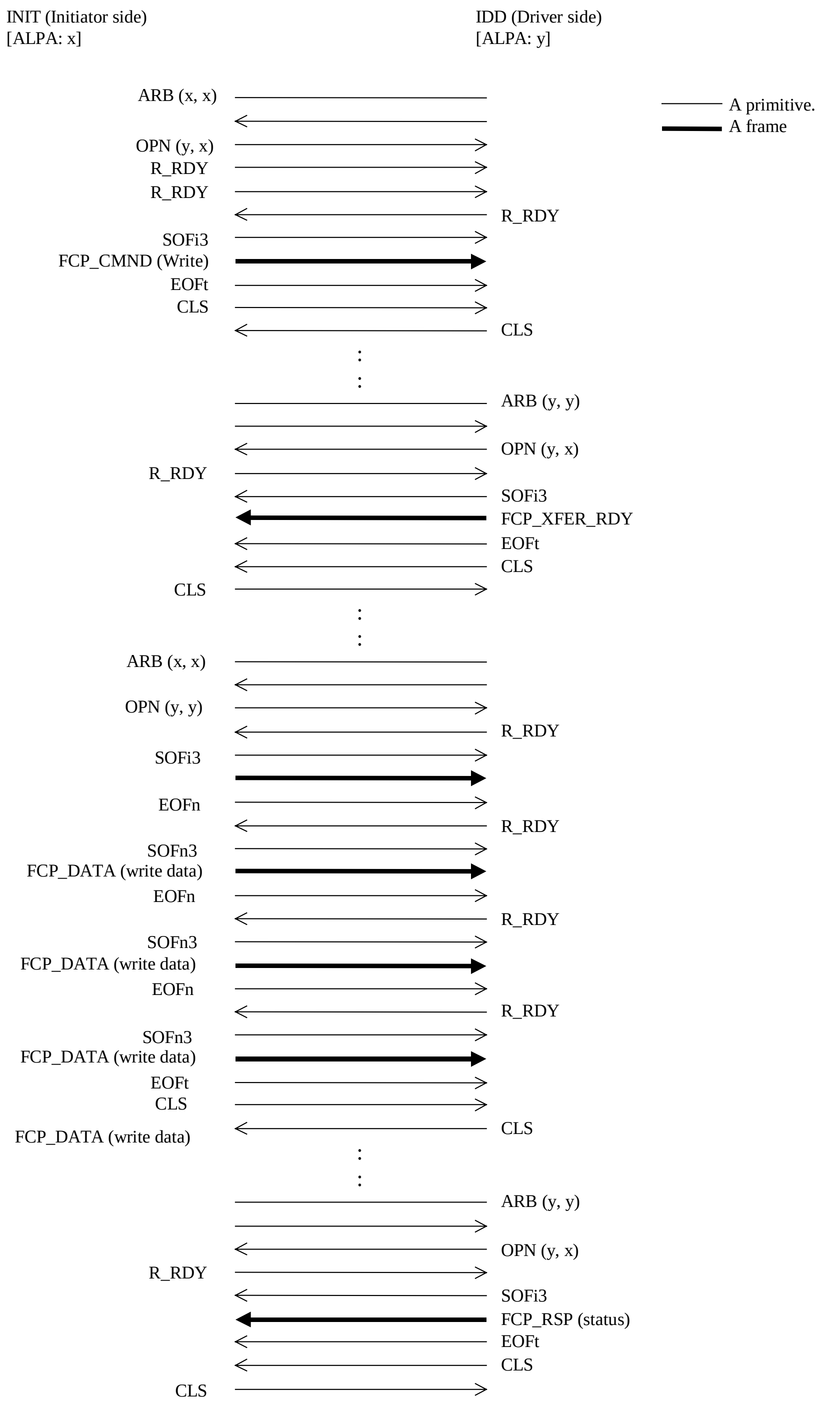


Figure 2.2 General write data transfer sequence

(1) Signal Interchanges on the FC Loop

a. Acquisition of loop use rights

The IDD performs arbitration with the other devices on the loop in order to use the loop. Arbitration is accomplished by setting its own ALPA in the ARB primitive and outputting it in the form ARB (ALPA, ALPA).

Other devices connected to the loop output the ARB primitive they have received as the CFW (Current Fill Word) as long as they have no requests.

If the ARB (ALPA, ALPA) travels around the loop and returns to the device which output it, then that device acquires the loop use rights.

b. Establishing connections with the destination device where data are to be transferred

A device which has acquired loop use rights outputs the OPN primitive to establish connections with the destination device where data are to be transferred.

Ordinarily, many of the OPN primitives that are used are of two types, Full Duplex Open and Half Duplex Open, and are distinguished by the ALPA which sets the OPN primitive.

Full Duplex Open: OPN (ALPD, ALPS)

ALPD = ALPA of destination device where data are to be transferred.

ALPS = ALPA of source device which is transferring data.

Half Duplex Open: OPN (ALPD, ALPD)

ALPD = ALPA of destination device where data are to be transferred.

ALPS = ALPA of source device which is transferring data.

This IDD responds to the OPN primitive when received by both Full and Half Duplex communications, the OPN primitive issued by this IDD is sent by Full Duplex Open communications.

The device that receives the OPN primitive sends the R_RDY primitive if there is allowance for storage of frames in its Buffer and informs the transfer source device that reception is possible.

If the transfer destination device cannot receive, it sends the CLS primitive. The transfer source device receives the CLS primitive, then it resends the CLS primitive and releases its loop use rights.

In the case of a device which uses Full Duplex Open, while connections are established, since it is possible to receive other frames from the transfer destination device, it can send the OPN primitive, followed by the R_RDY primitive to newly inform the source device that reception is possible and that data equal in volume to its buffer size can be output. (In the example, it shows that it is possible for it to receive 2 frames and outputs two R_RDY primitives.)

c. Frame transfer

The transfer source device, by receiving the R_RDY primitive, can judge that it is possible for the transfer destination device to receive frames, so, it can send frames.

Since one frame can be output for one R_RDY primitive, when wanting to send 2 or more frames, after 1 frame is sent, the transfer source device must wait until another R_RDY primitive is sent from the transfer destination device.

However, if the buffer is not empty and it is impossible for the transfer destination device to receive data, the CLS primitive is sent.

At this time, the CLS primitive is resent and loop use rights are released.

Furthermore, after this IDD receives a normal OPN primitive, it sends four R_RDY primitives (that is, it is possible for the transfer source device to send four frames).

A frame is sandwiched between a SOF (Start of Frame delimiter) primitive and an EOF (End of Frame delimiter) primitive.

The SOF primitives and EOF primitives supported by this IDD are as shown below.

– SOFi3: SOF of starting frame

– SOFn3: SOF of continuing frames

– EOFn: EOF of continuing frames

– EOFt: EOF of final frame

SOFi3	Frame	EOFt

SOFi3	Frame	EOFn	SOFn3	Frame	EOFt

SOFi3	Frame	EOFn	SOFn3	Frame	EOFn	SOFn3	Frame	EOFt

Figure 2.3 Combination of SOF and EOF primitives used for transferring frames

d. Disconnecting from the transfer destination device

When the transfer source device completes transfer of the frames it is sending, it sends the CLS primitive, disconnecting from the transfer destination device and releasing its loop use rights.

When the transfer destination device receives the CLS primitive, it resends it, returning the CLS primitive to the transfer source device.

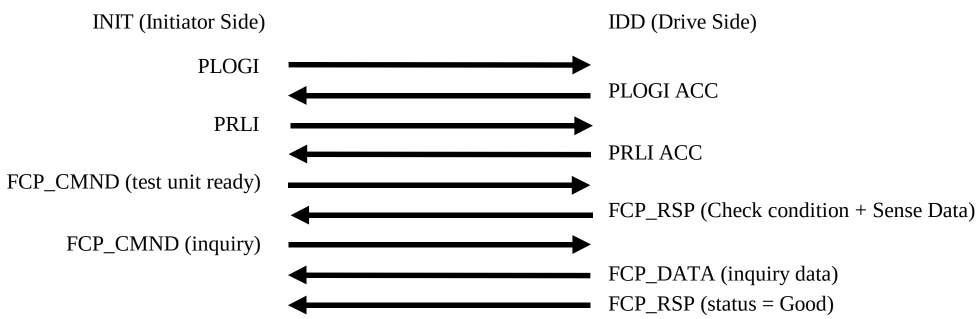
At this time, there is a lapse of time from the point when the frame is received until CLS primitive is received, so the R_RDY primitive may be sent to the transfer source device to the transfer destination device.

This R_RDY primitive is received by the transfer source device, but when the CLS primitive is returned to the transfer source device, it is destroyed as an invalid R_RDY primitive.

(2) Establishing Connections with the INIT and Command Execution

Even if this IDD receives a SCSI command after the power is turned on and loop initialization is completed, that command is not executed.

In order to execute a SCSI command, it is necessary to establish logical connections with the INIT. An example of that is shown below.



Remark. The primitives are omitted.

Figure 2.4 Example of establishing logical connections between the INIT and IDD

If connections are not established, operation is as follows.

PLOGI is not implemented:

The IDD responds with the LOGO (Extended Link Service) frame.

If PLOGI is already implemented, PRLI is not implemented:

The IDD responds with the PRLO (Extended Link Service) frame.

PRLI is implemented without implementing PLOGI: This combination should not exist.

Furthermore, this IDD supports connections with a maximum of 32 INITs (without relation to the port).

As for PLOGI of the 33th and subsequent INITs, the LS_RJT frame is sent as a response and notification to the effect that there are no internal resources for establishing connections is sent.

(3) Loop initialization after establishing connections with the INIT and subsequent processing

After connections between the INIT and IDD are established, if loop initialization occurs for any reason, SCSI commands which were being executed when loop initialization was carried out are aborted (however, if a command from a different port was being executed, it is not aborted).

After loop initialization is terminated, the IDD waits for approximately 2 seconds for connections with the INIT to be reestablished.

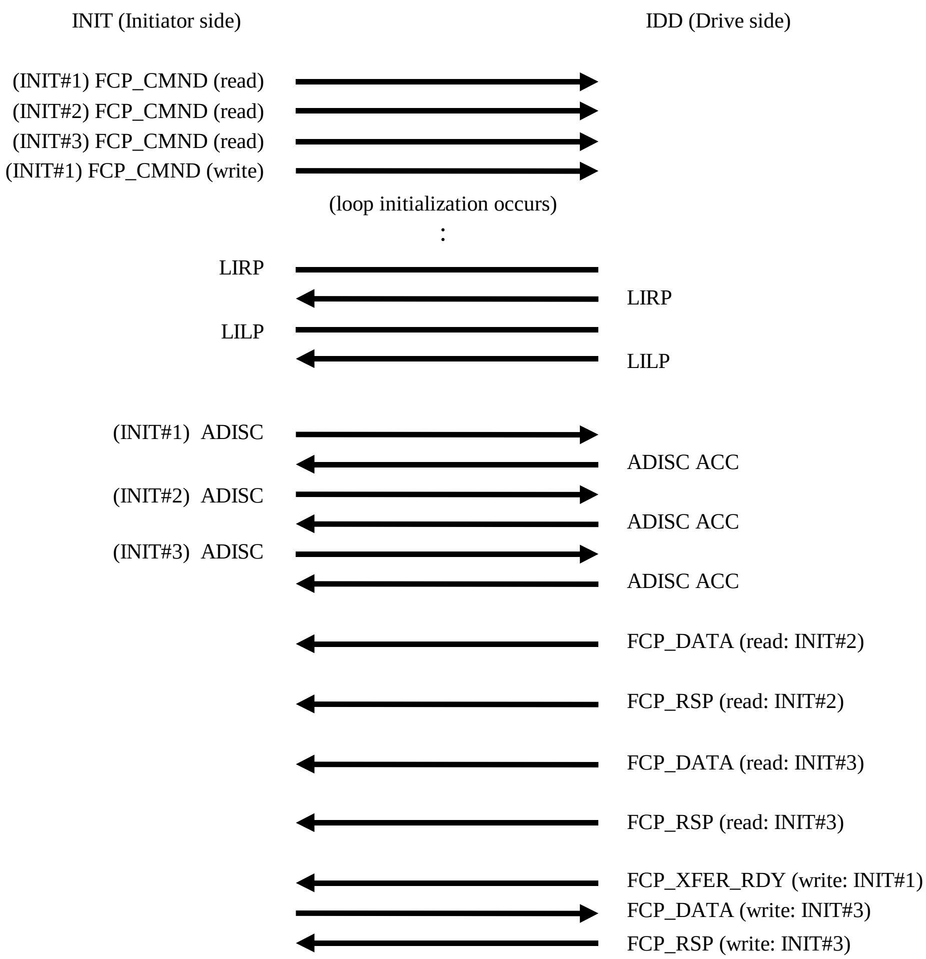
This period of time is for the purpose of confirming any changes that may have occurred to previously held ALPAs due to loop initialization.

Furthermore, if this time is exceeded, the IDD carries out an implicit logout and interrupts the connection with the INIT.

If the connection is interrupted, commands waiting in the queue are all aborted and no response is returned.

Also, the LOGO (Extended Link Service) frame is returned as a response to the SCSI command from the INIT.

An example of confirmation of connections that is performed by the INIT is shown below.



Remark: This example is described with the premise that the INIT#1 read command is aborted by loop initialization.

Figure 2.5 Loop initialization after establishing connections with the INIT, and subsequent processing

(4) Write related command operations

During write related command operations, before receiving of data, the INIT is notified in the FCP_XFER_RDY frame of the volume of data which the device can receive and the pointer for those data.

The volume of data which can be received is called the Burst length, and the data pointer is called the Relative Offset.

If multiple FCP_XFER_RDY frames are sent during 1 exchange, the Relative Offset is added to the Burst length, and is incremented continuously.

(5) Transfer of Odd-numbered Bytes

On the FC loop, since the smallest unit is 4 bytes, transfer of odd numbers of bytes cannot be done. For that reason, through the Fill Byte function, which defines bit 1 and bit 0 of the F_CTL field of the frame header, the effective data transferred is shown and odd-numbered bytes are transferred.

Operations when the Fill Byte is specified are shown below.

Table 2.7 Fill byte

bit 1	bit 0	Meaning
0	0	No filled byte.
0	1	1-byte fill is performed. Therefore, three bytes of effective data are transferred.
1	0	2-byte fill is performed. Therefore, two bytes of effective data are transferred.
1	1	3-byte fill is performed. Therefore, one byte of effective data is transferred.

2.3.2 Command link

Not supported.

2.4 Command Queuing Function

The IDD is equipped with the command queuing function. Through command queuing, the IDD can receive multiple commands in advance and can execute them.

For the queuing function, there are two methods, tagged and untagged. In tagged queuing, it is possible to receive multiple commands from each INIT.

2.4.1 Untagged queuing

Using untagged queuing, the IDD can receive a command from an INIT while it is executing processing of a command from another INIT. The IDD can receive one command at a time from each INIT. It is the role of the INIT to confirm that only one command is issued every time.

When the IDD receives a new command from an INIT, if it is processing another command from a different INIT, or if it is currently executing its initial self-diagnosis, that command is queued in the command queue. In this case, the IDD executes disconnect processing after command queuing processing is completed.

After the IDD finishes executing the current processing command, if there is a command in the queue, it fetches that command and executes it. If there are multiple commands in the queue, they are fetched and executed in the order in which they were received.

When a command is in the queued state, if an IDD receives LIP (YX), or if the IDD receives a TARGET RESET message from any INIT, it clears all the commands in the queue. At this time, the IDD generates on UNIT ATTENTION condition for all the INITs.

Untagged queuing exception processing (events and operations executed by the IDD) is shown below.

- If the TEST UNIT READY, REQUEST SENSE or INQUIRY or Report LUN command is received.

  When one of these commands is received, if there is no link instruction in that command, the IDD executes that command immediately without queuing the command or executing disconnect processing. At this time, there is no effect on the commands from other INITs which are currently being executed, or on the commands in the queue.

- If the IDD is reserved

  If the IDD has been reserved by an INIT using the RESERVE command and receives a TEST UNIT READY command after that, when that command conflicts with the reserved state, it responds with a RESERVATION CONFLICT status. Commands after that are queued, and the reserved state is checked when a command is fetched from the queue. Conflicts with the reserved state are explained in the description of the RESERVE command (Section 4.1.11).

Note:

Through the operation of the command queuing function, except for exceptions described on this page, the IDD does not respond to commands issued by the INIT with a BUSY status. This function is applied under the multi-initiator environment, and overhead for re-issuing commands caused by the BUSY status is unnecessary. Normally, the INIT does not have to be aware of the existence of a queuing function, but it is necessary to exercise caution in the following items when controlling input/output processing.

1) When a command is queued, the time from the queuing of the command to its actual execution will vary depending on the commands already in the queue, or on the content of the processing currently being executed. Particularly in cases where the FORMAT UNIT command and START/STOP UNIT command (Immed = 0), and data access commands which specify large processing block counts, are already queued or being executed, the newly queued command will be forced to wait a long time until it is executed.

2) In the following cases, a command may not be executed even after it has been queued.

   a) When there is an error in the CDB, the IDD responds with a CHECK CONDITION status at the point when that command is fetched from the queue.

   b) If the IDD is in the not ready state at the point when the queued command is fetched, it responds with a CHECK CONDITION status.

   c) If a UNIT ATTENTION condition is generated before the queued command is fetched, a CHECK CONDITION status may be replied.

2.4.2 Tagged queuing

Through the tagged queuing function, the IDD can receive multiple commands from the same INIT or from different INITs until the command queue is full. The number of commands that can be received by the IDD is 128 per IDD, without relation to the INIT. When the IDD receives a new command, if the command queue is full, the new command is responded to with the TASK SET FULL status.

The IDD controls the command queue, but it is possible for the INIT to delete commands from the queue by adding a command. When adding a command to the queue, it is possible for the INIT to specify to the IDD the command execution sequence and the command to be executed next.

An inherent tag (OX_ID) is added to each exchange. As long as a single INIT has inherent OX_IDs for respective exchanges. It can issue multiple exchanges to the IDD.

So that an INIT does not issue duplicate tags (OX_ID) for each of the exchanges it issues, it is necessary to control the tags.

In the case of an ORDERED QUEUE, the IDD executes commands in the order in which they are received.

All the commands received with a SIMPLE QUEUE before commands received with an ORDERED QUEUE are executed before the commands received with an ORDERED QUEUE, without relation to the INIT.

Commands received with a HEAD OF QUEUE are registered at the top of the queue for waiting execution. The IDD does not interrupt the current command execution and executes them after completion of current command execution. When commands with the HEAD OF QUEUE are received continuously, the IDD first executes the command which was received last.

All commands received with a SIMPLE QUEUE after commands received with an ORDERED QUEUE are executed after the commands received with an ORDERED QUEUE.

A command received with a HEAD OF QUEUE is registered at the head of the execution queue and is executed when execution of the current command is completed. Processing of the command currently being executed is not interrupted.

When commands with a HEAD OF QUEUE are received continuously, the IDD executes the latest command to be received first.

The RESERVE, RELEASE, RESERVE EXTENDED and RELEASE EXTENDED commands should be issued together with an ORDERED QUEUE. If HEAD OF QUEUE is used with these commands, it may result in duplication of the previously issued command and the Reserve state.

The TEST UNIT READY and INQUIRY commands do not exert an influence on the IDD's state, so they can be issued together with a HEAD OF QUEUE.

The INIT can specify two recovery options by the QErr bit of the control mode parameter (Page A) of the Mode Select parameters, but this IDD does not support the QErr bit.

Reporting of commands for which deferred errors were previously terminated is done. Therefore, the queue tag values assigned to those commands are not reported.

Use ABORT TASK SET, ABTS, TARGET RESET or CLEAR TASK SET to clear some or all of the queued commands.

If “0001” is specified by the Queue algorithm modifier in the control mode page, the IDD performs reordering processing of commands with respect to commands issued together with the SIMPLE QUEUE. Reordering processing is performed with the purpose of reducing the total processing time in command processing.

- Conditions for Reordering:

  If commands which are objects of reordering are issued by an INIT which permits reordering together with a SIMPLE QUEUE.

- Commands which are Objects of Reordering:

  READ, READ EXTENDED, WRITE, WRITE EXTENDED

If the INIT permits command reordering processing, the IDD changes the command processing order. It is necessary for the INIT to control concerning the validity of data.

For details of the control mode page, see 4.1.5, "MODE SELECT EXTENDED (55)".

2.5 UNIT ATTENTION Condition

The Unit Attention condition is a function for notifying the INIT asynchronously of events (status changes) which occur in the TARG or logical unit.

2.5.1 Generation of the UNIT ATTENTION condition

Events which cause the Unit Attention condition to be generated are any of the following events.

(1) When a Power On, LIP (YX), PRLI or TARGET RESET occurs.

If the IDD is reset by a power on, LIP (YX), PRLI or TARGET RESET, regardless of whether the disk drive is in the ready state or not, the Unit Attention condition is generated to all the INITs.

(2) Mode parameters changed (if changed by another INIT)

If any of the following parameters specified by the MODE SELECT or MODE SELECT EXTENDED command are changed by any INIT, the Unit Attention conditions is generated toward all the INITs except the INIT that changed that parameter.

- Parameters related to the data format (block descriptor, page 3: format parameter, page 4: any drive parameter)
- Parameters related to the cache segment (page 8: Caching parameter, byte 13)
- Parameters related to command queuing (page A: control mode parameter, except the RLEC bit in byte 3)
- Micro code has been changed [=3F-d]

(3) Commands cleared by another INIT

If the following events have occurred, the command which is currently being executed and commands in the queue are cleared, and this Unit Attention condition is generated.

- The CLEAR TASK SET is issued by any INIT.

  However, the Unit Attention condition hold state is not entered in the INIT that issued the CLEAR TASK SET, the INIT that issued the MODE SELECT or MODE SELECT EXTENDED command or the INIT that canceled the sense hold state.

2.5.2 Response and release condition at UNIT ATTENTION condition hold state

A Unit Attention condition generated by the IDD due to the occurrence of one of the above-mentioned events is held for each INIT individually, and this condition is held until the Unit Attention condition is cleared by an INIT which is the object of the hold issues the commands specified below.

When the IDD is holding the Unit Attention condition, if it receives a command from an INIT which is the object of the hold, one of the operations below, depending on the type of command issued, is performed by the IDD.

(1) Commands other than the INQUIRY and REQUEST SENSE commands

The IDD reports the CHECK CONDITION status in response to the issued command. Through the CHECK CONDITION status report, the Unit Attention condition with respect to that INIT is cleared. The sense key for the sense data generated at this time is UNIT ATTENTION [= 6] and the sense code shows the event which generated the Unit Attention condition, as shown below.

- Power on [=29-01]
- TARGET RESET [=29-03]
- Mode parameters changed [=2A-01]
- Commands cleared by another INIT [=2F-00]
- Micro code has been change [=3F-01]

However, if the IDD responds with a TASK SET FULL because the issued command is not received, the Unit Attention condition is not cleared.

(2) INQUIRY command

The INQUIRY command is executed normally, but the Unit Attention condition is not cleared.

(3) REQUEST SENSE command

The IDD executes the REQUEST SENSE command normally, and sends the sense data which show the Unit Attention condition which is currently being held to the INIT. At this time, the Unit Attention condition with respect to that INIT is cleared.

(4) REPORT LUN command

The REPORT LUN command is executed normally, but the Unit Attention condition is not cleared.

2.5.3 UNIT ATTENTION condition multiple hold

If any Unit Attention condition occurs and another Unit Attention condition occurs which is caused by other factors before the first Unit Attention condition is cleared by the INIT for which that condition is held, those multiple Unit Attention conditions are held and the IDD reports multiple unit attention conditions in sequence.

2.6 Sense Data Hold State

If the status is the Check Condition status when the status is reported, this IDD adds that sense data to the response frame and notifies the INIT of it.

Therefore, the sense data hold state does not occur and the CA status does not occur.

The function which reports sense data automatically is called the Auto Sense function.

This IDD operates with the Auto Sense function activated at all times and this function cannot be deactivated. Also, since this IDD does not support ACA, it does not enter the ACA state.

2.7 Command Processing Exceptions

2.7.1 Overlapping commands

The IDD recognizes when overlapping commands have occurred when the following conditions occur and terminates the commands abnormally.

a) If, while the IDD is executing a tagged command or is queuing it, the initiator that issued the command issues a tagged command with the same tag specified or a command without a tag before execution of the first command has been completed.

After execution of the command is completed, normally, the TARG notifies the INIT of its RESPONSE. Also, execution of a command is terminated by LIP, TARGET RESET, CLEAR TASK SET, ABORT TASK SET or ABTS.

The IDD terminates abnormally all commands (which are being executed or are being queued) which it has already received from an overlapping INIT and also terminates abnormally both the commands that caused the overlap, in the order described below.

1) If, during execution of a command received from an INIT, the IDD terminates execution of the command. If the command is still in the queue and has not yet been executed, the IDD clears that command.

2) The IDD reports the CHECK CONDITION status with for the command that caused the overlap. The sense data generated by the IDD at this time shows ABORTED COMMAND [= B]/Overlapped commands attempted [= 4E-00].

IMPORTANT

1) The INIT is permitted to sent an ABTS, ABORT TASK SET, CLEAR TASK SET or TARGET RESET command, specifying the logical unit in order to terminate processing of a command that is currently disconnecting. (Shown in item 2.7.6.)
2) Overlapped command specifications are applicable without dependence on the type of command that was issued second. For example, even if the command that was issued second is an INQUIRY or REQUEST SENSE command, the IDD reports the CHECK CONDITION status and terminates both commands abnormally.

2.7.2 Illegal LUN specification

The IDD supports only the logical unit number (LUN) LUN = 0. If a LUN other than this is specified, the IDD operates in one of the following ways, depending on the type of command that is issued at that time.

1) For an INQUIRY command, even if an invalid LUN is specified, the command is executed normally. However, byte 0 of the “Standard INQUIRY Data” transferred to the INIT by that command (the “Qualifier” field and the “Device Type Code” field) shows X‘7F’.

2) If an invalid LUN is specified for any command other than the INQUIRY command or the REQUEST SENSE command, that command is executed normally.

2.7.3 Reserved operation code

Group 7 command operation codes (X‘E0’ ~ X‘FF’) are reserved by Fujitsu. When any command which has these operation codes is issued, the IDD may not necessarily respond with the CHECK CONDITION status (ILLEGAL REQUEST [= 5] Invalid command operation code [= 20-00]).

The INIT must not issue commands which have these operation codes.

2.7.4 Command processing in the not ready state

If the initial self-diagnosis after the power is turned on is completed normally and the spindle motor reaches its rated speed, the IDD reads out the "System Information", such as information on MODE SELECT parameters or disk medium defects from the system space on the disk drive and initializes each type of control information. When this operation is completed, the IDD enters the Ready state. Furthermore, the Not Ready state is when the IDD is in either of the following states.

- When the spindle motor has not reached the rated speed.
- When a system information reading operation is not completed, or the IDD failed.

Also, in cases where initialization of the disk medium (formatting) did not terminate normally for any number of reasons, accessing of the data on the disk medium becomes impossible.

Below, the IDD’s processing and response to commands received in the case that it is in a not ready state, or in a state where initialization is incomplete are described. Furthermore, the spindle motor starting control method when the power is turned on can be selected by means of the setting information (motor start mode) given from the external, controlled so that it starts simultaneously when the power is turned on or by the START/STOP UNIT command.

(1) General response in not ready state

The IDD, except in cases where the received command corresponds to either of the commands in item 2.7.4 (2), reports the CHECK CONDITION status in response to that command. The sense data generated at this time show one of the conditions in Table 2.8, depending on the state of the IDD.

Table 2.8 Sense data in not ready state

IDD State	Sense Key	Sense Code
Spindle motor not rotating at normal speed.	NOT READY [=2]	Logical unit in Inprocess of Becoming ready. [=04-01]
Reading system information have not completed.	NOT READY [=2]	Logical unit not ready, Initializing cmd required. [=04-02]
Reading system information failed.	HARDWARE ERROR [=4]	Logical unit failed self-configuration [=4C-nn]

(2) Commands that can be executed even in the not ready state

The IDD can execute any of the following commands when they are received, even when in the Not Ready state.

- START/STOP UNIT command
- RESERVE command
- RELEASE command
- WRITE BUFFER command
- READ BUFFER command
- INQUIRY command
- REQUEST SENSE command: When the REQUEST SENSE command is executed normally and the IDD is in the sense data hold state, the sense data held at that time are transferred to the INIT. If not in the sense data hold state, sense data corresponding to the IDD's state at that time (See Table 2.10) are transferred to the INIT.
- REZERO UNIT command: If the direct drive's spindle motor has reached the rated speed, even if reading of system information failed, these commands are executed. When the spindle motor has not reached the rated speed, or if reading of system information is in progress, the IDD responds with the CHECK CONDITION status in the same way as in item 2.7.4 (1).

(3) Operation if formatting is not completed normally

While the FORMAT UNIT command is not being executed following a change of parameters related to data format with the MODE SELECT command, or if the operation terminates abnormally for any reason (for example, the power going off or a RESET condition) during FORMAT UNIT command execution, the data on the disk medium cannot be accessed normally. In this case, the IDD responds to disk medium access commands with the CHECK CONDITION status.

The sense data generated at this time show MEDIUM ERROR [= 3]/Medium format corrupted [=31 - 00] in the case of the former, and MEDIUM ERROR [= 3]/FORMAT command failed [=31-01]. In both cases, the IDD is restored to a usable condition by using the FORMAT UNIT command and reinitializing the disk medium.

2.7.5 Error recovery processing

When an error which it is possible to retry is detected in the IDD, the IDD attempts error recovery processing of the detected error during command execution.

The INIT can specify whether or not to report detailed parameters and successfully recovered errors related to error recovery processing using either the MODE SELECT or the MODE SELECT EXTENDED command. Also, by the INIT specifying those parameters, they can be saved in the system space on the disk medium and they can be changed temporarily without being saved. After the power is turned on, or after reset (LIP (XY) or TARGET RESET), the IDD reads out the saved parameters and initializes the error recovery processing procedure.

See Chapter 4, “Command Specifications” concerning details of the MODE SELECT and MODE SELECT EXTENDED commands.

An outline of the error recovery processing executed by the IDD is shown below.

(1) Recovery processing for errors on FC Loop

The IDD does not perform recovery processing for errors detected on the FC LOOP. When a major error related to the FC Loop is detected, the IDD may clear the command which is currently being executed.

(2) Recovery procedures for disk drive errors

The IDD executes error recovery processing like that shown in Table 2.9 for errors detected during data access on the disk medium. Caution is necessary when performing these recovery processing procedures, because they are accompanied by rotational delays for repositioning data blocks on the disk medium or by added command processing time due to initialization of the positioning control system, etc.

The INIT can control the number of retries by page 1 (Read/Write error recovery parameters), page 7 (Verify error recovery parameters) or page 21 (Additional error recovery parameters) of the MODE SELECT parameters, but during normal use, it is recommended that the default values specified by the IDD be used.

Table 2.9 Outline of disk drive error recovery processing

Item	Type of Error	Error Recovery Processing
1	Seek Error	Rezero (Return to Zero Cylinder), readjustment of positioning control system, and repositioning to the data block.
2	Uncorrectable Data Error	Reread
3	Correctable Data Error	Correct by ECC.

IMPORTANT

The start of execution timing for this automatic readjustment operation is ordinarily impossible for the INIT to predict. The automatic readjustment operation is performed when there is no command being executed or waiting in the queue, but execution of commands issued immediately after the IDD starts a readjustment operation is caused to wait until the readjustment operation is completed.

2.7.6 Reset processing

Reset measures which can be performed by the INIT on the FC Loop are as shown below.

- LIP
- TARGET RESET
- CLEAR TASK SET
- ABORT TASK SET
- ABTS

Table 2.10 Comparison between FC and SCSI about definition

Definition by FC	Definition by SCSI
LIP (YX)	Comparable to SRST
TARGET RESET	Bus Device Reset Message
CLEAR TASK SET	Clear Queue Message
ABORT TASK SET	Abort Queue Message
ABTS	Abort Tag Message

An outline of each processing operation is shown below.

(1) LIP

LIP is a primitive defined by FC-AL, and by this primitive appearing in multiple loops, the loop initialization sequence for ALPA acquisition is implemented.

Generally, there are 3 types of LIP.

1. LIP (F7, F7): LIP that is output when ALPA is not fixed.
2. LIP (ALPD, ALPS): LIP that is output when the ALPS (transmission source) desires to reset the ALPD (transmission destination) device.

3. LIP (F8, F7), LIP (F8, ALPS): LIP that is output when the device recognizes that the loop has been disconnected for some reason.

LIP can implement loop initialization of all FC devices connected on the same FC LOOP and can return the state of the loop to the normal state.

LIP (YX) initializes the only specific FC device (TARG) selected by the INIT to the same state as when the power is turned on. All commands which are currently being executed or which are queued are cleared and all connections with all connected INITs are broken.

Therefore, after issuing LIP (YX), it is always necessary to establish logical connections (PLOGI/PRLI).

(2) TARGET RESET

This processing is the same as the processing of SCSI equivalent messages, as can be understood from Table 2.10.

However, this processing is transferred to the IDD by the FCP_CMND frame, and after processing is completed, notification is made of completion by the FCP_RSP frame.

Figure 2.6 TARGET RESET outline sequence

TARGET RESET can be used to reset only the specific FC device (TARG) selected by the INIT, and can initialize it to the same state as when the TARG's power is turned on, but in a multi-initiator environment, it is necessary to exercise caution, because all the commands, including commands issued by other INITs, are cleared.

(3) CLEAR TASK SET

This processing is the same as the processing of SCSI equivalent messages, as can be understood from Table 2.10.

However, this processing is transferred to the IDD by the FCP_CMND frame, and after processing is completed, notification is made of completion by the FCP_RSP frame.

The operation sequence is the same as that in Figure 2.6.

CLEAR TASK SET clears all commands which are currently being executed or which are queued. The previously set environment and conditions such as the MODE SELECT parameters are not changed.

(4) ABORT TASK SET

This processing is the same as the processing of SCSI equivalent messages, as can be understood from Table 2.10.

However, this processing is transferred to the IDD by the FCP_CMND frame, and after processing is completed, notification is made of completion by the FCP_RSP frame.

The operation sequence is the same as that in Figure 2.6.

For an INIT which wants to clear only specific commands that it has issued, ABORT TASK SET or ABTS must be used. In this case, if that command is now being executed on the FC LOOP, the INIT sends ABORT TASK SET at the desired point. Either that or a tag is specified and ABTS is sent. In the case of ABORT TASK SET, only commands issued in the past (currently being executed or in the queue) in the logical unit specified at that time by the INIT which issued the ABORT TASK SET are cleared, and other commands are not influenced (however, exercise caution, because this IDD supports only LUN=0).

(5) ABTS

This processing is implemented by Basic Link Service.

If the OX_ID of the exchange you would like to abort is set in the ABTS header and transferred, if there are no errors in the header information, BA_ACC is sent as a response and if there are errors, BA_RJT is sent as a response.

Furthermore, ABTS is used to abort not only for SCSI commands but also to abort Extended Link Service.

When ABTS is received, since only the exchange specified by the ABTS is cleared, there is no influence on the other commands. Concerning commands which are cleared by this processing, no RESPONSE is reported.

In particular, if a command to write data to the disk medium which is currently being executed is cleared, the IDD aborts processing of that command as shown in Table 2.11. Stopping overlapped commands which are currently being executed (see 2.7.1) is accomplished by the same treatment. The INIT must investigate the command completion status, then if necessary, it must implement data recovery processing.

Table 2.11 Reset processing during write

Type of command	Halting process of command execution
WRITE WRITE EXTENDED WRITE AND VERIFY SEND DIAGNOSTIC (Write/Read Test) WRITE LONG WRITE SAME	Data blocks which are currently being written are processed normally, including the ECC portion, and execution of the command is terminated at the point when that processing is completed. Not all the data transferred from the INIT to the IDD will necessarily be written to the disk media.
FORMAT UNIT	At the point when processing of the data block that is currently being written (initialized) is completed, execution of the command is halted. Since the formatting results cannot be guaranteed for the entire disk surface, it is necessary for the INIT to reissue the command.
REASSIGN BLOCKS	At the point when processing of alternate blocks which are currently being assigned is completed, execution of the command is halted. Not all the alternate blocks specified for reassignment processing by the INIT will necessarily have been processed.
MODE SELECT MODE SELECT EXTENDED LOG SENSE (Specifying parameter save)	If a parameter save operation has already started, that command is executed until it is completed. However, since the INIT cannot judge whether the parameters have been saved or not, it is necessary for the INIT to confirm the status by the MODE SENSE command or the LOG SENSE command, or reissue the command.
SYNCHRONIZE CACHE	Data blocks which are currently being written are processed normally, including the ECC portion and the command is halted at the point when that processing is completed. Not all the data which is the write object will necessarily be written to the disk media.

2.7.7 Fatal hardware errors

(1) Self-diagnostic errors

If a fatal error was detected in the hardware through an initial self-diagnosis, off-line self-diagnosis or on-line self diagnosis (SEND DIAGNOSTIC Command), turning of the spindle motor is stopped.

When in this state, the IDD reports the CHECK CONDITION status for all Input/Output operation requests except the REQUEST SENSE command. The sense data reported at this time shows HARDWARE ERROR [=4]/Diagnostic failure on component “nn” [= 40-nn]. It is necessary for the INIT to generate a RESET condition or sent a TARGET RESET and attempt recovery of the error state. The recommended procedure for error recovery is explained in 5.2, “INIT Error Recovery Methods (Recommended)”.

See the SEND DIAGNOSTIC Command and RECEIVE DIAGNOSTIC RESULT Command concerning the self-diagnosis function.

(2) Unrecoverable hardware errors

Limited to cases in which a fatal hardware error occurs during execution of a command, and termination processing such as a CHECK CONDITION status report cannot be executed, the IDD may halt rotation of the spindle motor.

After this state occurs, the IDD reports the CHECK CONDITION status for all input/output operation requests except the REQUEST SENSE command. The sense data reported at this time indicate HARDWARE ERROR [=4] / Internal target failure [=44-nn]. For recommended procedures for error recovery methods, see the explanation in Section 5.2 “INIT's Error Recovery Methods (Recommended)”.

2.8 Data Block Addressing

2.8.1 Definition of data space

The IDD divides the data storage area on the disk drive into the following two types of data area and controls them as such.

- User space: user data storage area
- System space: IDD exclusive area

Of these two types, the use can clearly gain access to the user space. This space has the same data formatting and defect control methods and it is possible to access it by logical data block addressing, as described in item 2.8.2. The system space is accessed when the power is turned on, or during processing of specific commands, but the user cannot access it directly.

Figure 2.7 shows the configuration of data space on the disk drive. The number of cylinders allocated to user space can be specified by the user (by the MODE SELECT or MODE SELECT EXTENDED command).

A spare sector area (replacement area) is assured in the user space for replacement of defective sectors. The user can (using the MODE SELECT or MODE SELECT EXTENDED command), allocate several sectors in the final track of each cylinder and several cylinders (replacement cylinders) inside the user space (replacement cylinders) as the replacement area.

For defective sectors on the disk medium, through IDD internal defect management, data blocks for replacement are assigned in defective sector units. Through this defect management, the INIT can regard all the logical data blocks in the user space as error free and can access them.

For details concerning the data format on the disk medium (cylinder configuration, track format and sector format) as well as details on defect management methods and replacement block assignment methods, see Chapter 3, “Data Format” in the “Product Manual”. Also, see Chapter 6, “Management of the Disk Medium”, for an outline of defect management methods.

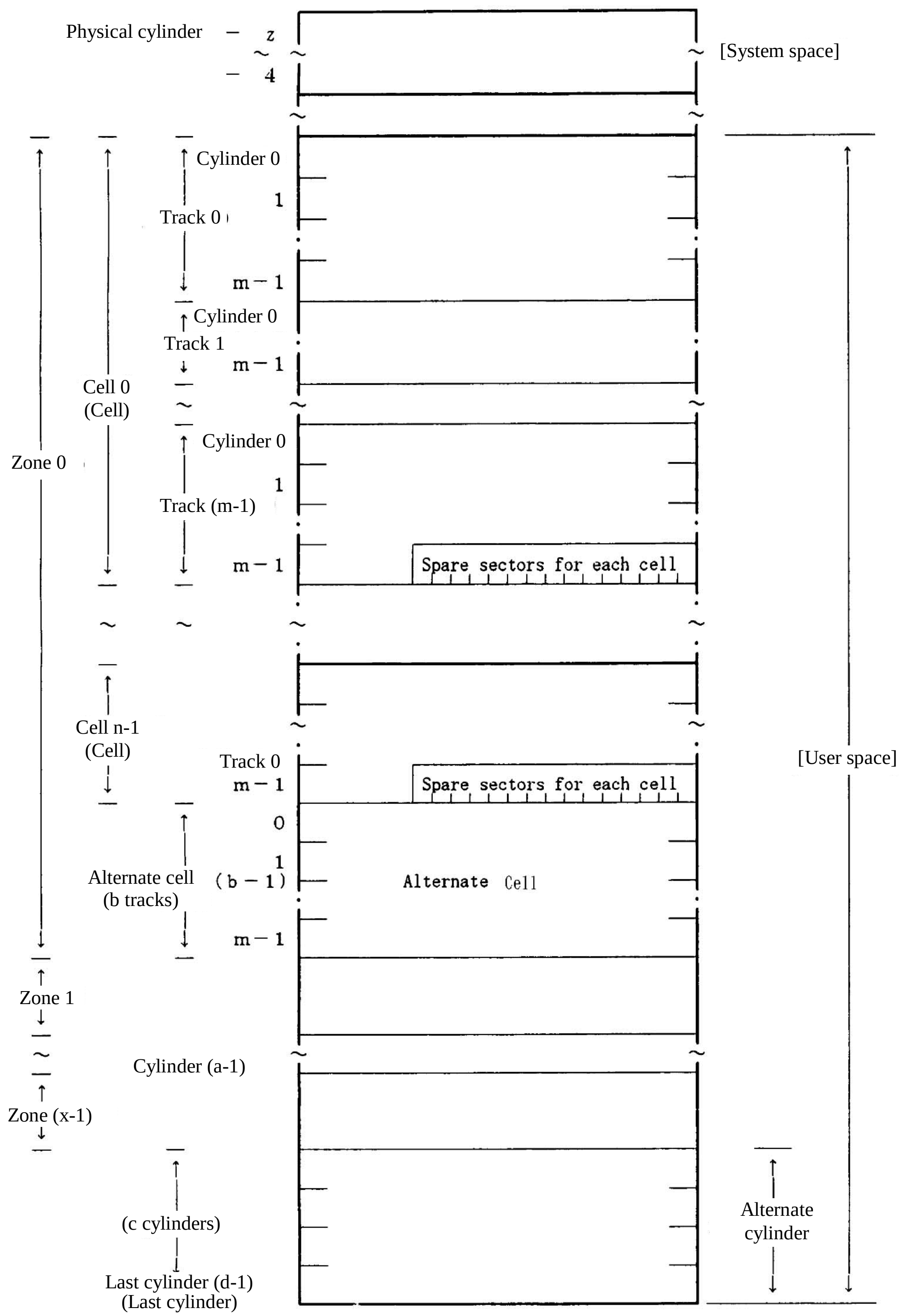


Figure 2.7 Data space configuration

2.8.2 Logical block addressing

The IDD uses logical data block addressing which is not dependent on the disk drive's physical structure as the method of data access on the disk medium. The IDD makes correspondence between each physical sector and each logical data clock address during formatting. Access to the data on the disk medium is performed in logical data block units and the INIT specifies the logical data block address that is its object during access.

In logical data block addressing, specifying of a data block address is a function which specifies 2 continuous binary numbers for each drive. Furthermore, the INIT can know the logical data block address range in the user space where specification is possible using the READ CAPACITY command.

(1) User space logical block addresses

The top data block in the user space is made logical data block address "0," then continuous logical data block addresses are allocated to each data block until the last data block in the user space.

The IDD makes cylinder 0, track 0, and sector 0 the top logical data block, and allocates subsequent logical data blocks in the order described below to addresses in ascending order.

1) Within the same track, logical data blocks are allocated to sector numbers in ascending order.

2) Within the same head of the same cell, succeeding logical data blocks are allocated to the sectors in each track according to 1) in the ascending order of cylinder numbers.

3) Within the next head of the same cell, succeeding logical data blocks are allocated to the sectors in each track according to 1) and 2) in the ascending order of track numbers.

4) On the last track inside the same cell, succeeding logical data blocks are allocated to sectors except for spare sectors according to 1).

5) After all the allocation in 1) to 4) is completed within the same cell, succeeding logical data blocks are allocated to the next cell beginning with track 0, according to 1) to 3), and so on to each cell number in ascending order until the last cell in each zone (refer to alternate cell b-1 in Figure 1.5) in the user space, with the exception of alternate cells.

(2) Alternate area

The alternate area in user space (spare sectors within each cell and alternate cells) are excluded from the abovementioned logical data block addresses. Access to allocated sectors as alternate blocks within the alternate area is performed automatically by the IDD's defect management (sector slip processing and alternate block processing), so it is not particularly necessary for the user to access the alternate area. Also, data blocks in the alternate area cannot be clearly specified and accessed directly.

2.8.3 Variable TPI/BPI

The IDD selects a possible combination of TPI (tracks per inch) types per head and BPI types per head × zone from the following ranges:

TPI: Seven types within a range defined by the maximum value - 20%

BPI: Eight types within a range defined by the standard value ±10%

Up to four TPI types can be selected in a single device. Only the required BPI types can be selected (determined by factory settings).

Accordingly, in an area in which TPI and BPI differ, the number of cylinders in the user space, the number of cylinders in a cell, and the number of sectors in a track vary according to the head.

Basic device capacity:

The basic capacity of a device is defined as its maximum TPI - 3.3% (29 cylinders per cell) + standard BPI. This basic device capacity is guaranteed for any combination of TPI and BPI.

Basic device performance:

The performance of a device is defined as its maximum TPI (30 cylinders per cell) + standard - 3.3% BPI. Devices with other combinations of TPI and BPI also satisfy this basic performance value.

CHAPTER 3 Data Buffer Management

In this chapter, the configuration of the data buffer with which the IDD is equipped, its operation and the operation of the cache feature are described.

3.1 Data Buffer

3.1.1 Data buffer configuration and basic operation

The IDD is equipped with a 6,797 KB data buffer, which makes it possible to efficiently execute data transfer operations between INIT (initiator) and a disk drive.

The IDD divides data buffer into 64 Pages, which are minimum allocation size for Cache. Actually two or more Pages are linked and a Cache Segment is constructed per the requested data size from INIT.

Since IDD automatically controls the best suitable Cache Segment, INIT cannot be changed neither the Page size nor the Segment size.

Each data buffer is a 2 ports of FIFO (First-In First-Out) ring buffer, with one port allocated for transfers with the disk media and the other port for data transfers with the FC interface. Mutual ports operate asynchronously and since it is possible to efficiently absorb variations in data transfer speed between the ports, the INIT can perform data transfer operations with the IDD while being virtually unaware of differences between the FC interface data transfer rate and the disk drive data transfer rate.

Even if the data transfer capacity of the FC interface (INIT) is lower than the disk drive's data transfer rate, the data buffer can perform data transfers to the system under optimum conditions without using sector interleave. Also, if the data transfer capacity of the FC interface (INIT) is higher than the disk drive's data transfer rate, it is possible to minimize the occupancy time on the FC Loop by accumulating an appropriate amount of data in the data buffer.

Only one cache segment of the divided data buffer is used by one command and the data in the other cache segments are held.

Figure 3.1 shows the data buffer image.

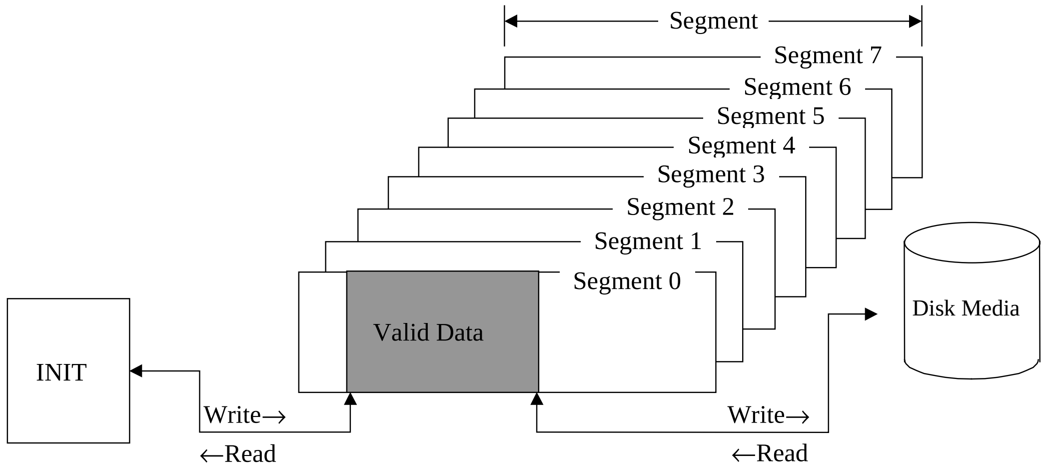


Figure 3.1 Data buffer configuration (in the case of 8 cache segments)

The basic functions and operations of the data buffer in a read operation and a write operation are shown below.

(1) Read operation

Data read from the disk media are temporarily stored in the data buffer. Then, they are transferred to the FC interface with the timing specified in the MODE SELECT parameter. The basic read operation procedure is as shown below.

1) When the IDD receives a command, normally, it disconnects from the FC interface through disconnect processing and locates the data block specified by the command where it is stored on the disk media.

2) When the target data block has been located, the IDD reads the data form the disk media to the data buffer. At this time, if a recoverable error is detected, the IDD performs error recovery processing according to the specification in the MODE SELECT parameter or corrects the data in the data buffer.

3) When the IDD has read the amount of data specified by the buffer full ratio in the MODE SELECT parameter (see Section 3.1.2) to the data buffer, it performs reconnection processing with the FC interface and begins transferring data to the INIT (FC interface) from the data buffer while continuing to read subsequent data blocks to the data buffer.

4) If the data transfer capacity of the INIT (FC interface) is high and the data buffer becomes empty before completing transfer of the number of data blocks specified by the command, the IDD performs disconnect processing at that point. Thereafter, Loop OPEN, data transfer and Loop CLOSE (the operations in 3) and 4) above) are repeated until all the data blocks specified in the command have been transferred.

5) If the number of blocks specified in the command to be transferred is larger than the capacity of a cache segment and if the data transfer rate of the INIT is lower than the data transfer rate of the disk drive, the empty space in the data buffer disappears from step 3) and the IDD may soon not be able to read data from the disk media (data overrun). In this case, the IDD relocates the block that caused the data overrun after waiting one disk revolution, and continues the reading process.

6) When transfer of all the specified data is completed, the IDD reports the status and terminates the command.

IMPORTANT

In order to avoid frequent repetition of the Loop CLOSE/OPEN processing after data frame transfer starts on the FC interface, and avoid the occurrence of data overruns, it is necessary to set the buffer full ratio (see Section 3.1.2) of the MODE SELECT parameter so the difference in the data transfer rates between the INIT (FC interface) and the disk drive is maintained in a good balance.

Figure 3.2 shows an example of the data buffer operating state during a read operation. Details are explained in Section 3.1.2.

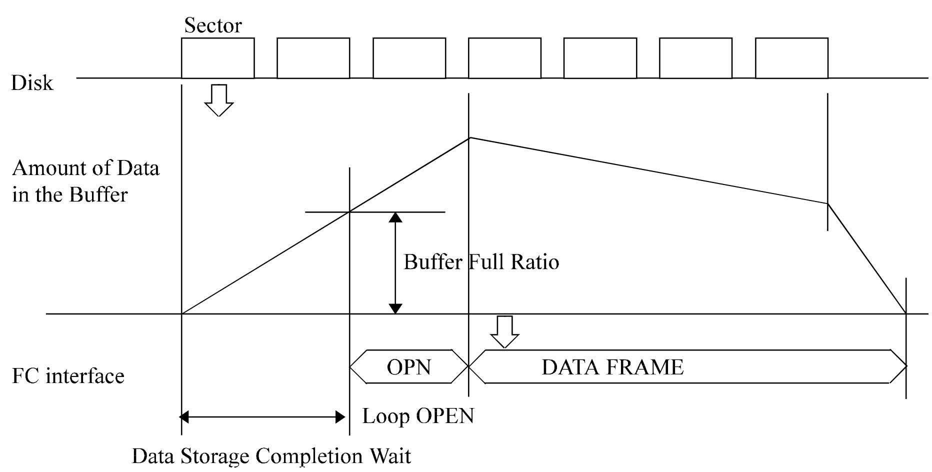


Figure 3.2 Example of data buffer operation during read

(2) Write operation

After data transferred from the INIT are stored temporarily in the data buffer, they are written to the disk media. The basic write operation procedure is as shown below.

1) When the IDD receives a command, it transfers the XFER_RDY flame to INIT. Later it stores data transferred from the INIT to the data buffer (data pre-fetch). At this time, the IDD locates the position of the data block on the disk media specified by the command in parallel.

   When storing of all the size of data specified in the XFER_RDY flame in the data buffer is completed, the IDD performs Loop CLOSE processing.

2) When locating of the target data block on the disk media is completed, the IDD writes the data in the data buffer to the disk media. If the target data block location operation is completed during the data pre-fetch processing in 1), writing of data to the disk media is performed in parallel with the data pre-fetch to the data buffer.

3) If the data transfer rate of the INIT (FC interface) is lower than the data transfer rate of the disk drive, since the data pre-fetch of data that are to be written to that data block is not completed, it may not be possible to write the data continuously to the disk (data underrun). In this case, the IDD waits one disk revolution while continuing to pre-fetch data from the INIT, then repositions the block that caused the data underrun and continues the writing of data to the disk.

4) If all the blocks of data specified in the command have not yet been transferred from the INIT, as writing of data to the disk media progresses, at the point when the empty space in the data buffer reaches the amount specified in the buffer empty ratio in the MODE SELECT parameter, the IDD performs Loop OPEN processing and begins transferring the succeeding data (data pre-fetch) after it transfers the XFER_RDY frame.

   Writing of data to the disk media is performed in parallel and data transfer with the INIT continues until the empty space in the data buffer is full or until transfer of all the data specified in the command is completed. From then on, the XFER_RDY data receiving are repeated until transfer of all the blocks of data specified in the command is completed.

5) When writing of all the specified data is completed, the IDD reports the status and terminates the command.

IMPORTANT

1) If the amount of transfer data specified in a command is smaller than the capacity of the cache segment, all the data necessary for execution of the command are pre-fetched in a batch in the processing in 1) above, so the value specified in the buffer empty ratio has not meaning.
2) If the amount of data processed with a single command exceeds the capacity of one cache segment, in order to avoid frequent repetition of Loop OPEN/CLOSE processing during command execution, and in order to escape the occurrence of data underrun, it is necessary to set the buffer empty ratio (see Section 3.1.2) of the MODE SELECT parameter so the difference in the data transfer rates between the INIT (FC interface) and the disk drive is maintained in a good balance.

Figure 3.3 shows an example of the data buffer operating state during a write operation. Details are explained in section 3.1.2.

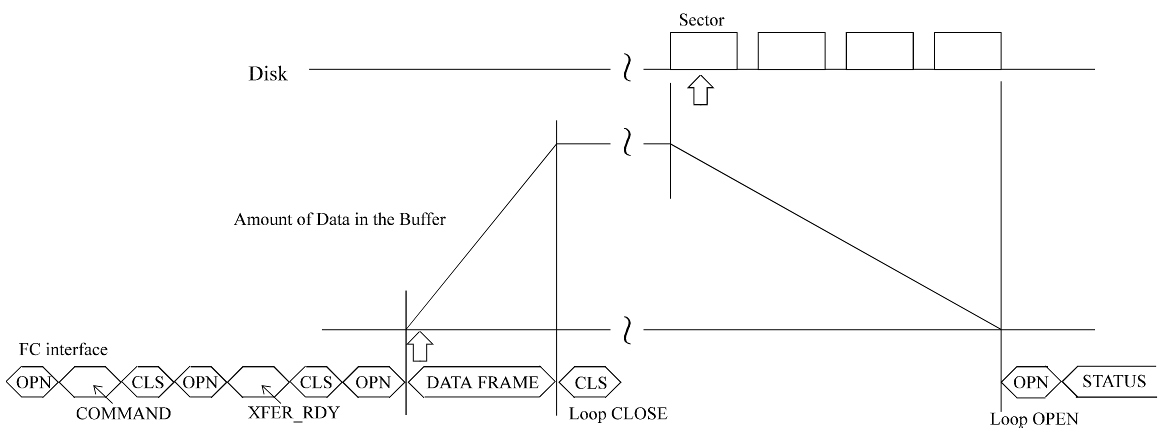


Figure 3.3 Example of data buffer operation during write

3.1.2 Operation mode setting

(1) MODE SELECT parameter

In order to make it possible to control from the INIT the Loop OPEN processing start timing for executing data transfers to the FC interface in read and write operations, the IDD is provided with the MODE SELECT parameter (Disconnect/Reconnect Parameter: Page code = 2) shown in Table3.1. The user can set the optimum operating state in the system environment as necessary. See Section 4.1.4 for details of the MODE SELECT command.

Table 3.1 Parameters for controlling reconnection timing

[Disconnect/Reconnect Parameter (Page code = 2)]

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	1	0
1	X‘0E’ (Page Length)							
2	Buffer Full Ratio							
	Default Value: X‘00’ Variable Range: X‘00’ to X‘FF’							
3	Buffer Empty Ratio							
	Default Value: X‘00’ Variable Range: X‘00’ to X‘FF’							
4	(Other parameters)							
~								
15								

a. Buffer full ratio

This parameter specifies the timing for the IDD to open the loop to perform data transfer to the INIT in a READ or READ EXTENDED command.

The value specified in this parameter (n) shows the amount of data read to the IDD's data buffer from the disk media as a proportion [n/256] of the total capacity of the data buffer until reconnection processing with the FC Interface is started.

If it is possible to transfer the amount of data specified in this parameter to the INIT from the data buffer, Loop OPEN processing is executed and transfer of data to the INIT begins. However, if the total amount of transfer data specified in the command does not fill the capacity of the cache segment, the IDD executes Loop OPEN processing and begins transferring data to the INIT when it becomes possible to transfer the amount of data blocks from the data buffer which is equivalent to the proportion of the total volume of transfer data blocks specified in the command that is specified by this parameter.

For example, if a read operation of 16 blocks with a logical data block length of 512 bytes (8 Kbytes) is requested, when the value specified in this parameter is 32, Loop OPEN processing is performed when it becomes possible to transfer 2 blocks of data [16 x (32/256)], from the data buffer.

b. Buffer empty ratio

This parameter specifies the timing for the IDD to start Loop OPEN processing when it is requested by the INIT to transfer data in the WRITE, WRITE EXTENDED or WRITE AND VERIFY command. In a write operation, after the IDD receives a command, the IDD begins transferring data (data pre-fetch) while locating the position of the target data blocks on the disk media in parallel. Therefore, if the total number of bytes of data specified in the command is less than the capacity of a cache segment, all the data are pre-fetched in a batch, so the specification in this parameter is not applied.

The value specified in this parameter (n) indicates a proportion of the total data buffer capacity of the IDD when the buffer is empty [n/256].

While the IDD is writing data to the disk media, it is using the data pre-fetched to the data buffer in order and when the empty space in the data buffer reaches the amount specified in this parameter, it executes reconnection processing, requesting transfer of the succeeding data. However, if the number of data blocks remaining to be transferred according to the command being executed does not reach the amount of data specified in this parameter, the IDD executes Loop OPEN processing at the point when the number of data blocks remaining in the data buffer's empty space reaches the specified number of data blocks and requests transfer of the succeeding data.

Note:

If the value specified for the "buffer full ratio" or the "buffer empty ratio" is not within double the integral boundary of the logical data block length, the IDD rounds up the specified value which is the nearest data block boundary. Also, if zero is specified in any of these parameters, the IDD treats that parameter as though 1 logical data block has been specified.

3.2 Look-Ahead Cache Feature

In order to use the data buffer more effectively and improve the disk drive's effective access speed, the IDD is equipped with a simple cache feature called a "Look-Ahead Cache Feature." The Look-Ahead cache feature is an effective, simple cache function for an INIT which reads data block groups on the disk media sequentially using multiple commands.

3.2.1 Caching operation

When the IDD is executing a READ command or a READ EXTENDED command, it reads the requested data from the disk media and transfers it to the INIT while at the same time reading (looking ahead at) data blocks which are subsequent to the last logical data block specified in that command to the data buffer. Then, when a READ command or READ EXTENDED command issued later specifies any of those Look-Ahead data blocks, the IDD transfers those data directly to the INIT from the data buffer without accessing the disk media. In this way, when continuous logical data block groups are read sequentially by multiple commands, mechanical access operations can be eliminated and effective access time greatly reduced.

An INIT can prohibit the operation of this Look-Ahead cache feature by setting the caching parameter described in section 3.2.2.

(1) Caching object commands

Commands which execute caching operations are the commands shown below:

- READ
- READ EXTENDED

If all the data block groups which are objects of the processing specified in these commands, or a portion of the data blocks, including the top logical data block specified in these commands are relevant data (See item (2)) for caching in the data buffer (if they hit), when the IDD receives a command, it immediately opens the loop and sends the data on the data buffer which can be transferred to the INIT. The caching operation can be disabled by the FUA bit of the READ EXTENDED command. If "1" is specified in the FUA bit, the IDD reads data from the disk media.

On the other hand, if the top logical data block specified in a command is not relevant data for caching in the data buffer (if they miss), reading of data is performed from the disk media using the old cache segment.

(2) Data which are objects of caching

Data which exist in the data buffer and which are objects of caching in item (1) (data which are not accessed from the disk media but are transferred to the INIT from the data buffer) are as described below.

a) Data read by a READ or a READ EXTENDED command and which have been read to the data buffer by Look-Ahead are data which are objects of caching. Depending on the timing for halting Look-Ahead, it is possible that data read by the READ command will be overwritten by Look-Ahead.

b) Data which have been hit by the READ or READ EXTENDED command and transferred to the INIT once are also objects of caching as long as they are not invalidated.

c) Data transferred from the INIT and written to the disk media by the WRITE and WRITE EXTENDED, command are objects of caching.

d) Data transferred from the INIT and written to the disk media by WRITE AND VERIFY command is not the objects of caching.

(3) Disabling caching data

Various data which are objects of caching in the data buffer are disabled in the following cases.

a) If any of the following commands is issued for the same data block as data which are the object of caching, that data block ceases to be an object of caching.

- WRITE
- WRITE EXTENDED
- WRITE AND VERIFY

b) If any of the following commands is issued, all the data which are objects of caching are disabled.

- LOG SELECT
- MODE SELECT
- MODE SENSE
- READ BUFFER
- READ DEFECT DATA
- READ LONG
- RECEIVE DIAGNOSTIC RESULTS
- SEND DIAGNOSTIC
- START/STOP UNIT
- WRITE LONG
- FORMAT UNIT
- LOG SENSE
- MODE SELECT EXTENDED
- MODE SENSE EXTENDED
- READ CAPACITY
- READ DEFECT DATA (12)
- REASSIGN BLOCKS
- RELEASE EXTENDED

- RESERVE EXTENDED
- WRITE BUFFER
- WRITE SAME

c) If the data buffer where data which are objects of caching are stored is used by any of the following commands, the data existing in that data buffer which are objects of caching are disabled.

- READ
- READ EXTENDED
- WRITE
- WRITE EXTENDED
- WRITE AND VERIFY
- VERIFY

d) If any of the following events occurs, all the data which are objects of caching are disabled.

- Receiving LIP (y, x)
- Receiving TARGET RESET (FCP TASK MANAGEMENT)
- Receiving ABORT TASK SET (FCP TASK MANAGEMENT)
- Receiving CLEAR TASK SET (FCP TASK MANAGEMENT)
- Automatic alternate processing is executed.
- Receiving TPRLO
- Receiving ABTS (Link service)
- Read/Write is aborted in something causes.

3.2.2 Caching parameters

The IDD supports the MODE SELECT parameters (caching parameters: page code = 8) shown in Table 3.2 for controlling the cache feature. See Section 4.1 concerning details of the MODE SELECT parameters.

Table 3.2 Cache control parameters

[Caching Parameters (Page Code = 8)]

Byte \ Bit		7	6	5	4	3	2	1	0
0		0	0	0	0	1	0	0	0
1		X‘0A’ or X‘12’ (Page Length)							
2		IC	ABPF	CAP	DISC	SIZE	WCE	MS	RCD
	Default	0	0	0	1	0	1	0	0
	Variable	1	0	0	0	0	1	0	1
3		X‘00’ (Reserved)							
4-5		Prefetch-suppressed block count							
	Default	X‘FFFF’							
	Variable	X‘0000’							
6-7		Minimum prefetch							
	Default	X‘0000’							
	Variable	X‘0000’							
8-9		Maximum prefetch							
	Default	X‘xxxx’							
	Variable	X‘0000’							
10-11		Maximum prefetch limit block count							
	Default	X‘FFFF’							
	Variable	X‘0000’							
12		FSW	LBCSS	DRA	VS	VS	Reserved		
	Default	1	0	0	0	0	0	0	0
	Variable	0	0	0	0	0	0	0	0
13		Cache segment count							
	Default	X‘08’							
	Variable	X‘3F’							
14-15		Cache segment size							
	Default	X‘0000’							
	Variable	X‘0000’							
16		X‘00’ (Reserved)							
17-19		Non cache buffer size							
	Default	X‘000000’							
	Variable	X‘000000’							

Remark:

The variable column indicates whether the parameter can be changed or not (if "1", the parameter can be changed).

3.2.3 Look-Ahead operation, Look-Ahead volume

1) Excluding the conditions in 3) and 4) for the amount of data specified as the minimum pre-fetch volume, data are read for look-ahead irrespective of track boundaries or cylinder boundaries. Commands which are already in the queue or commands which are newly received while a look-ahead operation is in progress, are executed after the look-ahead operation is completed. However, if the new command is a READ or READ EXTENDED command, and it is a command in which the first specified logical data block is a sequential access data block, the command is executed without the look-ahead operation being halted. When a newly received command is a command which is not the object of caching, that command is executed immediately in parallel with a look-ahead operation.

   Also, in the case of a command which disables all data which are objects of caching (see Section 3.2.1 (3)), the look-ahead operation is halted and that command is executed immediately.

2) When commands exist in the queue, the look-ahead operation is halted at the point when reading of the specified amount of data at the minimum pre-fetch volume is completed, then execution of the new command starts. When there are no commands that need to be newly executed, the data look-ahead operation is continued, even after the volume of data specified as the minimum amount of pre-fetch data have been read, until one of the following conditions, 1), 3) or 4), occurs.

   – When "1" is specified in the DISC bit, if look-ahead of data equal in volume to a cache segment is completed.

   – When "0" is specified in the DISC bit, if look-ahead of all the data is completed up to the track boundary or the cylinder boundary.

3) During a data look-ahead operation, when any error occurs, the data look-ahead operation is terminated at that point (retry is not executed).

4) When receiving LIP (y, x), or when any INIT issues a TARGET RESET (FCP TASK MANAGEMENT), the look-ahead operation is terminated at that point and all the look-ahead data stored in the data buffer are invalidated.

5) During a look-ahead operation, if "sector slip processing" is applied, or defective sectors exist in the same cylinder to which "alternate processing" is applicable, the look-ahead operation is continued without interruption.

3.3 Write Cache

The IDD is equipped with a write cache function in order to reduce the INIT's command processing time. If that operation is permitted by the MODE SELECT command (caching parameters: Page code = 8, WCE bit), at the point when the IDD completes the transfer of all data specified in the WRITE or WRITE EXTENDED command, it reports the GOOD status and terminates the command.

IMPORTANT

If the write cache function is permitted, data transferred form the INIT by a WRITE or WRITE EXTENDED command are written to the disk media after the GOOD status is reported, so when an unrecoverable write error is detected in that write operation, sense data is generated. When those sense data is being held, the IDD ordinarily responds to the command that is executed next by a "CHECK" status (deferred error), notifying the INIT that sense data is being held. However, ordinarily, it is troublesome for the INIT to retry when there is an unrecoverable error in a write cache operation, so adequate caution should be exercised when using this function.

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CHAPTER 4 Command Specifications

This chapter describes detailed specifications of the SCSI commands which the IDD is equipped with and how to use them.

4.1 Control/Sense Commands

4.1.1 TEST UNIT READY (00)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘00’							
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0

This command checks the status of the disk drive.

If the IDD is in the ready state and it is possible for it to be used by the INIT (initiator) which issues this command, a GOOD status is reported for this command.

If the IDD is not in the ready state, it reports a CHECK CONDITION status for this command. The sense data generated at this time indicate the IDD's state at this time.

4.1.2 INQUIRY (12)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'12'							
1	0	0	0	0	0	0	CmdDt	EVPD
2	Page Code/Operation Cpde							
3	0	0	0	0	0	0	0	0
4	Transfer Byte Length							
5	0	0	0	0	0	0	0	0

This command transfers the information showing the IDD's characteristics (INQUIRY data) to the application client. This command is executed immediately without queuing in a system which issues only commands with no tags or links.

This command is executed normally even in cases where the UNIT ATTENTION condition is held, and the UNIT ATTENTION condition is not cleared. This command is also executed normally when the disk drive is not in the ready state or even when an illegal logical unit number (LUN) is specified.

A CHECK CONDITION status is reported for this command and it is terminated abnormally only in the case that one of the following conditions is detected.

- There is an error in the specifications other than the LUN field of the CDB.
- It is impossible to send INQUIRY data because of an IDD hardware error.
- An unrecoverable error was detected on the SCSI bus.
- An error detected during command execution was recovered in the IDD's error recovery processing (Retry), but the mode which reports "RECOVERED ERROR" is specified in the MODE SELECT parameter.
- Applicability to overlapping command exception conditions (See Section 2.7.1.)

If bytes 1, the "EVPD (enable vital product data)" bits, the "CmdDt (Command Support Data)" bits, and byte 2, the "Page code" field in the CDB are enabled only in the case that transfer of the SCSI-2/SCSI-3 mode's INQUIRY data is specified. In the case of the SCSI-1/CCS mode, zero must be set in these bits and in this field. And if both the "EVPD" and "CmdDt" bits are one, this command is terminated by a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid Field in CDB [=24-00]).

(1) EVPD (Enable Vital Product Data)

a) If the specification in this bits is zero, the IDD transfers the standard INQUIRY data or the command supported data, mentioned later, to the application client.

b) If the specification in this bits is one, product information called VPD (vital product data) is transferred to the application client.

(2) CmdDt (Command Supported Data)

a) If the specification in this bits is zero, the IDD transfers the standard INQUIRY data, mentioned later, to the application client.

b) If the specification in this bits is one, the IDD transfers the command supported data, mentioned later, to the application client.

(3) Page code / Operation code

a) When the "EVPD" bits is one, this field specifies that the IDD transfers the kind of the VPD information.

b) If the "EVPD" bit is zero and the "CmdDt" bits is one, this field specifies the operation code (CDB byte 0) of commands generated command supported data.

(4) Transfer Byte Length

Byte 4 of the CDB, the "Transfer Byte Length" field, shows the number of bytes of standard INQUIRY data or VPD information that the application client can receive by this command.

The IDD transfers data with the byte length specified in the "Transfer Byte Length" field, or the byte length in the standard INQUIRY data or VPD information which it is holding, whichever has the smallest number of bytes, to the application client. When zero is specified in the "Transfer Byte Length" field, this command is normally terminated without anything being transferred.

(5) Standard INQUIRY data

Table 4.1 shows the format and contents of the standard INQUIRY data transferred to the INIT by this command if "0" is specified in the "EVPD" and the “CmdDt” bit.

Table 4.1 Standard INQUIRY data

Byte \ Bit	7	6	5	4	3	2	1	0	SCSI mode
0	Qualifier			Device Type Code					
	(0, 0, 0) or (0, 1, 1)			(0, 0, 0, 0, 0) or (1, 1, 1, 1, 1)					----
1	RMB	Reserved							
	0	0	0	0	0	0	0	0	SCSI-3
2	Version								----
	X' 04' (SPC-2)								SCSI-3
3	AERC	Obsolete	NORMACA	HISUP	Response Data Format				----
	0	0	0	0	0	0	1	0	SCSI-3
4	Additional Data Length								
	0	1	0	1	1	0	1	1	
5	SCCS	Reserved							SCSI-3
	0	0	0	0	0	0	0	0	
6	BQue	EncServ	Part	MultiP	MCHNGR	Obsolete		Addr16	SCSI-3
	0	1	0/1	1	0	0	0	0	
7	RelAdr	obsolete	Wbus16	Sync	Linked	TranDis	CmdQue	VS	SCSI-3
	0	0	0	0	0	0	1	0	
8 9 ~ 15	FUJITSU (Vendor ID: ASCII)								----
16 17 ~ 31	(Product ID: ASCII)								
32 33 34 35	Microcode Version No. (ASCII) (Product Revision: ASCII)								----
36 37 ~ 47	Device Serial No. (ASCII)								
48-55	X'00' (Vendor Specific)								
56	Reserved				CLOCKING		QAS	IUS	SCSI-3
	0	0	0	0	0	0	0	0	
57	X'00' (Reserved)								
58-73	Version Descriptor								SCSI-3
74-95	X'00' (Reserved)								

a. Qualifier field

(0,0,0): The specified logical unit shows the type of input/output device shown in the "Device Type Code" field. Even if this code is reported, it does not mean that that logical unit is in the ready state.

(0,0,1): The specified logical unit shows the type of input/output device shown in the "Device Type Code" field, but it shows that an actual input/output device is not connected to that logical unit. The IDD does not report this code.

(0,1,1): Shows that the specified logical unit is not supported. When this code is reported, it X '1F' is shown in the "Device Type Code" field.

b. Device type code

(0,0,0,0,0): Direct access device

(1,1,1,1,1): Undefined device

When LUN=0 is specified, the IDD reports "(0,0,0,0,0) : direct access device" as the device type code. At this time, the "Qualifier" field is "(0,0,0)." Therefore, byte 0 indicates X '00.' On the other hand, when a LUN other than "0" is specified, the IDD reports "(1,1,1,1,1) : undefined device" as the device type code. At this time, the "Qualifier" field is "(0,1,1)." Therefore, byte 0 indicates X '7F.'

c. RMB bit

When this bit is "1," it indicates that the storage media is a removable disk device. The IDD is a fixed disk device, so this bit is always reported as "0."

d. Version

The VERSION field indicates the implemented version of this standard and is defined below.

Table 4.2 VERSION field

Code	Description
X'01'	ANSI X3.131: 1986 (SCSI-1)
X'02'	ANSI X3.131: 1994 (SCSI-2)
X'03'	ANSI X3.301: 1997 (SPC Rev.11)
X'04'	T10/1236-D (SPC-2) IDD always Responds this value.

e. Response data format field

This field shows the code which shows the standard INQUIRY data format. The definition of the code is (0,0,0,1) for SCSI-1/CCS mode or (0,0,1,0) for SCSI-2 or SCSI-3 mode.

f. Additional data length

This field shows the length of the INQUIRY data (byte length) after byte 5. This value shows the length in the INQUIRY data held by the IDD without relation to the specification in the transfer byte length field in the CDB, and is always X‘5B’ (total data length = 96 bytes).

g. Supported functions

The bit positions shown below are valid only when the CHANGE DEFINITION command is set so that the SCSI-2 or SCSI-3 mode INQUIRY data are transferred, and the functions which the IDD supports are shown in the bit correspondence.

"1" indicates that that function is supported and "0" indicates that that function is not supported. When the CHANGE DEFINITION command is not set so that SCSI-2 mode INQUIRY data are transferred, "0" is displayed in all these bit positions.

– SCSI-3 mode

  [Byte 3]

  – AERC (Asynchronous event reporting capability):
    Asynchronous condition notify function [0]

  – NORMACA (Normal ACA supported):
    ACA support [0]

  – HISUP (Hierarchical support):
    Defined the hierarchical addressing model to assign LUN [0]

  [Byte 5]

  – SCCS (SCC support):
    Embedded storage array controller equipment [0]

  [Byte 6]

  – BQue (Basic queuing):
    Combination with CMDQUE [0]

  – EncServ (Enclosure service):
    Enclosure service [1]

  – MultiP (Multi port):
    Supported multi-port [1]

- MChngr (Medium changer):
  Medium Changer [0]

- Addr16 (Wide SCSI address 16):
  16 bit SCSI addressing [0]

[Byte 7]

- RelAdr (Relative addressing):
  Relative logical block addressing [0]

- WBus16 (16-bit wide data transfer):
  Data transfer on a 2-byte bus [0]

- Sync (Synchronous data transfer):
  Data transfer on the synchronous mode [0]

- Linked (Linnked command):
  Command link function [0]

- TranDis (Transfer disable):
  Continue task and target transfer disable message [0]

- CmdQue (Command queuing):
  Command queuing function [1]

Table 4.3 Command queuing

Bque	CmdQue	Description
0	0	No command queuing of any kink supported
0	1	Command queuing with all types of task tags supported
1	0	Basic task set model supported
1	1	Illegal combination of BQue and CmdQue bits

- VS (Vendor specific):
  Not defined [0]

- SCSI-2 mode

  [Byte 3]

  - AENC (Asynchronous event notification capability):
    Asynchronous condition notify function [0]

  - TrmIOP (Terminate I/O process):
    TERMINATE I/O PROCESS message [0]

[Byte 6]

– DualP (Dual port):
  Dual port function [1]

– Port:
  Connection port, '0'= connect to port A [0/1]
  '1'= connect to port B

– ACKBREQB (ACKB/REQB):
  Use the ACKB and REQB signals with the B cable or the Q cable [0]

– Addr32 (Wide SCSI address 32):
  32 bit SCSI addressing [0]

– Addr16 (Wide SCSI address 16):
  16 bit SCSI addressing [0]

[Byte 7]

– RelAdr (Relative addressing):
  Relative logical block addressing [0]

– WBus32 (32-bit wide data transfer):
  Data transfer on a 4-byte bus [0]

– WBus16 (16-bit wide data transfer):
  Data transfer on a 2-byte bus [0]

– Sync (Scychronous data transfer
  Data transfer in the synchronous mode [0]

– Linked (Linked command):
  Command link function [0]

– TTD (Target transfer disable):
  Target transfer disable message [0]

– CmdQue (Command queuing):
  Tagged command queuing feature [1]

– SftRe (Soft Reset):
  Soft reset condition [0]

h. Vendor ID field

This field indicates the name of the product's supplier in left-justified ASCII code, and always indicates FUJITSU. The unused right end is space for the ASCII code.

i. Product ID field

The product's model name is displayed in left-justified ASCII code in this field.

j. Product Revision field

The IDD's microcode version number is displayed in ASCII code in this field.

k. Device Serial Number field

The value following byte 4 of the device serial number in the VPD information is indicated in this field. Higher order digits which do not contain valid numbers are filled with ASCII code spaces (X '20').

l. Clocking field

"0" as Reserved.

m. QAS (Quick Arbitrate Supported) bit

"0" as Reserved.

n. IUS (Information unit supported) bit

"0" as Reserved.

o. Version Descriptor field

This field is provided for identifying upto eight standards to which the Device claims conformance.
The IDD shall be indicated as shown below.

Table 4.4 Version descriptor

BYTE	Code	Description
58 to 59	0x0D, 0x3C	FC-PH
60 to 61	0x0D, 0x61	FC-AL-2
62 to 63	0x13, 0x3C	FC-FLA
64 to 65	0x09, 0x00	FCP-2
66 to 67	0x00, 0x40	SAM-2
68 to 69	0x02, 0x60	SPC-2
70 to 71	0x01, 0x9B	SBC
72 to 73	0x01, 0xDB	SES

(6) Command support data

Table 4.5 shows the format and contents of the command support data transferred to the INIT by this command if "0" is specified in the "EVPD" bit and "1" is specified in the "CmdDt" bit.

Table 4.5 Command support data

Byte \ Bit	7	6	5	4	3	2	1	0
0	Qualifier			Device Type Code				
1	0	0	0	0	0	Support		
2	Version							
3	X'00' (Reserved)							
4	X'00' (Reserved)							
5	CDB Size (m-5)							
6 ~ m	CDB Usage Data							

a. Qualifier, Device Type Code, Version

These fields are the same as those in the previously mentioned standard INQUIRY data.

b. Support

This field indicates the value defined in Table 4.6.

Table 4.6 Support

"Support" Bit	2	1	0	Description
	0	0	0	Data about the requested SCSI operation code is not currently available.
	0	0	1	The device server does not support the tested SCSI operation code. All data after byte 1 is undefined.
	0	1	0	Reserved
	0	1	1	The device server supports the tested SCSI operation code in conformance with an SCSI standard.
	1	0	0	Vendor-specific (undefined)
	1	0	1	The device server supports the tested SCSI operation code in a vendor-specific manner.
	1	1	0	Vendor-specific (undefined)
	1	1	1	Reserved

If the "Support" field contains "000b", all data after byte 1 is not valid. One possible reason for "support" being "000b" is the device server's inability to retrieve information stored on the media. When this is the case, a subsequent request for command support data may be successful.

c. CDB size

This field contains the number of bytes in the CDB for the operation code being queried, and the size of the "CDB Usage Data" field in the return data.

d. CDB usage data

This field contains information about the CDB for the operation code being queried. The first byte of the "CDB usage data" contains the operation code for the operation being queried. All bytes except the first byte of the "CDB usage data" contains a usage map for bits in the CDB for the operation code being queried.

The bits in the "Usage map" have a one-for-one correspondence to the CDB for the operation code being queried. If the device server evaluates a bit as all or part of a field in the CDB for the operation code being queried, the usage map contains a one in the corresponding bit position. If the device server ignores or treats as reserved a bit in the CDB for the operation code being queried, the usage map contains a zero in the corresponding bit position. The usage map bits for a given CDB field all have the same value.

Thus, the CDB usage bit map for this command for a device server that implements command support data but not vital product data is: 12h, 02h, FFh, 00h, FFh, 00h.

(7) VPD information

When "1" is specified in the "EVPD" bits of the CDB, the VPD information described below is transferred to the INIT by this command. The INIT specifies the type of VPD information required in the "Page code" field of the CDB. The type of VPD information supported by the IDD and its page code number are as shown in Table 4.7.

Table 4.7 VPD information

Page Code Page (Hex)	Function
00	Page code list of supported VPD information
80	Device serial number
C0	Operation mode

Furthermore, if page codes other than those shown above (VPD information that is not supported by the IDD) are specified in the CDB, that command is terminated with a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in CBD [=24-00]).

The format and contents of each type of VPD information are shown below.

a. Page code list

This VPD information reports the page code list of VPD information supported by the IDD. The format of this VPD information is shown in Table 4.8.

Table 4.8 VPD information: VPD identifier list

Byte \ Bit	7	6	5	4	3	2	1	0
0	Qualifier			Device Type Code				
1	X‘00’ (Page Code)							
2	X‘00’							
3	X‘03’ (Page Length)							
4	X‘00’ (Page Code List)							
5	X‘80’ (Device Serial No.)							
6	X‘C0’ (Operation Mode)							

The values indicated in the "Qualifier" and "Device Type Code" fields in byte 0 are the same as those in the previously mentioned standard INQUIRY data. The "Page code" field in byte 1 indicates the page code (X '00') of this VPD information itself. Also, the "Page length" field in byte 3 indicates the length (byte length) after byte 4. This value has no relationship to the specification in the "Transfer Byte Length" in the CDB, but indicates the length of this VPD information and is always X '03' (Total data length = 7 bytes).

Byte 4 and subsequent bytes list all the VPD information page codes supported by the IDD, with the VPD page code indicated in ascending order in each byte.

b. Device serial No.

This VPD information reports the device serial number of the IDD. The format of this VPD information is shown in Table 4.9.

Table 4.9 VPD information: device serial No

Byte \ Bit	7	6	5	4	3	2	1	0
0	Qualifier			Device Type Code				
1	X'80' (Page Code)							
2	X'00'							
3	X'0C' (Page Length)							
4	Device Serial No. (ASCII)							
5								
~								
15								

The values indicated in the "Qualifier" and "Device Type Code" fields in byte 0 are the same as those in the previously mentioned standard INQUIRY data. The "Page code" field in byte 1 indicates the page code (X '80') of this VPD information itself. Also, the "Page length" field in byte 3 indicates the length (byte length) after byte 4. This value has no relationship to the specification in the "Transfer Byte Length" in the CDB, but indicates the length of this VPD information and is always X '0C' (Total data length = 16 bytes).

Bytes 4 to 15 indicate the IDD's device serial number in right-justified decimal (ASCII code).

If LUN ≠ 0 is specified, all bytes of these fields are filled with 0X20.

c. Operation mode

This VPD information reports the IDD's current operation mode. The format of this VPD information is shown in Table 4.10.

Table 4.10 VPD information: operation mode

Byte \ Bit	7	6	5	4	3	2	1	0
0	Qualifier			Device Type Code				
1	X‘C0’ (Page Code)							
2	X‘00’							
3	X‘04’ (Page Length)							
4	0	0	0	0	UNTATN	0	0	0
5	0	0	0	0	0	0	0	0
6	X‘78’ (Spindle Motor Start Delay Timing)							
7	X‘00’ (Reserved)							

The values indicated in the "Qualifier" and "Device Type Code" fields in byte 0 are the same as those in the previously mentioned standard INQUIRY data. The "Page code" field in byte 1 indicates the page code (X 'C0') of this VPD information itself. Also, the "Page length" field in byte 3 indicates the length (byte length) after byte 4. This value has no relationship to the specification in the "Transfer Byte Length" in the CDB, but indicates the length of this VPD information and is always X '04' (Total data length = 8 bytes).

– UNTATN (UNIT ATTENTION Report Mode)

When the IDD is holding the Unit Attention condition, this specifies methods of response to commands received from the INIT (In FC, always the value "1")

"1" (Report): Report the "CHECK CONDITION" status (SCSI standard specifications) for commands other than the INQUIRY and REQUEST SENSE commands.

"0" (Don't Report): Terminates all received commands normally (the "CHECK CONDITION" status caused by the UNIT ATTENTION condition is not reported.)

– Spindle Motor Start Delay Timing

The Byte6 indicates "Spindle motor Start Delay Time".
If "Delay Start Mode" set by START/MATED pin.
The motor will delay spin-up.
The delay time is calculating by formula.
Delay Time = 120 $\times$ 0.1 $\times$ modulo (SEL_ID/8)

4.1.3 READ CAPACITY (25)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'25'							
1	0	0	0	0	0	0	0	0
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	PMI
9	0	0	0	0	0	0	0	0

This command transfers information related to the disk drive's capacity and the data block size to the INIT.

When bit 0 "PMI (partial medium indicator)" of CDB byte 8 is "0," the logical block address and block length (byte length) of the final data block which is accessible in the disk drive (user space) are transferred to the INIT. At this time, the "Logical Block address" field in the CDB must specify zero.

When the "PMI" bit is "1," the logical block address and block length (byte length) of data blocks which satisfy either of the following conditions is transferred to the INIT.

- The data block on the track where the specified block exists, which is just before the block where the first alternate sector processing (not including defective block sector slip processing) is implemented. However, when alternate sector processing is being implemented in the specified block, the data block specified in the CDB.
- When no alternate sector processed data block exists in the track where the specified block exists, the last data block in that track.

By using this command with the "PMI" bit specified as "1", the INIT can search for usable data space continuously without being interrupted by data transfers for alternate sector processing or switching of cylinders.

The format of the data transferred to the INIT by this command is shown in Table 4.11.

Table 4.11 READ CAPACITY data

Byte \ Bit	7	6	5	4	3	2	1	0
0	Logical Block Address (MSB)							
1	Logical Block Address							
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Block Length (MSB)							
5	Block Length							
6	Block Length							
7	Block Length (LSB)							

4.1.4 MODE SELECT (15)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘15’							
1	0	0	0	PF	0	0	0	SP
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	Parameter List Length							
5	0	0	0	0	0	0	0	0

This command performs setting and changing of each type of parameter related to disk drive physical attributes, data format, timing of FC interface transferring processing and error recovery procedures, etc. The INIT can know the types of parameters, the current settings of each parameter and the types of parameters which can be changed, and the ranges for such changes, etc. by using the MODE SENSE or MODE SENSE EXTENDED command.

The data (MODE SELECT parameters) transferred from the INIT to the IDD by this command, are configured from a "Header," "Block Descriptor" and one or more "Page Descriptors" which describe each parameter, each of which will be explained later.

When the "PF (page format)" bit in CDB byte 1 is "1," it indicates that the MODE SELECT parameters transferred from the INIT by this command are in the "Page Descriptor" format. The IDD disregards the value specified in this bit and regards the MODE SELECT parameters transferred from the INIT as being in the "Page Descriptor" format and executes this command.

The "SP (save pages)" bit in CDB byte 1 specifies whether or not to save the MODE SELECT parameters specified in this command on the disk. It is possible for the IDD to save all the MODE SELECT parameters described in the "Page Descriptor" (except for those on page C), but this bit's specification is valid only for parameters other than "Format parameters (Page 3)" and "Drive parameters (Page 4: excluding byte 17)."

If "1" is specified in the "SP" bit, the parameters transferred from the INIT are saved to the disk when this command is executed, except for "Format parameters (page 3)" and "Drive parameters (Page 4: excluding byte 17)." When the "SP" bit is "0," these parameters are not saved to the disk. On the other hand, as for "Format parameters (Page 3)" and "Drive parameters (Page 4: excluding byte 17)," regardless of the specification of the "SP" bit when this command is executed, these parameters are always saved to the disk when the FORMAT UNIT command is executed.

The "Parameter length" field of the CDB specifies the total byte length of the MODE SELECT parameters transferred from the INIT by this command. If zero is specified in the "Parameter length" field, this command is terminated normally without data transfer being executed with the INIT. The MODE SELECT parameters have specifically defined formats and lengths, as explained by the descriptions of each page descriptor in this item, and the INIT must always specify (transfer) those formats and lengths.

If a "Header," "Block Descriptor" or any "Page Descriptor" cannot be transferred with all the defined length because the total defined length of the MODE SELECT parameters actually transferred from the INIT do not match the value specified in the "Parameter List Length" field, or if the total of the MODE SELECT parameter's defined length transferred from the INIT exceeds the value specified in the "Parameter list length" field, this command is terminated with a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in CDB [=24-00]) and all the MODE SELECT parameters transferred in the command are disabled.

Three types of values exist in the MODE SELECT parameters, "Current," "Save" and "Default" values. "Current" values are parameters which actually control the IDD's operation, and the parameters specified by this command are converted to "Current" values. "Save" values are parameter values specified by this command which are preserved on the disk. And "Default" values are values which the IDD uses as "Current" values during the time until reading of "Save" values is completed after the IDD's power is switched on, or when no "Save" values exist and no MODE SELECT command is being issued.

The IDD has a common set of "Current", "Save" and "Default" values of all the MODE SELECT parameters for all the INITs.

When the IDD's power is switched on, when TARGET RESET is received, when LIP (YX) is received - When TPRLO (Third Party Process Log-out... Extended Link Service) Global bit = 1, the "Current" MODE SELECT parameter values are changed to the "Save" parameter values, if they exist, and are changed to the "Default" parameter values if the "Save" values do not exist.

Note:

> In the FC, there is only one MODE parameter in one device set (PORT A/B Common). For that reason, in cases where factors which are initialized by previously written MODE parameters (TARGET RESET, LIP (Y, X) etc. are received, an influence is also exerted on other ports (MODE parameters are initialized).

When any of the parameters related to the data format on the disk media (Block Descriptor, Format parameters: Page 3, and Drive parameters: Page 4), parameters related to the segment buffer (Caching parameters: Page 8, byte 13) and parameters related to command queuing (Control mode parameters: Page A, byte 3) is changed by this command, a UNIT ATTENTION condition (Mode parameters changed [=2A-01]) is generated for all the INITs other than the INIT that issued this command. The details of the function are described in Section 4.1.10 RESERVE (16).

Figure 4.1 shows the relation between the three types of parameters, "Current," "Save" and "Default".

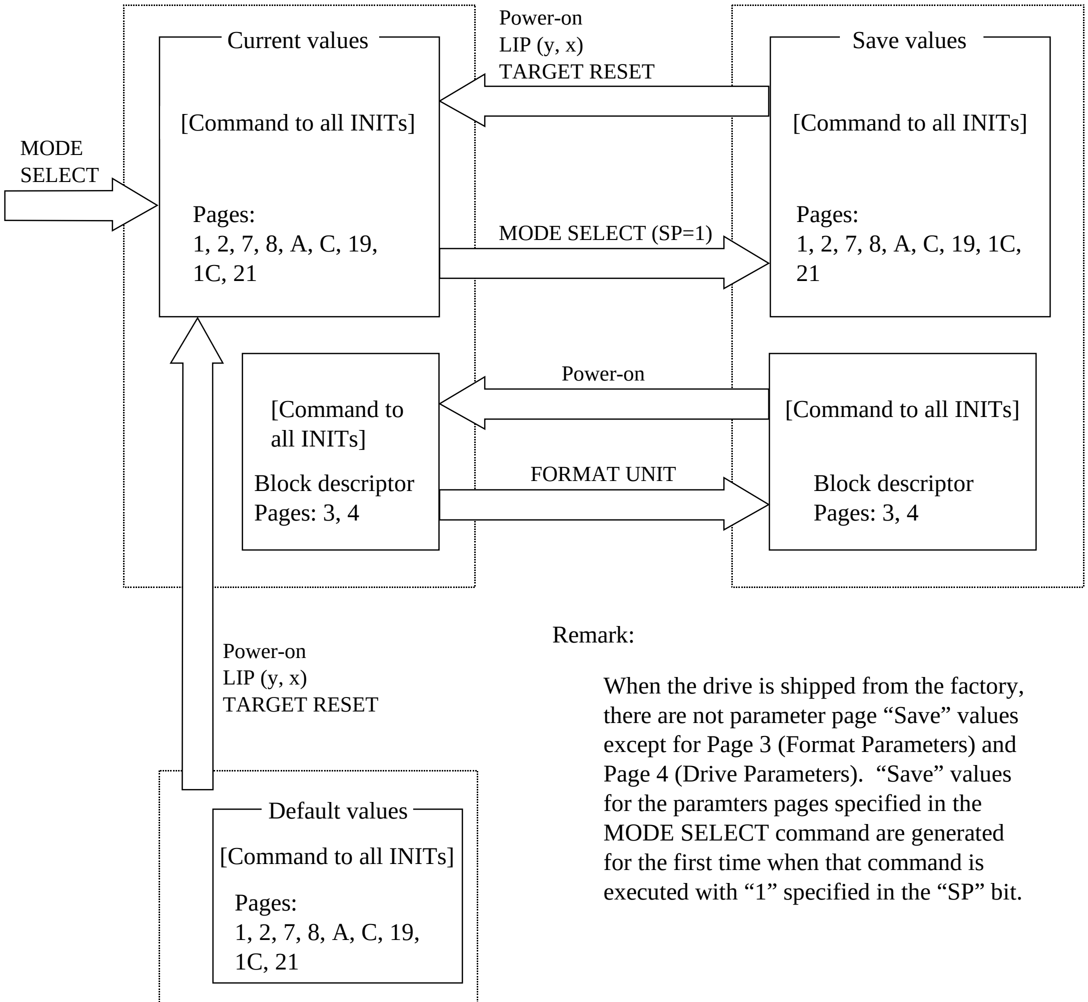

Figure 4.1 MODE SELECT parameter structure

The MODE SELECT parameters include parameters which can be changed by the INIT as desired, parameters which the INIT cannot change, which whose values are determined by the IDD unilaterally and parameters which can be changed by the INIT within certain appropriate limits. The IDD also contains parameter fields which are applicable for rounding processing ("rounding up" or "rounding down") of parameter values specified by the INIT to values which the IDD can use in actual operation.

When changing of parameters other than "variable parameters" is requested by the INIT in the MODE SELECT parameters which it transfers in this command, or when changes which are outside the permissible range are requested, even though they are "variable parameters," this command is terminated with a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in parameter list [=26-00]) and all the parameters specified by the INIT are disabled. Furthermore, parameter fields exist which ignore the values specified by the INIT, even if the parameters are "variable parameters." Details are explained in the description of each page descriptor in this item.

If the IDD performs rounding processing ("rounding up" or "rounding down") of parameter values specified by the INIT, in some cases a "CHECK CONDITION" status (RECOVERED ERROR [=1] / Rounded parameter [37-00]) is reported, and in some cases it is not reported. Whether or not a "CHECK CONDITION" status is reported is determined by the type of "rounding up" or "rounding down" and the conditions.

If the INIT would like to confirm that the IDD is implementing rounding processing, it issues a MODE SENSE or MODE SENSE EXTENDED command after issuing this command and reads the values for the "Current" parameters, then compares them with the parameter values sent in the MODE SELECT command.

Parameter fields which are the object of rounding processing are explained in the descriptions of each page descriptor in this item.

Table 4.12 lists the data configuration of the parameter list transferred by the INIT in this command. The parameter list is configured from header 4 bytes in length followed by a block descriptor with a length of 8 bytes. This is followed by one or more page descriptors, or, when there is no block descriptor the 4-byte header is followed by one or more page descriptors. The INIT may transfer a header only, or the header and block descriptor only without the page descriptor added.

The page descriptor is processed correctly whether the supported pages are sent individually or if all pages are sent continuously. Also, when multiple pages are sent continuously, even if the order of each page is optional, they are executed normally.

Table 4.12 MODE SELECT command (Group 0) parameter configuration

Header

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'00'							
1	X'00' (Media Type)							
2	×	0	0	×	0	0	0	0
3	X'00' or X'08' (Product Descriptor Length)							

Block Descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	Data Block Count (MSB)							
1	Data Block Count							
2	Data Block Count							
3	Data Block Count (LSB)							
4	X'00'							
5	Data Block Length (MSB)							
6	Data Block Length							
7	Data Block Length (LSB)							

Page Descriptor

	Byte \ Bit	7	6	5	4	3	2	1	0
Page Header	0	0	0	Page Code					
Page Header	1	Page Length							
	2	Parameter Field							
	~								
	n								

a. Header

– Media type

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

– Byte 2

Bits 7 and 4 of this field have meaning only in the header transferred to the INIT by the MODE SENSE and MODE SENSE EXTENDED commands. The values specified in these bits are disregarded in the MODE SELECT and MODE SELECT EXTENDED commands. "0" must always be specified by the INIT in the other bit positions.

– Block descriptor length

This field indicates the length (block count) of the "Block descriptor" which follows the header (not including the length of the "Page descriptor"). It is possible to define only 1 "Block descriptor" to the IDD, and either X '00' or X '08' must be specified in this field. When X '00' is specified in this field, it indicates that the "Block descriptor" is not included in the parameter list transferred from the INIT and the "Page descriptor" follows immediately after the "Header."

b. Block descriptor

The logical attributes of the data format on the disk media are described in the 8-byte long "Block descriptor."

– Data block count

This field specifies the total number of logical data blocks (the block length is specified in "Data block length") allocated in the user space on the disk media. The maximum logical block address is a value with 1 subtracted from the value in this field.

If only the "Block descriptor" in this command is changed accessible data block count can be limited without formatting if "Data block count" value is within a "Cylinder count" value of page 4.

If zero is specified for the "Data block count," or when the block descriptor is not specified, the IDD retains its current capacity, if the block size or alternate sector count has not changed. If the "Data block count" is set to zero and the Data block size or alternate sector count has changed, the IDD shall set to its maximum capacity when new block size or alternate sector count to be effect.

– Data block length

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

The logical data block length and physical data block length are the same in the IDD. The data block length can be specified at 512 to 528 bytes (4-byte boundary).

If less than 512 bytes is specified in this field, the IDD performs rounding processing (there is a rounding processing report), setting the data block length at 512 bytes. If more than 528 bytes is specified, rounding processing is performed (there is a rounding processing report), setting the data block length at 528 bytes. If the block length is not 4-byte boundary, rounding processing is performed to change 4-byte boundary.

If zero is specified in this field, the value specified in bytes 12 and 13 (Data byte length/sector) of Page 3 (Format Parameter) is set. At that time, if Page 3 is not specified at the same time, the current value in Page 3 is used.

If the value set in this field differs from the value specified in bytes 12 and 13 (Data byte length/sector) of Page 3 (Format Parameter), the data block length in the block descriptor is set.

c. Page descriptor

The "Page descriptor" is configured from a 2-byte page header followed by a parameter field and each parameter function attribute is classified in a unit called a "Page." The individual "Page descriptors" in the MODE SELECT and MODE SELECT EXTENDED commands may be specified independently by the INIT and multiple "Page descriptors" may be specified continuously in the desired sequence.

– Page code

This field specifies a code (Page No.) that indicates the type of "Page descriptor."

– Page length

This field indicates the length of the parameter field (number of bytes) after byte 2, excluding the page header, of the "Page descriptor" and is a fixed value for each page code. The INIT must specify the same value as the page length reported by the IDD in the MODE SENSE or MODE SENSE EXTENDED command, except in cases it is described in each of the page descriptor descriptions in this item.

d. MODE SELECT parameters of the IDD

The parameter list configuration and its length that can be transferred to the IDD by the INIT in the MODE SENSE or MODE SENSE EXTENDED command are as shown in Table 4.13. If a "Page descriptor" that is not supported by the IDD is specified, the command is terminated with a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in parameter list [=26-00]), and all the MODE SELECT parameters transferred in the command are disabled.

Table 4.13 MODE SELECT parameters

Parameter			Byte Length
Header			4
Block Descriptor			8 or 0
Page Descriptor	Page 1:	Read/Write Error Recovery Parameter	8 or 12
	Page 2	Disconnect/Reconnect Parameter	12 or 16
	Page 3:	Format Parameter	24
	Page 4:	Drive Parameter	20 or 24
	Page 7:	Verify Error Recovery Parameter	12
	Page 8:	Caching Parameter	20
	Page A:	Control Mode Parameter	12
	Page C:	Notch Parameter	24
	Page 19:	Fibre Channel Control Parameter	16
	Page 1C:	Information Exception Control Parameter	12
	Page 21:	Additional Error Recovery Parameter	4

IMPORTANT

1) The MODE SELECT parameter is ordinarily different in its configuration depending on the input/output device and the type of controller. It is also possible that current definitions may be expanded in accordance with the expansion of the functions of the IDD in the future. In order to assure independence of software from the individual specifications of input/output devices, before the INIT issues this command, it should follow the procedure of using the MODE SENSE and MODE SENSE EXTENDED command to determine the types of parameters the TARG is actually equipped with and the attributes of those parameters, such as whether or not they can be changed.
2) After changing anything in the "Block descriptor," "Format parameters (Page 3)" or "Drive parameters (Page 4)," with the MODE SELECT or MODE SELECT EXTENDED command, it is impossible to execute a command to access the data on the disk media until execution of the FORMAT UNIT command is completed, and a CHECK CONDITION status (MEDIUM ERROR [=3] / Medium format corrupted [=31-00]) is reported for all such commands.

The configuration and functions of the "Page descriptors" supported by the IDD are described below.

IMPORTANT

In the diagram that shows the configuration of each individual "Page Descriptor," the default column shows that parameter's "default" value and the "variable" column shows whether or not it is possible to vary that parameter ("1" indicates that it can be varied). The INIT can know those values and attributes by using the MODE SENSE or MODE SENSE EXTENDED command.

(1) Read/Write error recovery parameters (page code = 1)

Table 4.14 lists the format of the page descriptor of this MODE SELECT parameter.

Table 4.14 MODE SELECT parameters: read/write error recovery parameters

Byte \ Bit		7	6	5	4	3	2	1	0	
0		0	0	0	0	0	0	0	1	
1		X‘0A’ or X‘06’ (Page Length)								(Note)
2		AWRE	ARRE	TB	RC	ERR	PER	DTE	DCR	
	Default	1	1	1	0	1	0	0	0	
	Variable	1	1	1	1	1	1	1	1	
3		Number of retries during READ								
	Default	X‘3F’								(=63 times)
	Variable	X‘FF’								
4		Correctable Bit Length								
	Default	X‘FF’ (MAT3*** Series)/X‘T.B.D’ (MAU3*** Series)								
	Variable	X‘00’								
5		X‘00’ (Head Offset Count)								
6		X‘00’ (Data Strobe Offset Count)								
7		X‘00’ (Reserved)								
8		Number of retries during WRITE								(=63 times)
	Default	X‘3F’								
	Variable	X‘FF’								
9		X‘00’ (Reserved)								
10-11		Recovery Time Limit								
	Default	X‘7530’								(=30s)
	Variable	X‘FFFF’								

IMPORTANT

If transfer of this page descriptor is requested by the MODE SENSE or MODE SENSE EXTENDED command, the IDD reports X '0A' as the page length (byte 1). However, if either X '0A' or X '06' is specified for the page length in the MODE SELECT or MODE SELECT EXTENDED command, the IDD treats it as though the correct page length was specified. If X '06' is specified for the page length, the value specified in the "Number of retries during READ" field is used as is in the "Number of retries during WRITE" field and the value specified in the "Number of retries during READ" field is also used as is in the "Number of retries during VERIFY" field. The X '06' page length is included in consideration of compatibility with previous models, but as much as possible, it is recommended that the INIT use the X '0A' page length.

Error recovery parameters defined in this page descriptor are applicable for the following commands, except in cases where it is specifically pointed out.

- READ
- READ EXTENDED
- READ LONG
- SEND DIAGNOSTIC (Write/read test)
- WRITE
- WRITE AND VERIFY (Write operation)
- WRITE EXTENDED
- WRITE LONG

a. AWRE (automatic write reallocation enabled)

"1": An "automatic alternate block allocation processing" operation is specified during execution of a write operation.

"0": An "automatic alternate block allocation processing" operation is prohibited during execution of a write operation.

Automatic alternate block allocation processing is explained in Section 5.3.2.

b. ARRE (automatic read reallocation enable)

"1": An "automatic alternate block allocation processing" operation is specified during execution of a read operation.

"0": An "automatic alternate block allocation processing" operation is prohibited during execution of a read operation.

Automatic alternate block allocation processing is explained in Section 5.3.2.

c. TB (transfer block)

"1": Data blocks which contain errors that are impossible to correct are transferred to the INIT during a read operation.

"0": Data blocks which contain errors that are impossible to correct are not transferred to the INIT during a read operation.

d. RC (read continuous)

This bit specifies continuous transfer of all the data requested by a command unaccompanied by a delay for executing error recovery processing.

The IDD disregards the specification in this bit and operates according to the default value (=0).

e. EER (enable early recovery)

"1": When a correctable data check has been detected, data correction according to the ECC is applied immediately without executing retry (rereading) up to the number of times specified in the "Number of retries during READ" parameter.

"0": When a correctable data check has been detected, retry (rereading) is executed up to the number of times specified in the "Number of retries during READ" parameter, then data correction according to the ECC is applied if possible.

The IDD disregards this bit and operates according to the default value (=1).

f. PER (post error)

"1": When several errors (errors related to the disk drive), which were recovered from normally through the IDD's error recovery processing, have been detected, a CHECK CONDITION status is reported when execution of that command is completed. In the sense data generated at this time, the sense key indicates "RECOVERED ERROR [=1]" and the content of the final error to be corrected successfully is reported.

"0": Even when several errors (errors related to the disk drive), which were recovered from normally through the IDD's error recovery processing, have been detected, that command is completed with a GOOD status and the contents of the recovered errors are not reported.

g. DTE (disable transfer on error)

"1": Even when several errors on the disk drive, which were recovered from normally through the IDD's error recovery processing, have been detected, execution of that command terminates at that point.

"0": When several errors on the disk drive, which were recovered from normally through the IDD's error recovery processing, have been detected, execution of that command is continued.

The IDD disregards this bit and operates according to the default value (=0).

h. DCR (disable correction)

"1": Even when a correctable data check has been detected, data correction according to the ECC is prohibited. However, On-the-fly correction processing is not prohibited.

"0": When a correctable data check has been detected, data correction according to the ECC is applied.

The IDD disregards this bit and operates according to the default value (=0).

i. Number of retries during read

This parameter specifies the number of retries that should be executed for "Data Check" type errors detected in read operations on the disk media. The number of retries specified in this parameter is the maximum number of times reading is retried for each individual portion of data in each logical data block. If the IDD cannot perform correction of the data On-the-fly for each portion of data in the data block, it retries the reading of those portions. The reread retry is executed the number of times specified by the drive parameter internally by the IDD before this retry is executed, so actually the retry is executed the number specified here plus the number of internal retries.

The value specified in this parameter is applicable to the READ/READ EXTENDED commands and the read test in the SEND DIAGNOSTIC command.

When the page length in Page 1 is specified as X '06,' the value specified in this field is copied to the "Number of retries during WRITE" on this page and "Number of retries during VERIFY" on Page 7.

j. Correctable bit length

This parameter indicates the burst error length (bit length) which it is possible to apply data correction according to the ECC to. It is impossible to change this parameter from the INIT. The IDD disregards the value specified in this parameter and operates according to the "Default" value.

k. Head offset count (not supported)

This field specifies in two's-complement notation an incremental offset position from the track center to the radial position the heads are moved. Any value specified in this field does not preclude the device server from using positive or negative head offset during error recovery. However, after any error recovery is completed the device server returns the head offset to the value specified in this field.

The IDD is not supported this field. Therefore, the IDD ignores the specified value in this field.

l. Data strobe offset count (not supported)

This field specifies in two's-complement notation an incremental position to where the recovered data strobe is adjusted from its nominal setting. Any value specified in this field does not preclude the device server from using positive or negative data strobe offset during error recovery. However, after any error recovery is completed the device server returns the data strobe offset to the value specified in this field.

The IDD is not supported this field. Therefore, the IDD ignores the specified value in this field.

m. Number of retries during write

This field specifies the maximum number of times writing of data to the disk media is retried in the case that there has been an interruption in a write operation such as a shock. The number of retries specified in this field is applied to each logical block unit. When zero is specified in this field, retrying of writing to the disk is prohibited.

The value specified in this field is applicable to the WRITE command, WRITE EXTENDED command, write operation in the WRITE AND VERIFY command and write test in the SEND DIAGNOSTIC command. When the page length in Page 1 is specified as X '06,' the value specified in this field is not transferred from the INIT, but in this case, the value specified in the "Number of retries during READ," on the same page, is also applied to this field by the IDD.

n. Recovery time limit (not supported)

This parameter specifies the maximum time that can be used by the TARG for error recovery processing, as a 1ms constant. The value specified in this parameter is the maximum permissible time for error recovery processing for each individual command. When both this parameter and the "Number of retries" parameter are specified, the parameter which specifies the shortest time must be given priority in application.

If less than 5000ms is specified, the IDD performs rounding processing and sets 5000ms.

Table 4.15 Combination of error recovery flags (1/4)

EER	PER	DTE	DCR	Error Recovery Procedure
0	0	0	0	1. Rereading is tried repeatedly up to the number of times specified in the "Read Retry Count", "Write Retry Count" or "Verify Retry Count" parameter. If possible, data correction is executed afterward according to the ECC. 2. When error recovery has succeeded, processing of the command is continued. 3. The contents of recovered errors are not reported. 4. If unrecoverable errors have been detected, execution of that command is terminated at that point. 5. Transfer of data in blocks which include unrecoverable errors to the INIT is done in accordance with the specification in the TB bit (read commands).
0	0	0	1	1. Rereading is tried repeatedly up to the number of times specified in the "Read Retry Count", "Write Retry Count" or "Verify Retry Count" parameter. Data correction is not executed according to the ECC. 2. When error recovery has succeeded, processing of the command is continued. 3. The contents of recovered errors are not reported. 4. If unrecoverable errors have been detected, execution of that command is terminated at that point. 5. Transfer of data in blocks which include unrecoverable errors to the INIT is done in accordance with the specification in the TB bit (read commands).
0	0	1	0	(Setting prohibited) (See *1 at the end of this table.)
0	0	1	1	(Setting prohibited) (See *1 at the end of this table.)
0	1	0	0	1. Rereading is tried repeatedly up to the number of times specified in the "Read Retry Count", "Write Retry Count" or "Verify Retry Count" parameter. If possible, data correction is executed afterward according to the ECC. 2. When error recovery has succeeded, processing of the command is continued. 3. If unrecoverable errors have been detected, execution of that command is terminated at that point. 4. Transfer of data in blocks which include unrecoverable errors to the INIT is done in accordance with the specification in the TB bit (read commands). 5. When recovery from all detected errors has been successful, a CHECK CONDITION status (RECOVERED ERROR [=1]) is reported after all processing of the command is completed and the sense data indicate the content of the last error that was successfully recovered from and the address of the data block where that error occurred.

Table 4.15 Combinations of error recovery flags (2/4)

EER	PER	DTE	DCR	Error Recovery Procedure
0	1	0	1	1. Rereading is tried repeatedly up to the number of times specified in the "Read Retry Count", "Write Retry Count" or "Verify Retry Count" parameter. Data correction is not executed according to the ECC. 2. When error recovery has succeeded, processing of the command is continued. 3. If unrecoverable errors have been detected, execution of that command is terminated at that point. 4. Transfer of data in blocks which include unrecoverable errors to the INIT is done in accordance with the specification in the TB bit (read commands). 5. When recovery from all detected errors has been successful, a CHECK CONDITION status (RECOVERED ERROR [=1]) is reported after all processing of the command is completed and the sense data indicate the content of the last error that was successfully recovered from and the address of the data block where that error occurred.
0	1	1	0	1. Rereading is tried repeatedly up to the number of times specified in the "Read Retry Count", "Write Retry Count" or "Verify Retry Count" parameter. If possible, data correction is executed afterward according to the ECC. 2. When error recovery has succeeded, or even when recovery is impossible, execution of the command is terminated with a CHECK CONDITION status at the point when error recovery processing is completed, and the sense data indicate the data block address where that error occurred. 3. Transfer to the INIT of data in blocks with recovered errors is done, but transfer to the INIT of data blocks in which the errors were unrecoverable is done in accordance with the specification in the TB bit (read commands).
0	1	1	1	1. Rereading is tried repeatedly up to the number of times specified in the "Read Retry Count", "Write Retry Count" or "Verify Retry Count" parameter. Data correction is not executed according to the ECC. 2. When error recovery has succeeded, or even when recovery is impossible, execution of the command is terminated with a CHECK CONDITION status at the point when error recovery processing is completed, and the sense data indicate the data block address where that error occurred. 3. Transfer to the INIT of data in blocks with recovered errors is done, but transfer to the INIT of data blocks in which the errors were unrecoverable is done in accordance with the specification in the TB bit (read commands).

Table 4.15 Combinations of error recovery flags (3/4)

EER	PER	DTE	DCR	Error Recovery Procedure
1	0	0	0	1. When a correctable data check is detected, immediately, correction is executed according to the ECC. For data checks which cannot be corrected, rereading is tried repeatedly up to the number of times specified in the "Read Retry Count", "Write Retry Count" or "Verify Retry Count" parameter. However, if a correctable error is detected during reading, data correction is executed at that point according to the ECC. 2. When error recovery has succeeded, processing of the command is continued. 3. The contents of recovered errors are not reported. 4. If unrecoverable errors have been detected, execution of that command is terminated at that point. 5. Transfer of data in blocks which include unrecoverable errors to the INIT is done in accordance with the specification in the TB bit (read commands).
1	0	0	1	(Setting prohibited) (See *1 at the end of this table.)
1	0	1	0	(Setting prohibited) (See *1 at the end of this table.)
1	0	1	1	(Setting prohibited) (See *1 at the end of this table.)
1	1	0	0	1. When a correctable data check is detected, immediately, correction is executed according to the ECC. For data checks which cannot be corrected, rereading is tried repeatedly up to the number of times specified in the "Read Retry Count", "Write Retry Count" or "Verify Retry Count" parameter. However, if a correctable error is detected during reading, data correction is executed at that point according to the ECC. 2. When error recovery has succeeded, processing of the command is continued. 3. If unrecoverable errors have been detected, execution of that command is terminated at that point. 4. Transfer of data in blocks which include unrecoverable errors to the INIT is done in accordance with the specification in the TB bit (read commands). 5. When recovery from all detected errors has been successful, a CHECK CONDITION status (RECOVERED ERROR [=1]) is reported after all processing of the command is completed and the sense data indicate the content of the last error that was successfully recovered from and the address of the data block where that error occurred. However, if the error is corrected with ECC only, the CHECK CONDITION is not reported and no sense data is created.
1	1	0	1	(Setting prohibited) (See *1 at the end of this table.)

Table 4.15 Combinations of error recovery flags (4/4)

EER	PER	DTE	DCR	Error Recovery Procedure
1	1	1	0	1. When a correctable data check is detected, immediately, correction is executed according to the ECC. For data checks which cannot be corrected, rereading is tried repeatedly up to the number of times specified in the "Read Retry Count", "Write Retry Count" or "Verify Retry Count" parameter. However, if a correctable error is detected during reading, data correction is executed at that point according to the ECC. 2. When error recovery has succeeded, or even when recovery is impossible, execution of the command is terminated with a CHECK CONDITION status at the point when error recovery processing is completed, and the sense data indicate the data block address where that error occurred. 3. Transfer to the INIT of data in blocks with recovered errors is done, but transfer to the INIT of data blocks in which the errors were unrecoverable is done in accordance with the specification in the TB bit (read commands).
1	1	1	1	(Setting prohibited) (See *1 at the end of this table.)

*1 If a setting-prohibited combination of error recovery flags is specified, the MODE SELECT or MODE SELECT EXTENDED command is terminated with a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in parameter list [=26-00]) and all the parameters specified at that time are disabled.

Remark:

Just as explained for the EER, PER, DTE and DCR bits, the IDD can only make a valid specification for the PER bit. Therefore, among the error recovery flag combinations listed above, the only one which can actually operated is (EER, PER, DTE, DCR) = (1, 0, 0, 0) and (1, 1, 0, 0).

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

The format of the page descriptor in this MODE SELECT parameter is shown in Table 4.16.

Table 4.16 MODE SELECT parameters: disconnect/reconnect parameters

Byte \ Bit		7	6	5	4	3	2	1	0	
0		0	0	0	0	0	0	1	0	
1		X‘0E’ or X‘0A’ (Page Length)								(See the "Note.")
2		Buffer Full Ratio								
	Default	X‘00’								
	Variable	X‘FF’								(See the "Note.")
3		Buffer Empty Ratio								
	Default	X‘00’								
	Variable	X‘FF’								(See the "Note.")
4-5		Bus Inactivity Limit								
	Default	X‘0000’								
	Variable	X‘0000’								(See the "Note.")
6-7		Disconnect Time Limit								
	Default	X‘0000’								
	Variable	X‘0000’								(See the "Note.")
8-9		Connect Time Limit								
	Default	X‘0000’								
	Variable	X‘0000’								
10-11		Maximum Burst Size								(See the "Note.")
	Default	X‘0100’								
	Variable	X‘0000’								
12		EMDP	FARd	FAWrt	FAStat	DImm	DTDC			
	Default	0	1	1	1	0	0	0	0	
	Variable	0	0	0	0	0	0	0	0	
13		X‘00’								
14-15		(Burst Size During the Initialize Connection)								
	Default	X‘0000’								
	Variable	X‘0000’								

IMPORTANT

If transfer of this page descriptor is required by the MODE SENSE or MODE SENSE EXTENDED command, the IDD reports X '0E' as the page length (byte 1). However, if either X '0E' or X '0A' is specified for the page length in the MODE SELECT command, the IDD regards it as if the correct page length was specified. The X '0A' page length, is provided in consideration of compatibility with previous models, but it is recommended that the page length X '0E' be used by the INIT to support expansions in the specifications in the future.

See Section 2.1, "Data Buffer" concerning specification methods for the "Buffer Full Ratio" and "Buffer Empty Ratio" parameters in this page descriptor and details of data buffer operation.

a. Buffer full ratio

This parameter specifies the timing for the IDD to start Loop OPEN processing in order to transfer data to the INIT by the READ or READ EXTENDED command.

The value specified in this parameter (n) shows the amount of data read to the IDD's data buffer from the disk media as a proportion [n/256] of the total capacity of the data buffer until it opens the loop for transferring the data on the FC interface is started.

If it is possible to transfer the amount of data specified in this parameter to the INIT from the data buffer, opens the loop and transfer of data to the INIT begins.

b. Buffer empty ratio

This parameter specifies the timing for the IDD to start Loop OPEN processing when it is requested by the INIT to transfer data in the WRITE, WRITE EXTENDED or WRITE AND VERIFY command.

The value specified in this parameter (n) indicates the size of the empty area in the IDD's data buffer as a proportion of the total data buffer capacity of the IDD [n/256].

While the IDD is writing data to the disk media, it is using the data pre-fetched to the data buffer in order, and when the empty space in the data buffer reaches the amount specified in this parameter, it opens the loop, requesting transfer of the succeeding data.

If the total number of bytes in the transferred data block count specified in the command is less than the capacity of the buffer segment, all the data are pre-fetched in a batch, so the specification in this parameter is not applied.

Note:

If the value specified for the "buffer full ratio" or the "buffer empty ratio" is not within double the integral boundary of the logical data block length, the IDD rounds up the specified value to the value which is the nearest data block boundary. Also, if zero is specified in any of these parameters, the IDD treats that parameter as though 1 logical data block has been specified. However, parameter values specified from the INIT in the MODE SELECT or MODE SELECT EXTENDED command are held as is and those values are reported in response to a MODE SENSE or MODE SENSE EXTENDED command. (Rounding processing of the parameters is not done by the IDD.) Also, if the specified value does not reach 1 block, it is regarded as having specified 1 block.

c. Bus inactivity limit (not supported)

d. Disconnect time limit (not supported)

e Connect time limit (not supported)

f. Maximum burst size

This parameter specifies the maximum data that the TARG can transfer in one Loop OPEN, and specifies the maximum data volume that can be transferred continuously as a multiple of 512 bytes. (Valid only for WRITE and WRITE EXT).

In the IDD, this value is unlimited. It is impossible for this parameter to be changed by the INIT. The IDD disregards the value specified in this parameter and operates according to the default value"0100."

g. DTDC (data transfer disconnect control)

DTDC: Controls how to perform Loop CLOSE.

00b= Perform Loop CLOSE according to the instructions of other parameters without using DTDC.

01b= When a data transfer by the command is started, the target will never try Loop CLOSE until transmission of all the data to be transferred by the command is completed. The specified values in the "connect limit time" and "bus inactivity limit" fields are ignored during the data transfer.

The IDD disregards the value specified in this parameter and operates according to the default “00” value.

01b= Reserved.

11b= When a data transfer by the command is started, the target will never try Loop CLOSE until execution of the command is completed. The specified values in the "connect limit time" and "bus inactivity limit" fields are ignored during the data transfer.

The IDD disregards the value specified in this parameter and operates in accordance with the default value (00).

h. EMDP (enable modify data pointer) (not supported)

This bit indicates whether or not the initiator allows the data transfer to be re-ordered by the target.

The IDD are not supported a MODIFY DATA POINTER message. Therefore, The IDD disregards the value specified in this bit, and operates according to the "Default" value.

"0" : The IDD cannot transfer a MODIFY DATA POINTER message.

"1" : The IDD can transfer a MODIFY DATA POINTER message.

i. FARd, FAWrt, FAStat (fair arbitration read/write/status)

When connected is requested for Read, Write or Status transfers, this specifies whether Arbitration Fairness Control is enabled or disabled.

The IDD disregards the value specified in this parameter and operates in accordance with the default value.

j. DImm (disconnect immediate) (not supported)

This controls when to execute Loop CLOSE after receiving the frame. The IDD does not support this bit. If 1 is specified in this bit, the command is terminated with the "CHECK CONDITION" status.

k. Burst size during the initial connection

This parameter specifies the maximum data volume that can be transferred in the connected state when the TARG receives a command as a multiple of 512 bytes.

The IDD disregards the value specified in this parameter and operates in accordance with the default value (0000 = unlimited).

(3) Format parameters (page code = 3)

The Page descriptor format of this MODE SELECT parameter is shown in Table 4.17.

Table 4.17 MODE SELECT parameters: format parameters

Byte \ Bit		7	6	5	4	3	2	1	0
0		0	0	0	0	0	0	1	1
1		X‘16’ (Page Length)							
2-3		Track Count/Zone							
	Default	X‘T.B.D’							
	Variable	X‘0000’							
4-5		Alternate Sector Count/Zone							
	Default	X‘00F0’ (MATxxxx) or X’(T.B.D)’ (MAUxxx)							
	Variable	X‘FFFF’							
6-7		Alternate Track Count/Zone							
	Default	X‘0000’							
	Variable	X‘0000’							
8-9		Alternate Track Count/Drive							
	Default	X‘(T.B.D)’							
	Variable	X‘0000’							
10-11		Sector Count/Track							
	Default	X‘(T.B.D)’							
	Variable	X‘0000’							
12-13		Data Byte Length/Physical Sector							
	Default	X‘(T.B.D)’							
	Variable	X‘FFFF’							
14-15		Interleave Factor							
	Default	X‘0001’							
	Variable	X‘0000’							
16-17		Track Skew Factor							
	Default	X‘(T.B.D)’							
	Variable	X‘0000’							
18-19		Cylinder Skew Factor							
	Default	X‘(T.B.D)’							
	Variable	X‘0000’							
20		SSEC	HSEC	RMB	SURF	0	0	0	0
	Default	0	1	0	0	0	0	0	0
	Variable	0	0	0	0	0	0	0	0
21-23		X‘000000’ (Reserved)							

a. Parameters for specifying alternate processing areas for defective blocks (bytes 2 to 9)

The following 4 parameters specify the position and number of spare sectors for performing defective block alternate allocation processing on the disk media. See Chapter 3, "Data Format" of Product Manual for details of the IDD's alternate block processing.

– Track count/zone (bytes 2 to 9)

This parameter specifies the number of tracks a unit for alternating blocks. The INIT cannot clearly specify this value. The IDD ignores the specification for this bit. If the value of the Active Notch in Page C is 0, the “Number of Logic Heads a cell” is reported for the MODE SENSE and MODE SENSE EXTENDED commands.

If not, the total number of track of the zone which is specified as the Active Notch is reported.

– Alternate sector count/zone

This parameter specifies the number of sectors per one cell as the number of spare sectors secured for use as alternate blocks. In the IDD, this parameter indicates the number of spare sectors secured in each cell. The maximum permissible value of this parameter either the "number of physical sectors per track in the last cell - 1" or "240", whichever is smaller. It is possible for the INIT to vary this parameter within a range of 0 to the maximum permissible value. When a value which exceeds the maximum permissible value is specified, the IDD performs rounding down of the parameter and sets a value equal to this parameter's maximum permissible value. If the above rounding processing is performed, a CHECK CONDITION status (RECOVERED ERROR [= 1] / Rounded parameter [37-00]) is reported for that command.

– Alternate track count/zone

This parameter specifies the area secured for alternate blocks as the number of tracks per one cell. It is impossible to change this parameter. When a value other than zero is specified in this field, the IDD performs rounding down processing of this parameter and always sets this parameter value at zero.

– Alternate track count/drive

This parameter specifies the area secured for alternate blocks as the number of tracks per disk drive. In the IDD, this parameter indicates the number of tracks in the spare area secured as alternate cells. This value is fixed at a value that equals the number of tracks per cylinder multiplied by the number of zones in the IDD. This parameter cannot be changed by the INIT.

b. Parameters specifying track format (bytes 10, 11)

– Sector count/track

This parameter specifies the number of physical sectors per 1 track. In the IDD, the number of physical sectors in a track is set unilaterally according to the data format specified by the "Data Block Length" parameter in the block descriptor or the "Data byte length/Physical sector" parameter in this page descriptor, so this parameter cannot be changed. The IDD disregards the value specified in this field. This parameter indicates the value of zone specified in Active Notch of Page C. If it is 0, this parameter indicates the value in zone 0.

c. Parameters specifying sector format (bytes 12 to 19)

– Data byte length/physical sectors /

This parameter specifies the data length per 1 physical sector as the number of bytes. In the IDD, the data byte length per 1 physical sector is the same as the data byte length in 1 logical data block. The INIT can specify the value of this parameter at 0 or 512 to 528 bytes (4-byte boundary).

If a value less than 512 bytes, the IDD sets a byte length of 512. If more than 528 bytes is specified, the IDD performs rounding processing and sets a byte length of 528. If an odd number of bytes is specified within the specified range, the IDD performs rounding up processing. If the above rounding processing is performed, the IDD reports the CHECK CONDITION status (RECOVERED ERROR [=1] / Rounded parameter [37-00]) for that command.

If 0 is specified in this parameter, the value calculated based on the value of the "Data block length" in the block descriptor is used as this parameter value.

When both this page descriptor and the block descriptor are specified by the same MODE SELECT command, and a nonzero value is specified in this parameter which differs from the value in the "Data block length" parameter in the block descriptor, the value specified in the block descriptor has priority.

– Interleave factor/

This parameter field has meaning only with the MODE SENSE and MODE SENSE EXTENDED commands. The interleave factor (in the IDD, this is always X '0001' :non interleave) of the disk drive's current data format. The value specified in this field is disregarded in the MODE SELECT and MODE SELECT EXTENDED commands.

– Track skew factor

This parameter indicates the number of physical sectors existing between the data block with the highest order logical block address on a track and the data block with the next logical block address on the next track of the same cylinder (track skew). This parameter cannot be changed. The IDD disregards the value specified in this field and sets the optimum track skew value in the specified data block length. See Chapter 3, "Data Format" in the Product Manual for details about track skew. This parameter indicates the value of zone specified in active notch of Page C. If it is 0, this parameter indicates the value in zone 0.

– Cylinder skew factor

This parameter indicates the number of physical sectors existing between the data block with the highest order logical block address in a cylinder and the data block with the next logical block address in the next cylinder (cylinder skew). This parameter cannot be changed. The IDD disregards the value specified in this field and sets the optimum cylinder skew value in the specified data block length. See Chapter 3, "Data Format" in the Product Manual for details about cylinder skew. This parameter indicates the value of zone specified in active notch of Page C. If it is 0, this parameter indicates the value in zone 0.

d. Parameters related to device type (byte 20)

– SSEC (soft sectoring)

When this bit is "1," it indicates that the data formatting method on the disk media is "soft sectoring." However, since the IDD uses only the "hard sectoring" method (refer to previously shown item b), this bit is disregarded. Furthermore, it is impossible to change this parameter.

– HSEC (hard sectoring)

When this bit is "1," it indicates that the data formatting method on the disk media is "hard sectoring." However, since the IDD uses only the "hard sectoring" method, this bit is disregarded. Furthermore, it is impossible to change this parameter.

– RMB (removable medium)

When this bit is "1," it indicates that the storage media of the disk drive can be replaced. When this bit is "0," it indicates that the storage media is fixed. However, since the IDD has a fixed media, this bit is disregarded. Furthermore, it is impossible to change this parameter.

– SURF (surface addressing)

When this bit is "1," it indicates that after logical data block address allocation is performed over all the sectors in order on the same memory surface (same head), it is proceeding to the next memory surface (next head) after all the sectors have been done. When this bit is "0," it indicates that after logical data block address allocation is performed over all the sectors in order in the same cylinder (all heads), it is proceeding to the next cylinder. In the IDD, only the latter type of addressing is possible, so this bit is disregarded. It is also impossible to change this parameter.

Table 4.18 lists each parameter of pages 3, 4, and C in detail. (The contents are subject to change without notice.)

Table 4.18 MODE SELECT parameters: each parameters of pages 3, 4, and C in detail

	Page 3				Page 4		Page C			
							LPN=0 (Default)		LPN=1	
	Byte 2-3	Byte 10-11	Byte 16-17	Byte 18-19	Byte 2-4	Byte 5	Byte 8-11	Byte 12-15	Byte 8-11	Byte 12-15
	Number of tracks/ zone	Number of sectors/ track	Track skew factor	Cylinder skew factor	Number of cylinders	Number of heads	Starting boundary	Ending boundary	Starting boundary	Ending boundary
MAT3300 (Sector length = 512)	0x00E8	0x048D	0x0124	0x0071	0x0133A1	0x08	0x00000000	0x0133A007	0x00000000	0x22EF6677
MAT3147 (Sector length = 512)	0x0091	0x048D	0x0124	0x0071	0x0133A1	0x05	0x00000000	0x0133A004	0x00000000	0x15DIE58C
MAT3073 (Sector length = 512)	0x003A	0x048D	0x0124	0x0071	0x0133A1	0x02	0x00000000	0x0133A001	0x00000000	0x08B464A1

For the MAU3xxx, TBD

(4) Drive parameters (page code = 4)

The page descriptor format of this MODE SELECT parameter is shown in Table 4.19.

Table 4.19 MODE SELECT parameters: drive parameters

Byte \ Bit		7	6	5	4	3	2	1	0	
0		0	0	0	0	0	1	0	0	
1		X‘16’, X‘12’ or X‘0A’ (Page Length)								
2-4		Cylinder Count								(See the "IMPORTANT")
	Default	X‘xxxxxx’								
	Variable	X‘000000’								
5		Number of Heads								
	Default	X‘xx’								
	Variable	X‘00’								
6-8		"Write Precompensation" Starting Cylinder								
	Default	X‘000000’								
	Variable	X’000000’								
9-11		"Reduced Write Current" Starting Cylinder								
	Default	X‘000000’								
	Variable	X‘000000’								
12-13		Drive Step Rate								
	Default	X‘0000’								
	Variable	X‘0000’								
14-16		Landing Zone Cylinder								
	Default	X‘000000’								
	Variable	X‘000000’								
17		0	0	0	0	0	0	RPL		
	Default	0	0	0	0	0	0	0	0	
	Variable	0	0	0	0	0	0	0	0	
18		Rotational Synchronization Offset								
	Default	X‘00’								
	Variable	X‘00’								
19		X‘00’ (Reserved)								
20-21		Rotational Speed								
	Default	X’2729’ or X’3A98’								
	Variable	X‘0000’								(10,025 rpm or 15,000 rpm)
22-23		X‘0000’ (Reserved)								

IMPORTANT

When transfer of this page is requested by the MODE SENSE or MODE SENSE EXTENDED command, the IDD reports X '16' as the page length. However, in the MODE SELECT and MODE SELECT EXTENDED commands, if either X '16,' X '12' or X '0A' is specified, it is treated as if the IDD has specified the correct page length. The X '12' and X '0A' page lengths have been included in consideration of compatibility with previous models, but it is recommended that the INIT use the X '16' page length to support expanded specifications in the future.

a. Cylinder count

This parameter specifies the total number of cylinders configured in the user space on the disk media. This value includes the number of cylinders for alternate blocks specified in the "Alternate Track Count/Drive" parameter of the format parameters (Page code = 3).

It is impossible to change this parameter.

b. Number of heads

This parameter indicates the number of data Read/Write heads in the disk drive. It is impossible to change this parameter. If zero or a value which differs from the "Default" value is specified in this parameter field, the IDD performs rounding processing of the parameter, setting a value which is the same as the default value in it.

c. Bytes 6 to 16

The parameter defined in bytes 6 to 16 of this page descriptor is a parameter that it is clearly not necessary for the INIT to specify. The IDD disregards the values specified in this field.

d. RPL (rotational position locking)

These bits are used for rotational synchronization of the disk and can be specified. The IDD disregards the value specified in this field.

e. Rotational synchronization offset

This is a field which specifies the offset value used for rotational synchronization of the disk, but it is not supported in the IDD. The IDD disregards the value specified in this field.

f. Rotational speed

This specifies the disk's rotational speed in rpm (rotations/minute). This parameter cannot be changed by the INIT. The IDD disregards the value specified in this field and operates according to the “Default” value.

(5) Verify error recovery parameters (page code = 7)

The page descriptor format of this MODE SELECT parameter is shown in Table 4.20.

Table 4.20 MODE SELECT parameters: verify error recovery parameters

Byte \ Bit		7	6	5	4	3	2	1	0	
0		0	0	0	0	0	1	1	1	
1		X'0A' (Page Length)								
2		(Reserved)				EER	PER	DTE	DCR	(See the Note.)
	Default	0	0	0	0	1	0	0	0	
	Variable	0	0	0	0	1	1	1	1	
3		Number of retries during VERIFY.								
	Default	X'3F'								
	Variable	X'FF'								
4		Correctable Bit Length								
	Default	X'FF' (MAT3*** Series) or X'T.B.D' (MAU3*** Series)								
	Variable	X'00'								
5-9		X'0000000000' (Reserved)								
10-11		Recovery Time Limit								
	Default	X'7530'								
	Variable	X'FFFF'								

The error recovery parameters divided in this page descriptor are applicable for the following commands.

- VERIFY
- WRITE AND VERIFY (verify operation)

a. Error recovery flags

– EER (enable early recovery)

– PER (post error)

– DTE (disable transfer on error)

– DCR (disable correction)

The definitions and functions of these control flags are the same as for the read/write error recovery parameters. See item (1) concerning the details.

b. Number of retries during VERIFY

This parameter specifies the number of times reading of the disk media should be retried when a "Data Check" type error is detected in a read operation. the number of retries specified by this parameter is the maximum number of times reading of each individual data area in each logical data block is retried. The IDD retries reading the data area in each data block the specified number of times. When zero is specified in this field, retrying to read data from the disk is prohibited.

When X '06' is specified as the page length on Page 1, the IDD applies the value specified in the Number of retries during READ field on Page 1 to this field also.

c. Correctable bit length

This parameter indicates the burst error length (bit length) that can be applied for data corrections according to the ECC. This parameter cannot be changed by the INIT. However, the IDD disregards the value specified in this parameter and operations according to the "Default" value.

d. Recovery time limit

This parameter specifies the maximum time the TARG can be used for error recovery processing, as a 1ms constant. The value specified in this parameter is the maximum permissible error recovery processing time for an individual command. When both this parameter and the "Number of retries during VERIFY" parameter are specified, priority must be given to whichever parameter specifies the shortest time in its application.

The reported value in this field is a copy of the Recovery time limit in Page 1. The IDD disregards the value specified in this field.

(6) Caching parameters (page code = 8)

The page descriptor format of this MODE SELECT parameter is shown in Table 4.21.

Table 4.21 MODE SELECT parameters: caching parameters

Byte \ Bit		7	6	5	4	3	2	1	0
0		0	0	0	0	1	0	0	0
1		X'0A' or X'12' (Page Length)							
2		IC	ABPF	CAP	DISC	SIZE	WCE	MS	RCD
	Default	0	0	0	1	0	1	0	0
	Variable	1	0	0	0	0	1	0	1
3		Demand Read Retention Priority				Write Retention Priority			
	Default	1	0	0	0	0	0	0	0
	Variable	0	0	0	0	0	0	0	0
4-5		Pre-fetch inhibit block count							
	Default	X'FFFF'							
	Variable	X'0000'							
6-7		Minimum pre-fetch							
	Default	X'0000'							
	Variable	X'0000'							
8-9		Maximum pre-fetch							
	Default	X'xxxx'							
	Variable	X'0000'							
10-11		Maximum pre-fetch limit block count							
	Default	X'FFFF'							
	Variable	X'0000'							
12		FSW	LBCSS	DRA	VS	VS	(Reserved)		
	Default	1	0	0	0	0	0	0	0
	Variable	0	0	0	0	0	0	0	0
13		Cache Segment Count							
	Default	X'08'							
	Variable	X'3F'							
14-15		Cache Segment Size							
	Default	X'0000'							
	Variable	X'0000'							
16		X'00' (Reserved)							
17-19		Non Cache Segment Size							
	Default	X'000000'							
	Variable	X'000000'							

The parameters defined in this page descriptor control the range of look-ahead data in the Look-Ahead cache feature and enable or disable the caching operation. See Section 3.2, "Look-Ahead Cache Feature" and Section 3.3, "Write Cache" concerning details of the Look-Ahead cache feature and parameter setting methods.

a. RCD (read cache disable)

   This bit can be specified, and its operation is as specified.

   This bit specifies whether or not to activate the cache operation for a read command.

   "1": Prohibits operation of the Look-Ahead cache function.

   The IDD reads ahead all of the data requested by the READ command or READ EXTENDED command from the disk and transfers it to the INIT. Moreover, it does not read ahead data blocks after the requested data.

   "0": Specifies operation of the Look-Ahead cache function.

   If part or all of the data, including logical data blocks of headers, requested by a READ command or READ EXTENDED command exists in the data buffer, the IDD transfers that data without accessing the disk. Also, depending on the instructions for the bytes beyond byte 4 of the parameter page, it reads ahead the data blocks after the requested data in the data buffer.

b. MS (multiple selection)

   This bit specifies how to specify the "minimum prefetch count" (bytes 6 and 7) and "maximum prefetch count" (bytes 8 and 9) parameters in this page descriptor.

   1: The "minimum prefetch count" and "maximum prefetch count" parameters indicate a multiplier. The number of data blocks to be prefetch is calculated that the value in the "transfer byte count" in the CDB specified by the READ or READ EXTENDED command X multiplier.

   0: The "minimum prefetch count" and "maximum prefetch count" parameters indicate the data block count to be prefetched with the logical data block count.

   This bit cannot be changed, and the IDD ignores this bit specification and operates according to the default value ('0').

c. WCE (write cache enable)

   This bit can be specified, and its operation is as specified.

   This bit specifies whether or not to activate the cache operation for a write command.

"1": This enables the write cache.

Write data remains in the buffer memory, the cache is made the object even for a read command, and when all of the write data has been received, "GOOD" status is reported without disconnecting.

Sequential writing is performed without waiting for rotation.

"0": This prohibits operation of the write cache function.

Write data remains in the buffer memory, the cache is not made the object even for a read command, and as soon as all the data has been written to the disk, "GOOD" status is reported.

d. SIZE (size enable) (not supported)

"1": Divides the data buffer in accordance with the value specified for the cache segment size (bytes 14, 15).

"0": Divides the data buffer in accordance with the value specified for the number of cache segments (byte 13).

This bit cannot be changed. The IDD disregards the specification in this bit and operates according to the "Default" value (= "0").

e. DISC (discontinuity)

"1": Even if a track switch occurs during Look-Ahead, the Look-Ahead operation continues without interruption.

"0": Look-Ahead is terminated at the point where track switch occurs during Look-Ahead.

This bit cannot be changed. The IDD disregards the specification in this bit and operates according to the "Default" value (= "1").

f. IC (initiator control enable)

"1": Dividing of cache segments is according to the SIZE bit specification.

"0": Dividing of the cache segments is performed by an algorithm that is inherent in the IDD.

This bit can be changed, and its operation is as specified.

g. Demand read retention priority (not supported)

This field advises the device server the retention priority to assign for data read into the cache that has also been transferred from the logical unit to the application client.

The IDD are not supported this field. Thus, the IDD disregards the specification in this field.

"F": Data put into the cache via a READ command was not replaced if there is other data in the cache that was placed into the cache by other means and it may be replaced.

"1": Data put into the cache via a READ command was replaced sooner than data placed into the cache by other means.

"0": Indicates the device server was not distinguish between retaining the indicated data and data placed into the cache memory by other means.

h. Write retention priority (not supported)

This field advises the device server the retention priority to assign for data written into the cache that has also been transferred from the cache memory to the medium.

"F": Data put into the cache during a WRITE or WRITE and VERIFY command was not replaced if there is ohter data in the cache that was placed into the cache by other means and it may be replaced.

"1": Data put into the cache during a WRITE or WRITE and VERIFY command was replaced sooner than data placed into the cache by other means.

"0": Indicates the device server was not distinguish between retaining the indicated data and data placed into the cache memory by other means.

i. Pre-fetch inhibit block count (not supported)

This parameter is used to selectively prohibit data Look-Ahead operations in the READ command or the READ EXTENDED command. When the "Transfer block count" specified in the CDB of the READ command or the READ EXTENDED command is greater than the value in this parameter, data Look-Ahead operations are not executed in that command. This bit cannot be changed. The IDD disregards the specification in this bit and operates according to the "Default" value (= X 'FFFF').

j. Minimum pre-fetch (not supported)

This parameter specifies the minimum quantity of logical data blocks pre-fetched to the data buffer with the READ command or READ EXTENDED command.

This parameter cannot be changed. The IDD disregards the specification in this field.

k. Maximum pre-fetch (not supported)

This parameter specifies the maximum quantity of logical data blocks pre-fetched to the data buffer with the READ command or READ EXTENDED command.

The IDD varies the pre-fetch volume according to the volume of data requested by the READ command or READ EXTENDED command. The value reported to the MODE SENSE command always indicates the number of blocks corresponding to 1 cache segment – 1.

This parameter cannot be changed. The IDD disregards the specification in this field.

l. Maximum pre-fetch control block count (not supported)

This parameter specifies the maximum quantity of logical data blocks pre-fetched to the data buffer with the READ command or READ EXTENDED command. In the IDD the maximum pre-fetch quantity cannot be limited.

This parameter cannot be changed. The IDD disregards the specification in this field.

m. DRA (disable read-ahead) (not support)

This bit specifies whether or not activate the read-ahead operation.

This bit cannot be changed. The IDD disregards the specification in this bit.

"1": Requests that the device server not read into the buffer any logical blocks beyond the addressed logical blocks.

"0": The device server continues to read logical blocks into the buffer beyond the addressed logical blocks.

n. FSW (force sequential write) (not supported)

This bit specifies how to write multiple blocks.

"1": If the IDD writes multiple blocks, this indicates that data are recorded on the disk media in the order in which they are transferred from the INIT.

"0": If the IDD writes multiple blocks, this indicates that data are recorded on the disk media with their order changed in order to complete the command in the fastest time.

This bit cannot be changed. The IDD disregards the specification in this bit and operates according to the "Default" value (="1").

o. LBCSS (logical block cache segment size) (not supported)

"1": Indicates that the "Cache segment size" field units are interpreted as logical blocks.

"0": The "Cache segment size" field units are interpreted as bytes.

This bit is not supported for the IDD. The IDD disregards the specification in this bit.

p. Cache segment count

This parameter specifies the number of cache segments used by the IDD. This parameter is valid when the SIZE bit specification is "0."

When a value greater than max value is specified, the IDD performs rounding processing and sets max value. Also, when a value less than 3 is specified, the IDD performs rounding processing and set 4.

This parameter indicates the same value for all initiators and if it is changed by any initiator, a UNIT ATTENTION condition (UNIT ATTENTION [=6] / Mode select parameter changed [=2A-01]) is generated for all the initiators that did not change it.

This parameter can be changed though the IDD disregards the specification of this field. The IDD divided the Cache Segments according to the inherent algorithm. That is, the Cache Segment size is best tuned per the request data size of Host command. Within one Cache Segment, data for various commands are stored. The biggest Cache Segment size is approximately 476 KB.

IDD does not support this parameter. IDD disregards the specification of this field.

q. Non cache buffer size

If this field is greater than zero, this field advises the device server how many bytes the application client requests that the device server allocate for a buffer function when all other cache segments are occupied by data to be retained. If the number is at least one, caching functions in the other segments need not be impacted by cache misses to perform the SCSI buffer function. The impact of this field equals 0 or the sum of this field plus this field greater than the buffer size is vendor-specific.

This bit is not supported for the IDD. The IDD disregards the specification in this bit.

(7) Control mode parameters (page code = 0A)

The page descriptor format of this MODE SELECT parameter is shown in Table 4.22.

Table 4.22 MODE SELECT parameters: control mode parameters

Byte \ Bit		7	6	5	4	3	2	1	0
0		0	0	0	0	1	0	1	0
1		X‘0A’ or X‘06’ (Page Length)							
2		TST			(Reserved)			GLTSD	RLEC
	Default	0	0	0	0	0	0	0	0
	Variable	0	0	0	0	0	0	1	1
3		Queue Algorithm Qualifier				Reserved	Qerr		DQue
	Default	0	0	0	0	0	0	0	0
	Variable	1	1	1	1	0	0	0	0
4		Reserved	RAC	Reserved		SWP	RAERP	UAAERP	EAERP
	Default	0	0	0	0	0	0	0	0
	Variable	0	0	0	0	0	0	0	0
5		X‘00’ (Reserved)							
6-7		Ready Aer Holdoff Period							
	Default	X‘0000’							
	Variable	X‘0000’							
8-9		Busy Timeout Period							
	Default	X‘0000’							
	Variable	X‘0000’							
10-11		Extended Self-Test Completion Time							
	Default	X‘xxxx’							
	Variable	X‘0000’							

The parameters defined on this page control the operations of the tagged queuing function and statistical information function.

a. TST (task set type)

This field specifies the type of task set defined below.

Table 4.23 TST

Value	Description
000b	Task set per logical unit for all initiators
001b	Task set per initiator per logical unit
010b-111b	Reserved

The IDD operates according to "000b". If other value is specified in this field, the IDD reports a "CHECK CONDITION" status (ILLEGAL REQUEST [=5] / Invalid parameter in list [=26-00]).

b. Queue algorithm qualifier

This parameter controls the execution order algorithm of a command issued together with a SIMPLE QUEUE TAG message.

"0000": The IDD executes commands queued from each INIT in the order in which they were received. However, the command execution order for the READ, READ EXTENDED and PRE-FETCH commands may be changed.

"0001": The IDD executes queued commands by the method selected by the IDD. At this time, the INIT must verify the correctness of the data through appropriate commands and QUEUE TAG messages.

"1111": The IDD prohibits to order queued commands.

When other value is specified in this parameter, the IDD reports a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid parameter in List [=26-00]).

c. GLTSD (global logging target save disable) (not supported)

This bit specifies whether or not to permit the saving treatment of peculiar logging parameter within the IDD.

Since the IDD performs the saving treatment with itself algorithm regardless of specified value in this bit, disregards the specification in this bit.

d. RLEC (report log exception condition) (not supported)

This bit controls operations in cases where the accumulated value log parameter reaches the maximum value.

"1": The IDD reports a CHECK CONDITION status (UNIT ATTENTION [=6] / Log counter at maximum [5B-02]).

"0": The IDD executes the command which is issued next normally.

Since the IDD does not support the reporting function of exception condition, the IDD disregards the specification in this bit.

e. DQue (disable queuing)

This bit specifies whether the IDD will execute processing of tagged commands or not.

"1": The IDD prohibits tagged queuing processing. The IDD clears queued commands and generates a UNIT ATTENTION condition (Command cleared by another initiator [=2F-00]) for each of the INITs that issued the commands which were cleared. After that, the when a QUEUE TAG message is received, it is rejected with a MESSAGE REJECT message and executed as an untagged command.

"0": The IDD permits tagged queuing processing.

When using the fibre channel, "1" cannot be specified in this field since OX-ID is appended. When "1" is specified in this field, "Clock Condition" status (ILLEGAL REQUEST [=5] / Invalid Field in Parameter List [=26-00]) is reported.

f. QErr (queue error management)

This field controls processing of commands queued after a sense hold state is canceled when the IDD is in the sense hold state.

Table 4.24 QErr

Value	Description
00b	The IDD, when it has been in any one of various sense hold states, then that sense hold state is cleared, continues executing the commands which are queued by normal methods.
01b	The IDD, when it has been in any one of various sense hold states, then that sense hold state is cleared, clears the commands which are queued. At this time, the IDD generates a UNIT ATTENTION condition (UNIT ATTENTION [=6] / Command Cleared by Another Initiator [=2F-00]) for each of the INITs that issued the commands which were cleared.
10b	Reserved
11b	The IDD, when it has been in any one of various sense hold states, then that sense hold state is cleared, clears the commands which are queued by abnormal terminated INIT.

The IDD is not supported "11b" specified in this field. If "11b" or "10b" is specified in this field, the IDD reports a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid parameter in list [=26-00]).

Specifying "01b" alone is possible, but the IDD would not function.

g. RAC (report check) (not supported)

The IDD is not supported in this bit. Therefore, the IDD always report "0", and ignore specified value.

h. SWP (soft write protect) (not supported)

This bit specifies whether or not to execute for the device server write operation to the medium.

The IDD is not supported this bit. Therefore, the IDD always report "0", and ignore specified value.

i. RAERP, UAAERP, EAERP, READY AER HOLDOFF PERIOD (not supported)

These field specify the action method of asynchronous event reporting protocol.

The IDD is not supported these field. Therefore, the IDD always report '0', and ignore specified value.

j. Extended self-test completion time

This field contains advisory data that an application client may use to determine the time in seconds that the device server requires to complete an extended self-test when the device server is not interrupted by subsequent commands and no errors occur during execution of the self-test.

This field only use to report the value by the MODE SENSE / MODE SENSE EXTENDED command.

Therefore, the IDD ignores specified value by the MODE SELECT / MODE SELECT EXTENDED command.

(8) Notch parameters (page code = 0C)

Table 4.25 MODE SELECT parameters: notch parameters

Byte \ Bit		7	6	5	4	3	2	1	0
0		0	0	0	0	1	1	0	0
1		X‘16’ (Page Length)							
2		ND	LPN	X‘00’ (Reserved)					
	Default	0	0	0	0	0	0	0	0
	Variable	0	1	0	0	0	0	0	0
3		X‘00’ (Reserved)							
4-5		Maximum number of notches							
	Default	X‘0012’							
	Variable	X‘0000’							
6-7		Active Notch							
	Default	X‘0000’							
	Variable	X‘FFFF’							
8-11		Starting Boundary							
	Default	X‘00000000’							
	Variable	X‘00000000’							
12-15		Ending Boundary							
	Default	X‘xxxxxxxx’							
	Variable	X‘00000000’							
16-23		Page Notch							
	Default	X‘0000000000000008’							
	Variable	X‘0000000000000000’							

This page is used to report the top address and final address of each zone.

If the zone number + 1 of the notching zone is set in the "Active notch" field and this parameter is issued, the starting and ending address of the specified zone can be referred to by the MODE SENSE command.

Also, if Page 3 and Page 3F are specified by the MODE SENSE command, the parameters below the zone specified in the notch page can be referred to.

- Track/zone (Page 3, Byte 02, 03) (Note)
- Sector count/track (Page 3, Bytes 10, 11)
- Track Skew Factor (Page 3, Bytes 16, 17)
- Cylinder Skew Factor (Page 3, Bytes 18, 19)

Note:

> Normally, the number of tracks (logical heads) per cell is set in the track count/zone, but in the case of notching only, the total track count (number of cylinders in the zone x number of logical heads) of the affected zone is reported.

If this parameter is issued, only the format parameter of the zone specified by the MODE SENSE command can be referred to without changing the number of accessible blocks.

Also, if a MODE SENSE command with a SP = "1" that includes a notch page is issued, the current value is reported for this page and the zone value which is the object is reported if Page 3 is notched, then the command is terminated normally. However, in the case of the FORMAT CORRUPTED state, caution is necessary because the value following changing of the Format parameter is reported.

The contents of each parameter are explained below.

- ND (Notch Drive)

  "0": Since the device is not in the notched state, "0" is reported for LPN, active notch, starting boundary and ending boundary.

  "1": Since the device is in the notched state, the starting boundary and ending boundary for the zone number (+1) shown in the active notch is set in the format specified in the LPN Bit.

- LPN (Logical or Physical Notch)

  "0": This shows that the boundary address is based on the physical address format. At that time, the higher order 3 bytes show the logical cylinder number and the lowest order byte shows the logical head number.

  "1": This shows that the boundary address is based on the 4-byte logical block address format.

  This bit is a bit which must be set during MODE SELECT.

- Maximum Number of Notches

  This indicates the number of device zones. 18 (X'12') zones are set for all drives.

- Active Notch

  This specifies the zone number 1 to 18 of a notching zone. If "0" is specified, the page and parameter changed by the notch page, and the notch page itself, are changed to the initial value. If a value which exceeds the maximum number of notches has been specified, the test ends by "CHECK CONDITION" status (ILLEGAL REQUEST [=5]/Invalid parameter in List [=26-00]).

  This field is a field which must be set during MODE SELECT.

- Starting Boundary

  This field is enabled by the MODE SENSE command. This field indicates the beginning of the active notch or, if the active notch is zero, the beginning of the logical unit (IDD).

- Ending Boundary

  This field is valid in the MODE SENSE command. This field indicates the ending of the active notch or, if the active notch is zero, the ending of the logical unit (IDD) (see Table 4.18).

- Page Notch

  This is a bit map which shows whether or not other mode pages are being changed if the device is notched. The most significant bit of this field corresponds to page code 3Fh and the least significant bit corresponds to page code 00h. If it is specified, the IDD disregards this value.

(9) Informational exceptions control page (page code = 1C)

Table 4.26 MODE SELECT parameters: informational exception control page

Byte \ Bit		7	6	5	4	3	2	1	0
0		0	0	0	1	1	1	0	0
1		Page length (X’0A’)							
2		Perf	0	EBF	EWASC	DExcpt	Test	0	LogErr
	Default	0	0	0	0	1	0	0	0
	Variable	1	0	1	1	1	1	0	1
3		0	0	0	0	MRIE			
	Default	0	0	0	0	0	0	0	0
	Variable	0	0	0	0	0	1	1	1
4-7		Interval Timer							
	Default	X‘00000000’							
	Variable	X‘FFFFFFFF’							
8-11		Report Count							
	Default	X‘00000001’							
	Variable	X‘FFFFFFFF’							

This page specifies whether the drive failure prediction function is enabled or disabled and the reporting method when a drive failure is predicted.

a. LogErr (log error)

   This bit (LogErr) of zero indicates that the logging of informational exception conditions within a target is vendor specific. A LogErr bit of one indicates the target logs informational exception conditions.

b. TEST

"1": If "0" is set for DExcpt, a failure prediction is reported with a failure prediction reporting condition that is generated when the time specified with Interval Timer has elapsed.

The method and number of times of this reporting are determined according to the specifications in the MRIE and Report Count fields. At this time, the sense key of 0x5D and the additional sense code of 0xFF are reported.

"0": This specifies that the test of the failure prediction function and its reporting method be disabled.

The value of this bit cannot be saved, and the stored value is fixed at 0. The current value is initialized to 0 when power is turned on or when LIPyx or TARGET RESET is received.

c. DExcpt (disable exception control)

This bit of zero indicates information exception operations is enabled. The reporting of information exception conditions when the "DExcpt" bit is set to zero is determined from the method of reporting informational exceptions field. A "DExcpt" bit of one indicates the target disables all information exception operations. The method of reporting informational exceptions field is ignored when "DExcpt" is set to one.

d. EWASC (enable warning)

This bit of zero indicates the target disables reporting of the warning. The "MRIE" field is ignored when "DExcpt" is set to one and "EWASC" is set to zero. An "EWASC" bit of one indicates warning reporting is enabled. The method for reporting the warning when the "EWASC" bit is set to one is determined from the "MRIE" field.

e. EBF (enable background function)

If background functions are supported, this bit of one indicates the target enables background functions. An "EBF" bit of zero indicates the target disables the functions.

f. Perf (performance)

This bit of zero indicates that informational exception operations that are the cause of delays are acceptable. A Perf bit of one indicates the target is not cause delays while doing informational exception operations. A Perf bit set to one may cause the target to disable some or all of the informational exceptions operations, thereby limiting the reporting of informational exception conditions.

g. MRIE (method of reporting informational exceptions)

This field indicates the methods that is used by the target to report informational exception conditions. The priority of reporting multiple informational exceptions is vendor specific.

Table 4.27 MRIE (1/2)

MRIE	Descriptor
X'00'	No reporting of informational exception conditions: This method instructs the target to not report informational exception conditions.
X'01' (setting prohibited)	Asynchronous event reporting: This method instructs the target to report informational exception conditions by using the rules for asynchronous event reporting as described in the SCSI-3 Architecture Model and the relevant Protocol Standard. The sense key shall be set to RECOVERED ERROR and the additional sense code shall indicate the cause of the informational exception condition.
X'02'	Generate unit attention: This method instructs the target to report informational exception conditions by returning a CHECK CONDITION status on any command. The sense key shall be set to UNIT ATTENTION and the additional sense code shall indicate the cause of the informational exception condition. The command that has the CHECK CONDITION shall not be executed before the informational exception condition is reported.
X'03'	Conditionally generate recovered error: This method instructs the target to report informational exception conditions, dependent on the value of the per bit of the error recovery parameters mode page, by returning a CHECK CONDITION status on any command. The sense key shall be set to RECOVERED ERROR and the additional sense code shall indicate the cause of the informational exception condition. The command that has the CHECK CONDITION shall complete without error before any informational exception condition may be reported.
X'04'	Unconditionally generate recovered error: This method instructs the target to report informational exception conditions, regardless of the value of the per bit of the error recovery parameters mode page, by returning a CHECK CONDITION status on any command.. The sense key shall be set to RECOVERED ERROR and the additional sense code shall indicate the cause of the informational exception condition. The command that has the CHECK CONDITION shall complete without error before any informational exception condition may be reported.

Table 4.27 MRIE (2/2)

MRIE	Descriptor
X’05’ (setting prohibited)	Generate no sense: This method instructs the target to report informational exception conditions by returning a CHECK CONDITION status on any command. The sense key shall be set to NO SENSE and the additional sense code shall indicate the cause of the informational exception condition. The command that has the CHECK CONDITION shall complete without error before any informational exception condition may be reported.
X’06’	Only report informational exception condition on request: This method instructs the target to report informational exception(s) information. To find out about information exception conditions the Application Client polls the target by issuing an unsolicited REQUEST SENSE command. The sense key shall be set to NO SENSE and the additional sense code shall indicate the cause of the information exception condition.
X’07’- X’0B’	Reserved
X’0C’- X’0F’	Reserved (Vendor Specific)

h. Interval timer

This field indicates the period in 100 millisecond increments for reporting that an informational exception condition has occurred. The target does not report informational exception conditions more frequency than the time specified by the "Interval Timer" field and as soon as possible after the timer interval has elapsed.

After the informational exception condition has been reported the interval timer is restarted. A value of zero in the "Interval Timer" field indicates that the target shall only report the informational exception condition one time. A value of X’FFFFFFFF’ in the "Interval Timer" field indicates the timer interval is vendor specific.

In the implementation, actual period unit to be used in reporting information exception condition is minute. Therefore a value is rounded-up to minute as shown below. a value of zero and X’FFFFFFFF’ in the interval timer field indicates that drive report the information exception condition once.

Table 4.28 Interval timer

A value of TIMER INTERVAL field	Actual time interval (minutes)
0, 0xFFFFFFFFh	Drive reports the informational exception condition once
1-600	1
601-1200	2
1201-1800	3
0xFFFFFE11-0xFFFFFFFE	7158279

The "Report Count" field indicates the number of timer to report an informational exception conditions to the application client.

A value of zero in the Report Count field indicates there is no limit on the number of timers the target shall report an information exception condition.

(10) Fibre channel control parameters (page code = 19)

Table 4.29 MODE SELECT parameters: fibre channel control parameters

Byte \ Bit		7	6	5	4	3	2	1	0
0		PS*	0	0	1	1	0	0	1
1		X‘0E’ (Page Length)							
2		X‘00’ (Reserved)							
3		DTFD	PLPB	DDIS	DLM	RHA	ALWLI	DTIPE	DTOLI
	Default	0	0	0	0	0	0	0	0
	Variable	1	1	1	1	1	1	1	1
4		X‘00’ (Reserved)							
5		X‘00’ (Reserved)							
6							RR_TOV Units		
	Default	0	0	0	0	0	0	1	1
	Variable	0	0	0	0	0	0	0	0
7		RR_TOV Value							
	Default	X‘14’							
	Variable	X‘00’							
8								CONTROL_MCM	
	Default	0	0	0	0	0	0	0	1
	Variable	0	0	0	0	0	0	0	0
9		X‘00’ (Reserved)							
10		X‘00’ (Reserved)							
11		ORIGINATOR CMR							
	Default	X‘00’							
	Variable	X‘00’							
12		X‘00’ (Reserved)							
13		RESPONDER CMR							
	Default	X‘00’							
	Variable	X‘00’							
14-15		MCM Timeout Value							
	Default	X‘0000’							
	Variable	X‘0000’							

a. DTOLI (disable target originated loop initialization)

This bit is possible to specify and operates according to the specification.

This bit specifies concerning LIP.

"1": – An Initializing LIP is not issued when the IDD enters the loop.

– If the Initializing LIP is received, operation corresponds to the Initialization LIP.

– When a Loop Failure is detected, the Loop Failure LIP [LIP (F8, x)] is issued.

– When clearing a Loop Failure, the Initializing LIP [LIP (F7, x)] is issued.

"0": – An Initializing LIP is issued when the IDD enters the Loop.

b. DTIPE (disable target initiated port enable)

This bit is possible to specify and operates according to the specification.

This bit specifies concerning Port Enable.

"1": Before the IDD enters the Loop, it has the Loop Port Enable Primitive from the INIT. It uses the hard address, which is usable by a SCA connector or a device address jumper.

"0": The IDD does not have the Loop Port Enable primitive, so it enters the loop port.

c. ALWLI (allow login without loop initialization)

This bit is possible to specify and operates according to the specification.

This bit specifies concerning Loop Initialization.

"1": The IDD uses the hard address, which is usable by a SCA connector or a device address jumper, and in loop initialization, it makes the address to respond to login without confirming it. (Loop Initialization is not performed.)

"0": The IDD carries out confirmation of the address in the Loop Initialization process.

d. RHA (require hard address)

This bit is possible to specify and operates according to the specification.

This bit specifies settings concerning enabling or disabling the Soft Address.

"1": In Loop Initialization, even if a hard address cannot be fixed, a soft address is not used.
In this case, the IDD enters a Non-participating State.
In the Non-participating State, if Loop Initialization is detected, try fixing a hard address again.

"0": In the Loop Initialization process, try fixing a soft address.

e. DLM (disable loop master)

This bit is possible to specify and operates according to the specification.

This bit specifies enabling or disabling of the Loop Master operation.

"1": – The IDD does not become the Loop Master.

– The IDD only resends the LISM frames that it receives.

– The IDD Permits the INIT to become the Loop Master.

"0": – The IDD itself is permitted to become the Loop Master.

f. DDIS (disable discovery)

This bit is possible to specify and operates according to the specification.

This bit specifies settings concerning Port/Address Discovery.

"1": – Address or Port Discovery is not necessary after Loop Initialization.

– When Loop Initialization is completed, task processing is restarted.

"0": – Before the INIT restarts task processing, it must wait for Address Discovery or Port Discovery.

g. PLPB (prevent loop port bypass)

This bit is possible to specify and operates according to the specification.

This bit specifies settings concerning Loop Port bypass (LPB)/Loop Port Enable (LPE).

"1": – Ignores Loop Port bypass (LPB)/Loop Port Enable (LPE) Primitive.

"0": – Receiving Loop Port bypass (LPB)/Loop Port Enable (LPE) Primitive, it controls Port Bypass circuit according to the received Primitive.

Note:

It is prohibited that "1" is specified in DTIPE and PLPB simultaneously.

If DTIPE=PLPB=1 is specified, it responds with CHECK CONDITION (ILLEGAL REQUEST, VALID FIELD IN THE PARAMETER LIST).

h. RR_TOV UNITS (resource recovery timeout value UNITS) (not supported)

This field specifies the time unit of the RR_ROV field.

The value specified in this field is ignored, and the default value 001b is always valid for operation.

Table 4.30 RR_TOV UNITS

RR_TOV UNITS	RR_TOV time unit
000	Timer is not specified
001	0.001 seconds
011	0.1 seconds
101	10 seconds

i. RR_TOV (resource recovery timeout value) (not supported)

This field specifies the time of RR_TOV.

The value specified in this field is ignored, and the default value X'14' is always valid for operation.

j. CONTROL_MCM (not supported)

This field specifies the MCM operation.

The value specified in this field is ignored, and the default value 01b is always valid for operation.

Table 4.31 CONTROL_MCM

CONTROL MCM	MCM operation
00	Joins all MCM operations and starts MCM.
01	Does not respond to any MCM primitive.
10	Joins all MCM operations but does not start MCM
11	Reserved

k. ORIGINATOR CMR (not supported)

This field specifies the minimum number of MCM circuits for each port that is an IDD originator.

The value specified in this field is ignored, and the default value X'00' is always valid for operation.

l. RESPONDER CMR (not supported)

This field specifies the minimum number of MCM circuits for each port that is an IDD responder.

The value specified in this field is ignored, and the default value X'00' is always valid for operation.

m. MCM_TOV (MCM Time Out Value) (not supported)

This field indicates the minimum time (ms) that the MCM state is in effect before the MCM device ECMC is transmitted.

The value specified in this field is ignored, and the default value X'0000' is always valid for operation.

(11) Additional error recovery parameters (page code = 21)

The page descriptor format of this MODE SELECT parameter is shown in Table 4.32.

Table4.32 MODE SELECT parameters: additional error recovery parameters

[Fujitsu unique parameter]

Byte \ Bit		7	6	5	4	3	2	1	0
0		0	0	1	0	0	0	0	1
1		X‘02’ (Page Length)							
2		0	0	0	0	Number of retries during a Seek Error			
	Default	0	0	0	0	1	1	1	1
	Variable	0	0	0	0	1	1	1	1
3		RFJ							
	Default	0	0	0	0	0	0	0	0
	Variable	0	0	0	0	0	0	0	0

a. Number of retries during a seek error

This parameter specifies the number of times repositioning is retried when a seek error is detected. When zero is specified in this field, repositioning retries are prohibited. The value specified in this field is applicable for all commands which are accompanied by a seek operation.

b. RFJ (reserved by Fujitsu)

All the bits in byte 3 are reserved by Fujitsu. The user should specify "0" in this bit.

4.1.5 MODE SELECT EXTENDED (55)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'55'							
1	0	0	0	PF	0	0	0	SP
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	Parameter List Length (MSB)							
8	Parameter List Length (LSB)							
9	0	0	0	0	0	0	0	0

This command performs setting and changing of each type of parameter related to disk drive physical attributes, data format, timing of Loop OPEN and error recovery procedures, etc.

This command's function is the same as that of the Group 0 MODE SELECT command (Section 4.1.4), except that the format of its data transferred by the INIT differs partially from that of the (MODE SELECT) data format.

Table 4.33 shows the configuration of the parameter list (MODE SELECT parameters) transferred by this command from the INIT. Compared to the 4-byte header in the Group 0 MODE SELECT command, it is necessary for an 8-byte header to be transferred in this command. The contents of each field in the header except that the byte positions differ, are the same as in the case of the Group 0 MODE SELECT command. The contents of the other parameters (Block descriptor, Page descriptor) are also the same as in the case of the Group 0 MODE SELECT command.

Table 4.33 MODE SELECT EXTENDED command (group 2) parameter configuration

Header

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘00’							
1	X‘00’							
2	X‘00’ (Medium Type)							
3	×	0	0	×	0	0	0	0
4	X‘00’							
5	X‘00’							
6	X '00' (Block Descriptor Length: LSB)							
7	X‘00’ or X‘08’ (block descriptor length: MSB)							

Block Descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	Data Block Count (MSB)							
1	Data Block Count							
2	Data Block Count							
3	Data Block Count (LSB)							
4	X‘00’							
5	Data Block Length (MSB)							
6	Data Block Length							
7	Data Block Length (LSB)							

Page Descriptor

	Byte \ Bit	7	6	5	4	3	2	1	0
Page Header	0	0	0	Page Code					
	1	Page Length							
	2	Parameter Field							
	~								
	n								

4.1.6 MODE SENSE (1A)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘1A’							
1	0	0	0	0	DBD	0	0	0
2	PC		Page Code					
3	0	0	0	0	0	0	0	0
4	Transfer Byte Length							
5	0	0	0	0	0	0	0	0

This command reports the values for each type of parameter related to the disk drive's physical attributes, data format, timing for FC interface Loop OPEN/CLOSE processing, error recovery procedures, etc., as well as the attributes of those parameters, to the INIT.

The data (MODE SENSE data) transferred to the INIT from the IDD by this command are configured from a "Header," "Block Descriptor" and one or more "Page descriptors" which describe each type of parameter, each of which will be described later in this item.

When "1" is specified in the "DBD (disable block descriptors)" bit of CDB byte 1, it indicates that a "Block descriptor" is not included in the MODE SENSE data transferred to the INIT by this command and the IDD transfers MODE SENSE data composed from the "Header" and the specified "Page descriptor" only to INIT. When "0" is specified in this bit, the IDD transfers MODE SENSE DATA composed of the "Header, " a single "Block descriptor" and the specified "Page descriptor" to the INIT.

The "Page code" field in CDB byte 2 specifies the page code of the "Page descriptor" transferred to the INIT by this command. The types of "Page descriptor" supported by the IDD and their page codes and lengths are as shown in Table 4.34.

Table 4.34 Mode page

Page Code	Page Descriptor Name	SCSI-3
1	Read/Write Error Recovery Parameter	12 bytes
2	Disconnect/Reconnect Parameter	16 bytes
3	Format Parameter	24 bytes
4	Drive Parameter	24 bytes
7	Verify Error Recovery Parameter	12 bytes
8	Read Caching Parameter	20 bytes
A	Control Mode Parameter	12 bytes
C	Notch Parameter	24 bytes
19	Fibre Channel Control Parameter	16 bytes
1C	Information Exception Control Parameter	12 bytes
21	Additional Error Recovery Parameter	4 bytes
3F	All Page Descriptors Supported by the IDD	176 bytes

When the value specified in the "Page code" field is other than X '3F', the specified "Page descriptor" only is transferred to the INIT, and when X '3F' is specified, all the "Page descriptors" supported by the IDD are transferred to the INIT in the ascending order of the page code. Also, when X '00' is specified in the "Page code field," the "Page descriptor" is not transferred. If page codes other than the above mentioned ones ("Page descriptors" which are not supported by the IDD) are specified, the command is terminated with a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in CDB [=24-00]).

Also the "PC (page control)" field in CDB byte 2 specifies the type of parameter value in the "Page descriptor" transferred to the INIT by this command, as shown in Table 4.35.

IMPORTANT

Even in cases where the value specified in the MODE SELECT or MODE SELECT EXTENDED command is described in Table 4.35 as the value reported to the INIT by this command, if parameter rounding processing is applied by the IDD, or in cases of a parameter or bit with a specified value that is disregarded, different values than those specified by the INIT will be reported. For details, see the descriptions of each page descriptor (in Section 4.1.4). Also, "0" is reported in byte positions and bit positions which are reserved in each page descriptor.

Table 4.35 MODE SENSE data type specifications

PC	Type of Parameter Transferred to the INIT
00	Current Values: Reports each "Current" parameter value. The "Current" values are either of the following values. • Values specified by a MODE SELECT or MODE SELECT EXTENDED command which is finally normally terminated. • When a MODE SELECT or MODE SELECT EXTENDED command is not executed after the power is switched on, after a LIP or after a TARGET RESET issued by any INIT is received, the same values as "Save" values. However, if "Save" values do not exist for parameters other than those on Page 3 and Page 4 (excluding byte 17), the same values as "Default" values.
01	Variable Values: The INIT reports variable parameter fields and parameter bits through the MODE SELECT or MODE SELECT EXTENDED command. A "1" is reported in the variable fields and bit positions in each page descriptor and "0" is reported in the fields and bit positions which cannot be changed. See the description of each page descriptor for the MODE SELECT command (Section 4.1.4) concerning the variability of each parameter.
10	Default Values: Reports the "Default" value of each parameter. See the description of each page descriptor for the MODE SELECT command (Section 4.1.4) concerning the actual default value of each parameter.
11	Save Values: Reports the "Save" value of each parameter. The "Save" values are either of the following values. • For parameters other than those on Page 3 and Page 4 (excluding byte 17), these are the values specified in a MODE SELECT or MODE SELECT EXTENDED command in which the "SP" bit after the final execution is completed is "1." When a MODE SELECT or MODE SELECT EXTENDED command in which the "SP" bit is "1" is not executed (when "Save" values do not exist), these are the same values as the "Default" values. • The values in the parameters in Page 3 and Page 4 (excluding byte 17) are the values save to the disk media during execution of the FORMAT UNIT command.

The "Transfer Byte Length" field in the CDB specifies the total number of bytes of MODE SENSE data which can be transferred to the INIT by this command. The IDD transfers the number of bytes of all the MODE SENSE data specified in the "Page code" field or the portion of MODE SENSE data with the length specified in the "Transfer Byte Length" field, whichever is smaller. When zero is specified in the "Transfer Byte Length" field, this command is terminated without anything being transferred.

Table 4.36 lists the data configuration in the parameter list (MODE SENSE data) transferred to the INIT by this command. The parameter list consists of a 4-byte header, an 8-byte block descriptor and one or more page descriptors, specified in the CDB, which are transferred in order. However, when "1" is specified in the DBD bit of the CDB, the block descriptor is not transferred. Also, when X'00' is specified in the "Page code" field of the CDB, the page descriptor is not transferred.

Table 4.36 MODE SENSE command (group 0) parameter configuration

Header

Byte \ Bit	7	6	5	4	3	2	1	0
0	Sense Data Length							
1	X‘00’ (Media Type)							
2	WP	0	0	DPOFUA	0	0	0	0
3	X‘00’ or X‘08’ (Block Descriptor Length)							

Block Descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	Data Block Count (MSB)							
1	Data Block Count							
2	Data Block Count							
3	Data Block Count (LSB)							
4	X‘00’							
5	Data Block Length (MSB)							
6	Data Block Length							
7	Data Block Length (LSB)							

Page Descriptor

	Byte \ Bit	7	6	5	4	3	2	1	0
Page Header	0	PS	0	Page Code					
	1	Page Length							
	2	Parameter Field							
	~								
	n								

(1) Header

a. Sense data length

This field indicates the length (number of bytes) of the parameter list (MODE SENSE data) which it is possible to transfer to the INIT by this command. The length of the "Sense data length" field itself is not included in this value. Also, a value for a portion of data with a length that is supported by the IDD is reported in this field for a parameter list of the type specified in the CDB regardless of the specification of the "Transfer byte length" field in the CDB. In order for the INIT to confirm that all the parameter list requested in the command has been transferred, it should check whether the value which has the length of the "Sense data length" field itself added to the value indicated in this field is less than the value specified in the "Transfer byte length" field.

b. Media type

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

c. WP bit

When this bit is "1," it indicates that a write operation to the disk media is prohibited and when "0" is specified, it indicates that a write operation is permitted.

d. DPOFUA bit

When this bit is "0," it indicates that the IDD does not supports the DPO and FUA bit. When this bit is "1," it indicates that the IDD supports the DPO and FUA bits.

e. Block descriptor length

This field indicates the "Block descriptor" length (byte length) which follows after the header. The "Page descriptor" length is not included in this value. The IDD always reports X '08' in this field if "0" is specified in the DBD bit of this command's CDB, and thus indicates that one "Block descriptor" set follows after the header. When "1" is specified in the DBD bit of the CDB, the value of this field is X '00'.

(2) Block descriptor

The 8-byte "Block descriptor" indicates the logical attributes of the data format on the disk media.

a. Data block count

This field indicates the total number of logical data blocks (the block length is shown in the "Data block length" field) existing in the "User Space" on the disk media. This value does not include the number of spare sectors reserved for alternate block processing.

Furthermore, when this command specifies to transfer the "Default" value and "Variable" value, the value shown in this field is X '000000' (which means the maximum number of logical data blocks that it is possible to rank in the "User Space").

b. Data block length

This field indicates the length (byte length) of 1 logical data block on the disk media.

(3) Page descriptor

The "Page descriptor" is configured from a parameter field which follows a 2-byte page header, and is divided into units called "Page" for each parameter's functional attributes. See the description of the MODE SELECT command (Section 4.1.4) concerning the configuration of each page descriptor and their contents.

a. PS bit

When this bit is "1," the parameter value defined in that "Page descriptor" can be saved on the disk media, and when it is "0", it indicates that this is a parameter which cannot be saved to the disk. It is possible to save all the "Page descriptors" supported by the IDD. However, "1" is always indicated in this bit for all "Page descriptors" transferred by this command.

b. Page length

This field indicates the length of the parameter field (number of bytes) from byte 2, excluding the page header of that "Page descriptor." The IDD always shows a value in this field which is the same as the length defined in that "Page descriptor" regardless of the type of parameter requested in the "PC (page control)" field of the CDB, and reports all the parameter fields that "Page descriptor" in byte 2 and subsequent bytes.

c. Parameter field

The parameter field in byte 2 and subsequent bytes, indicates parameter values of the type (current values, variable values, default values or save values) requested in the "PC (page control)" field of the CDB. See the description of the MODE SELECT command (Section 4.1.4) concerning the definition of each parameter, "Default" values and "Variable" values.

4.1.7 MODE SENSE EXTENDED (5A)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘5A’							
1	0	0	0	0	DBD	0	0	0
2	PC		Page Code					
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	Transfer Byte Length (MSB)							
8	Transfer Byte Length (LSB)							
9	0	0	0	0	0	0	0	0

This command reports the values for each type of parameter related to the disk drive's physical attributes, data format, timing for FC interface Loop OPEN/CLOSE processing, error recovery procedures, etc., as well as the attributes of those parameters, to the INIT.

The functions of this command are the same as those of the Group 0 MODE SENSE command (Section 4.1.7) except that the format of data (MODE SENSE data) transferred to the INIT differs somewhat.

Table 4.37 lists the data configuration of the parameter list (MODE SENSE data) transferred to the INIT by this command. Compared to the 4-byte header in the case of a Group 0 MODE SENSE command, an 8-byte header is transferred in this command. The meanings of each field and bit in the header are the same as in the case of the Group 0 MODE SENSE command, except that the byte positions differ. Also, the contents of the other parameters (block descriptor and page descriptors) are the same as in the case of the Group 0 MODE SENSE command.

Table 4.37 MODE SENSE EXTENDED command (group 2) parameter configuration

Header

Byte \ Bit	7	6	5	4	3	2	1	0
0	Sense Data Length (MSB)							
1	Sense Data Length (LSB)							
2	X‘00’ (Media Type)							
3	WP	0	0	DPOFUA	0	0	0	0
4	X‘00’							
5	X‘00’							
6	X‘00’ (Block Descriptor Length: MSB)							
7	X‘00’ or X‘08’ (Block Descriptor Length: LSB)							

Block Descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	Data Block Count (MSB)							
1	Data Block Count							
2	Data Block Count							
3	Data Block Count (LSB)							
4	X‘00’							
5	Data Block Length (MSB)							
6	Data Block Length							
7	Data Block Length (LSB)							

Page Descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	PS	0	Page Code					
1	Page Length							
2 ~ n	Parameter Field							

4.1.8 REZERO UNIT (01)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘01’							
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0

This command moves the read/write heads of the disk drive to the initial position (physical cylinder 0 / physical track 0). A data block with the physical block address of zero exists at the initial position. Initialization of the disk drive's positioning control system and automatic adjustment are also performed by this command.

4.1.9 START/STOP UNIT (1B)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘1B’							
1	0	0	0	0	0	0	0	Immed
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	LoEj	Start
5	0	0	0	0	0	0	0	0

This command controls starting and stopping of the disk drive's spindle motor. Control of the spindle motor is performed through the "Start" bit in bit 0 of the CDB byte 4.

The spindle motor can be stopped if this command is issued with the "Start" bit as "0." On the other hand, the spindle motor can be started by specifying "1" in the "Start" bit.

Bit 1 (LoEj (load/eject) of byte 4 of the CDB is the exclusive bit which controls devices with replaceable recording media, and it has no meaning for the IDD. The IDD disregards the value specified in this bit and controls starting and stopping of the spindle motor in accordance with the "Start" bit only.

It is possible to select the disk drive's spindle motor starting mode through the extrnal setting terminal. If prohibition of motor starting control is set by this command at the setting terminal, the spindle motor starts automatically when the IDD's power is switched on. It is possible to delay the starting time by the value of SEL_ID. When the setting terminal is being set to perform motor starting control by command, the IDD's spindle motor will not start even when the power is switched on. In this case, it is necessary for the INIT to issue a command to start the spindle motor.

IMPORTANT

> The setting terminal specifies only the spindle motor starting method at power on time, and whichever mode is set, this command is valid.
>
> The INIT can issue this command whenever it is desired and stop or start the spindle motor regardless of the state of the setting terminal.

Depending on the value specified in the "Immed (immediate)" bit, bit 0 of CDB byte 1, the timing of completion (status byte report) of this command differs as shown below.

a. In the case of the start specification ("Start" bit = "1")

   – When the "Immed" bit is "1," simply by instructing starting of the spindle motor, a GOOD status is reported without waiting until the disk drive is in the Ready state, and command execution is completed.

   – When the "Immed" bit is "0," the status byte is reported, and command execution is completed, at the point when the disk drive has entered the Ready state after the spindle motor has started.

b. In the case of the stop specification ("Start" bit = "0")

   – When the "Immed" bit is "1," simply by instructing stopping of the spindle motor, the GOOD status is reported and command execution is completed.

   – When the "Immed" bit is "0," the status byte is reported, and command execution is completed, after the spindle motor is in the stopped state.

4.1.10 RESERVE (16)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'16'							
1	0	0	0	3rd Pty	3rd Pty Dev ID			0
2	×	×	×	×	×	×	×	×
3	×	×	×	×	×	×	×	×
4	×	×	×	×	×	×	×	×
5	0	0	0	0	0	0	0	0

Together with the RELEASE command, this command controls exclusive access to the logical unit (IDD) under a multi-initiator environment.

The IDD is reserved by this command for the INIT which issued this command.

The values specified in bytes 2 to 4 of the CDB have no meaning and are disregarded, but it is preferable that the INIT specify X'00' in these bytes.

(1) Logical unit reserve function

This command reserves the entire IDD (logical unit) for use as a special FC device. The reserve state established by this command is maintained until any one of the following conditions occurs.

1) The reserve condition is changed by the INIT that issued this command (Superseding Reserve).

2) Reserve is released by a RELEASE command from the INIT that issued this command.

3) Receiving TARGET RESET message from any INIT.

4) Receiving LIP (y, x).

5) Switching the IDD's power off or on.

When an IDD is reserved for any FC device, if this command is issued by an INIT that doesn't have the "Reserve Right" for that IDD, this command is terminated with a RESERVATION CONFLICT status.

After the Reserved status is established, a command issued by an INIT other than the FC device that reserved the IDD is rejected, except an INQUIRY, REQUEST SENSE or RELEASE command, and a RESERVATION CONFLICT status is reported to the INIT that issued that command. A RELEASE command is the release operation specified in a RELEASE command issued to the IDD by a FC device which does not have the Reserve Right is disregarded.

(2) Reserve right and third party reserve function

IMPORTANT

The third party reserve function is not supported by the drive.

If the "3rd Pty" bit in byte 1 of the CDB is "0," the IDD is reserved by the INIT which issued this command and that INIT has the Reserve right for the IDD.

If the "3rd Pty" bit is "1," the third party reserve function is specified. An INIT which specifies the third party reserve function and issues this command can reserve the IDD for use by another FC device. In this case, this command reserves the IDD for the device (called the third party device) with the ALPA specified in the "3rd Pty FC Dev ID" field in byte 1 of the CDB. Even if the IDD is reserved for another FC device using the third party reserve function the reserve right for that ID resides with the INIT that issued this command. Therefore, in order to release that reserve state, it is necessary for the INIT that issued this command to issue a RELEASE command (shown in Section 4.1.12) with the third party release function specified. Also, the conditions for maintaining the reserve state established by the third party reserve function are the same as in the case where the third party reserve function is not used. (See item (1).)

(3) Changing the reserve conditions (Superseding Reserve)

The INIT which has the reserve right for an IDD (the INIT which has issued this command in the past and has established the IDD reserve state) can change the IDD's reserve conditions by issuing a another RESERVE command (Superseding Reserve).

When a superseding reserve is executed, the IDD releases the reserve state it was in up to that point and establishes a new reserve state in accordance with the specifications in this newly issued command.

By using this function, the INIT can, for example, change the FC device (ALPA) for which the logical unit is reserved while continuing the reserve state of the logical unit with which the reserve state was established using the previous third party reserve function.

- Reserve right and the third party reserve function

Remark

In order to clarify the jurisdiction related to reserve and release, the term "Reserve Right" is used in this manual.

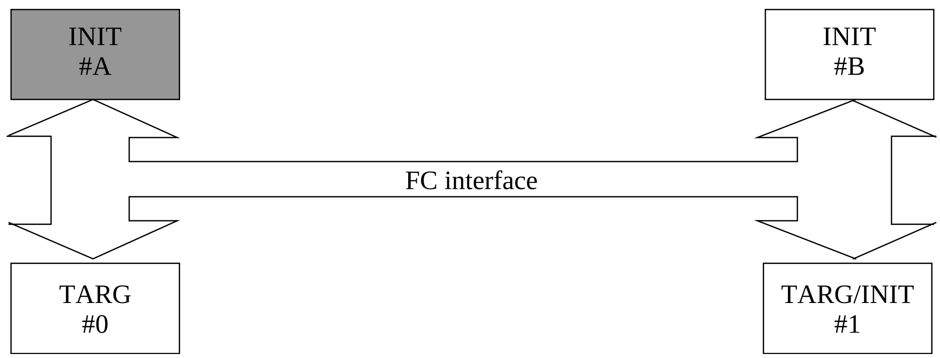

Figure 4.2 Reserve right and the third party reserve function

1. If INIT #A issues a RESERVE command which does not specify the third party reserve function to TARG #0, TARG #0 enters the reserved state from INIT #A and INIT #A has the reserve right with respect to TARG #0. In this case,

   – INIT #A has an exclusive monopoly over TARG #0.

   – Any commands issued to TARG #0 by any other FC device (INIT #B, TARG/INIT #1) are rejected with a RESERVATION CONFLICT status, with the exception of an INQUIRY, REQUEST SENSE or RELEASE command. The RELEASE command is terminated normally, but TARG #0's reserve state is not influenced by it.

2. If INIT #A issues a RESERVE command which specifies the third party reserve function ("3rd Pty Dev ID" = TARG/INIT#1), TARG #0 becomes reserved from TARG/INIT #1, but INIT #A has the reserve right. In this case,

   – TARG/INIT #1 has an exclusive monopoly of TARG #0. However, if TARG/INIT#1 issues a RESERVE command, that command is rejected with a RESERVATION CONFLICT status. Also, a RELEASE command is terminated normally, but it has no influence on the TARG #0 reserve right.

   – INIT #A can issue INQUIRY, REQUEST SENSE, RELEASE and RESERVE commands to TARG #0, but other commands are rejected with a RESERVATION CONFLICT status. A RELEASE or RELEASE EXTENDED command issued by INIT #A releases TARG #0's reserved state. Also, a RESERVE or RESERVE EXTENDED command changes the reserve state of TARG #0.

– Commands issued by INIT #B to TARG #0 are rejected with a RESERVATION CONFLICT status, except the INQUIRY, REQUEST SENSE and RELEASE commands. A RELEASE command is terminated normally, but it has no influence on the TARG #0 reserve right.

3. An example of the third party reserve function is applicable when using the COPY command. For example, TARG/INIT #1 supports the COPY command, uses the COPY command and in the case that a data transfer between TARG #0 and TARG/INIT#1 is executed, if the third party reserve in 2) is executed before INIT #A issues a COPY command to TARG/INIT #1, access to TARG #0 by INIT #B during execution of the COPY command can be prohibited.

4.1.11 RESERVE EXTENDED (56)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘56’							
1	0	0	0	3rd Pty	0	0	0	0
2	×	×	×	×	×	×	×	×
3	Third Party Device ID							
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	×	×	×	×	×	×	×	×
8	×	×	×	×	×	×	×	×
9	0	0	0	0	0	0	0	0

Together with the RELEASE command, this command controls exclusive access to the logical unit (IDD) under a multi-initiator environment.

4.1.12 RELEASE (17)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘17’							
1	0	0	0	3rd Pty	3rd Pty Dev ID			0
2	×	×	×	×	×	×	×	×
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0

This command releases the reserve state of an IDD in relation to the INIT that issued this command.

When a reserve state in relation to the INIT that issues this command, or an IDD does not exist, this command is terminated normally with a GOOD status.

Also, the value specified in CDB byte 2 has no meaning and is disregarded, but it is desirable for X '00' to be specified by the INIT in this byte.

Also, the value specified in CDB byte 3 to 4 reports CHECK CONDITION status "05-24-00" except for X"00" is specified.

(1) Release function

This command releases a reserve state if a reserve state exists, and if the INIT which issued this command has a reserve right for the entire IDD (logical unit).

(2) Release object and third party release function

IMPORTANT

The third party reserve function is not supported by the drive.

When the "3rd Pty" bit in CDB byte 1 is "0," this command cancels a reserve state if it exists in the IDD that has been reserved by a RESERVE command without the INIT that issued this command specifying the third party reserve function.

When the "3rd Pty" bit is "1," the third party release function is specified and this command can release a reserve state established in the past by the third party reserve function. When the third party release function is specified, this command releases the reserve state only when the INIT that issued this command is the same as the INIT that used the RESERVE command in the past to specify the third party reserve function which caused the IDD to be reserved for the FC device (third party device) specified in the "3rd Pty Dev ID" field in CDB byte 1 of this command.

4.1.13 RELEASE EXTENDED (57)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘57’							
1	0	0	0	3rd Pty	0	0	0	0
2	×	×	×	×	×	×	×	×
3	Third Party Devices ID							
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	×	×	×	×	×	×	×	×
8	×	×	×	×	×	×	×	×
9	0	0	0	0	0	0	0	0

Same as RELEASE command.

4.1.14 REQUEST SENSE (03)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘03’							
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	Transfer Byte Length							
5	0	0	0	0	0	0	0	0

This command transfers sense data to the INIT.

This command is executed in any state other than a CDB specification error.

The IDD's sense data has a length of 48 bytes. The IDD generates sense data in any of the following cases and holds the sense data for the INIT which issued that command.

1) When the command that is currently being executed terminates with the CHECK CONDITION status.

2) When the command which the IDD is currently executing terminates abnormally due to the occurrence of an irrecoverable error at the FC interface.

3) When an irrecoverable error occurs in a write command that is currently being executed after the "Good" status was reported by the WCE bit specification (deferred error).

4) When a failure state occurs (INITIAL SEEK failure, SA READ failure, etc.)

5) When a command terminates with the "CHECK CONDITION" status due to a Unit Attention being reported.

Sense data are basically sent to the INIT at the same time as the status in the command's response frame in the case where an error occurred in the issued command. (AUTO SENSE function)

In the case of the FC, the object of a sense hold is a deferred error, an interface system error and a UNIT ATTENTION.

Sense data being held are cleared if there is a SYSTEM RESET (LIP (y, x)) or LOGOUT, or a LIP (y, x) or Target Reset (TARGET RESET) from the INIT which is the object of the hold.

In the case of SCSI, at times such as when a command terminates with the "CHECK CONDITION" status, it is necessary for the INIT to issue this command and fetch sense data, but in the case of the FC, this is basically an AUTO SENSE function and the sense data are reported at the same time as that command's status, so caution should be exercised.

Concerning the format of sense data, see the "Sense Data Specifications" or for details on the sense data hold state, see the "Command Processing Function Specifications".

If this command is executed when the IDD is holding the Unit Attention condition, at that point, if the IDD is not in the sense data hold state, sense data showing the Unit Attention condition are created by this command and are sent to the INIT, and the Unit Attention condition is cleared.

If this command is issued when no valid sense data are being held, the IDD sends sense data with a sense key which shows "NO SENSE".

The "Transfer Byte Length" field in the CDB show the number of bytes of sense data that can be received by the INIT. The IDD transfers sense data with a length that is specified in the "Transfer Byte Length" field or the IDD's own sense data length (48 bytes), whichever is smaller.

When the value specified in the "Transfer Byte Length" shows 48 bytes or more, 48 bytes of sense data are transferred and the command terminates with the "GOOD" status.

This command reports the "CHECK CONDITION" status and terminates abnormally only in the cases where the conditions shown below are detected. In this case, new sense data are generated and the sense data held up to that time are lost.

1) When sending of sense data is impossible due to an IDD hardware error.

2) When an irrecoverable error is detected on the FC interface.

3) If an overlapped command occurs.

4) A error in a specification other than the LUN field of the CDB.

In cases other than the above, this command sends sense data showing the status to the INIT there are sense data being held or if an error is detected during execution of this command when no sense data are being held, and it terminates with the "GOOD" Status.

However, if an error is detected which is recovered from by a retry during execution of this command, and the mode which reports "RECOVERED ERROR" is set, after this command sends the sense data to the INIT, it terminates with the "CHECK CONDITION" status and sense data which show "RECOVERED ERROR" are newly generated.

4.1.15 LOG SELECT (4C)

Byte \ Bit	7	6	5	4	3	2	1	0
1	X'4C'							
2	0	0	0	0	0	0	PCR	SP
3	PC		0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	Parameter List Length (MSB)							
8	Parameter List Length (LSB)							
9	0	0	0	0	0	0	0	0

This command provides a means for an application client to manage statistical information maintained by the IDD about IDD. The INIT can know the types of statistical information and the current maintaining of each statistical information by using the LOG SENSE command.

A "Save Parameters (SP)" bit is one indicates that after performing the specified LOG SELECT operation the drive will save all parameters to the disc medium. A "SP" bit of zero specifies that parameters is not saved. It is not an error to set the "SP" bit to one and to set the DS bit of a log parameter to one. In this case, the parameter value for that log parameter is not saved.

The "Parameter Code Reset (PCR)" bit of one and a "Parameter list length" of zero cause all implemented parameters to be set to zero. It also clears the SMART Failure Warning and the Thermal Warning. If the "PCR" bit is one and the parameter list length is greater than zero, the command is terminated with CHECK CONDITION status (ILLEGAL REQUEST [=5] / INVALID FIELD IN CDB [=24-00]). In this case, the log parameters are not cleared. A PCR bit of zero specifies that the log parameters is not reset.

The "Page Control (PC)" bits specifies a kind and treatment content of parameters that changed by this command as shown in Table 4.38.

Table 4.38 PC (page control)

Value	Description
00b	Current threshold values
01b	Current cumulative values
10b	Default threshold values
11b	Default cumulative values

The "PC" bits are ignored by the drive. The drive assumes that current cumulative parameters are selected.

The "Parameter List Length" field specifies the length in bytes of the parameter list that is located in the Data-Out Buffer. If a parameter list length results in the truncation of any log parameter, the device server terminates this command with CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in CDB [=24-00]).

A "Parameter List Length" of zero indicates that no pages shall be transferred. This condition shall not be considered an error.

IMPORTANT

The IDD does not support that the application client should send pages in ascending order by page code value if the Data-Out Buffer contains multiple pages.

Table 4.39 LOG SELECT command parameter configuration

	Byte \ Bit	7	6	5	4	3	2	1	0
Header	0	Page Code							
	1	Reserved							
	2	Page Length (MSB)							
	3	Page Length (LSB)							
Log Paramete	4 ~ x+3	Log Parameter (First) (Length x)							
	~								
	n-y+1 ~ n	Log Parameter (Last) (Length y)							

a. Page code

This field identifies which log page is being transferred.

The log pages that can be transferred by this command are shown in Table 4.40.

Table 4.40 Page code

Page Code	Description	Changeable Parameter
01	Buffer Overrun/Underrun Page	Disable
02	Write Error Counter Page	Enable
03	Read Error Counter Page	Enable
05	Verify Error Counter Page	Enable
06	Non-medium Error Page	Enable
0D	Temperature Page	Disable
0E	Start-stop Cycle Counter Page	Enable only 0002
0F	Application Client Log Page	Enable
10	Self-Test Result Log Page	Disable

b. Page length

This field specifies the length in bytes of the following log parameters. If the application client sends a page length that results in the truncation of any parameter, the device server terminates the command with CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in parameter list [=26-00]).

The log pages contain one or more special data structures called log parameters as shown below. Each log parameter begins with a 4-byte parameter header followed by one or more bytes of "Parameter Value" data.

Table 4.41 Page descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	Parameter Code (MSB)							
1	Parameter Code (LSB)							
2	DU	DS	TSD	ETC	TMC		LBIN	LP
3	Parameter Length							
4 ~ n	Parameter Value							

a. Parameter code

This field identifies the log parameter being transferred for that log page.

b. Byte 2

1) DU (Disable Update)

"1": The IDD does not update the log parameter value except in response to a LOG SELECT command that specifies a new value for the parameter.

"0": The IDD updates the log parameter value to reflect all events that are noted by that parameter.

2) DS (Disable Save)

"1": The IDD does not support saving that log parameter in response to LOG SELECT or LOG SENSE command with an "SP" bit of one.

"0": The IDD supports saving for that log parameter. The IDD saves the current parameter value in response to LOG SELECT or LOG SENSE command with a "SP" bit of one.

3) TSD (Target Save Disable)

The IDD does not support this bit. For LOG SENSE command (See 4.1.16), the IDD always report zero. Also, for this command, the IDD accepts this bit value of "1", but ignores its functionality.

4) ETC (Enable Threshold Comparison)

The IDD does not support this bit. For LOG SENSE command (See 4.1.16), the IDD always report zero. Also, for this command, the IDD accepts this bit value of "1", but ignores its functionality.

5) TMC (Threshold Met Criteria)

This field is ignored when "ETC" bit is 0. For LOG SELECT command (See 4.1.15), the IDD accepts this field value of other than "00b", but ignores its functionality.

6) LBIN

This bit is only valid if the "LP" bit is one. If the "LP" bit is one and this bit is zero then the list parameter is a string of ASCII graphic codes.

If the "LP" bit is one and this bit is one then the list parameter is a list of binary information.

7) LP (List Parameter)

"1": The parameter is a data counter.

"0": The parameter is a list parameter.

If these bits are specified by LOG SELECT command, the IDD terminates normally.

But the IDD's action is not changed.

For LOG SENSE command, these bits always report value defined in each log page (see 4.2).

4.1.16 LOG SENSE (4D)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'4D'							
1	0	0	0	0	0	0	PPC	SP
2	PC		Page Code					
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	Parameter Pointer (MSB)							
6	Parameter Pointer (LSB)							
7	Parameter List Length (MSB)							
8	Parameter List Length (LSB)							
9	0	0	0	0	0	0	0	0

This command provides a means for the application client to retrieve statistical or other operational information maintained by the device about the device or its logical units.

It is a complementary command to the LOG SELECT command.

The "Parameter Pointer Control (PPC)" bit is not supported. It should be zero.

An "Save Parameters (SP)" bit of zero indicates the device server performs the specified this command and does not save any log parameters. If saving log parameters is implemented, an "SP" bit of one indicates that the device server performs the specified this command and saves all log parameters identified as savable by the "DS" bit to the disc medium.

The "Page Control (PC)" field defined the type of parameter values to be selected (see 4.1.15 for the definition of the page control field).

The "PC" bits are ignored by the drive. The drive assumes that current cumulative parameters are selected.

The "Page Code" field identifies which page of data is being requested. If the page code is reserved or not implemented, the device server terminates the command with CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in CDB [=24-00]).

The "Page Code" assignments for the log pages are listed in Table 4.42.

Table 4.42 "Page Code" assignment for the log pages

Page Code	Description	Parameter Pointer
00	Supported Log Pages	Ignored
01	Buffer Overrun / Underrun Page	Supported
02	Write Error Counter Page	Supported
03	Read Error Counter Page	Supported
05	Verify Error Counter Page	Supported
06	Non-medium Error Page	Should be zero
0D	Temperature Page	Supported
0E	Start-stop Cycle Counter Page	Supported
0F	Application Client Log Page	Supported
10	Self-Test Result Log Page	Supported
2F	SMART Status Page	Ignored
38	SMART Data Page	Ignored

The "Parameter Pointer" field allows the application client to request parameter data beginning from s specific parameter code to the maximum allocation length or the maximum parameter code supported by the target, whichever is less. If the value of the "Parameter Pointer" field is larger than the largest available parameter code known to the device server for the specified page, the device server terminates the command with CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in CDB [=24-00]).

The "Parameter List Length" field in the CDB specifies the total number of bytes of log parameter which can be transferred to the INIT by this command. The IDD transfers the number of bytes of all log parameters specified in the "Page Code" field or the portion of log parameters with the length specified in the "Parameter List Length" field, whichever is smaller. When zero is specified in the "Parameter List Length" field, this command is terminated without anything being transferred.

- **Log parameters**

This clause describes the log page structure and the log pages that are applicable to all FC devices. Pages specific to each device type are described in the command standard that applies to that device type. The LOG SENSE command returns a single log page specified in the page code field of the command descriptor block.

(1) Support log page (X'00')

The supported log page returns the list of log pages implemented by the drive.

Table 4.43 Support log page (X'00')

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0
1	X‘00’ (Reserved)							
2	X'00' (Parameter Length)							
3	X'0C' (Parameter Length)							
4	X'00' (Supported Page)							
5	X'01' (Supported Page)							
6	X'02' (Supported Page)							
7	X'03' (Supported Page)							
8	X'05' (Supported Page)							
9	X'06' (Supported Page)							
10	X'0D' (Supported Page)							
11	X'0E' (Supported Page)							
12	X'0F' (Supported Page)							
13	X'10' (Supported Page)							
14	X'2F' (Supported Page)							
15	X'38' (Supported Page)							

(2) Buffer overrun/underrun page (X'01')

Table 4.44 Buffer overrun/underrun page (X'01')

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	1
1	X'00' (Reserved)							
2	X'00' (Page Length)							
3	X'0C' (Page Length)							
4	X'00' (Reserved)							
5	Count Basis			Cause				Type
	0	0	0	0	0	0	0	0
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'02' (Parameter Length)							
8-9	X'0000' (Data Underrun)							
10	X'00' (Reserved)							
11	Count Basis			Cause				Type
	0	0	0	0	0	0	0	0
12	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
13	X'02' (Parameter Length)							
14-15	X'0000' (Data Overrun)							

Cause

0h : Undefined

1h : SCSI bus busy, optional

2h : Transfer rate too slow, optional

3h-Fh : Reserved

The drive dose not supports this field. Zero is always reported.

- Count Basis

  0h : Undefined

  1h : Per command, optional

  2h : Per failed reconnect, optional

  3h : Per unit of time, optional

  4h-7h : Reserved

  The drive does not support this field. Zero is always reported.

- Data Underrun

  Count of data underruns which occur during write operation when a buffer empty condition prevents continued transfer of data to the media from the buffer.

  The drive does not support this field due to a hardware limitation. Zero is always reported.

- Data Overrun

  Count of data overruns which occur during read operation when a buffer full condition prevents continued transfer of data from the media to the buffer.

  The drive does not support this field due to a hardware limitation. Zero is always reported.

(3) Write error count page (X'02')

Table 4.45 Write error count page (X'02')

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	1	0
1	X‘00’ (Reserved)							
2	Page Length (MSB)							
3	Page Length (LSB)							

All of the following parameters have this header.

Page Length will be defined based on the value of Parameter Pointer. (CDB 5-6)

- Write errors recovered without delays (page 02, code 0000)

Table 4.46 Write errors recovered without delays (page 02, code 0000)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0000' (Parameter code)							
5	(Errors Recovered Without Delays) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'04' (Parameter Length)							
8	(MSB)							
9	Counter Value							
10								
11	(LSB)							

The Counter Value indicates the count of all recovered write errors that would not be reported to the initiator during write operations, because no delay is incurred.

The drive does not support this field due to a hardware limitation. Zero is always reported.

- Write errors recovered with possible delays (page 02, code 0001)

Table 4.47 Write errors recovered with possible delays (page 02, code 0001)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0001' (Parameter code)							
5	(Errors Recovered With Possible Delays) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'04' (Parameter Length)							
8	(MSB)							
9	Counter Value							
10								
11	(LSB)							

The Counter Value indicates the count of all recovered write errors that would not be reported to the initiator during write operations, because possible delay is incurred.

- Total write errors posted (page 02, code 0002)

Table 4.48 Total write errors posted (page 02, code 0002)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0002' (Parameter code)							
5	(Total Posted Errors) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'04' (Parameter Length)							
8	(MSB)							
9	Counter Value							
10								
11	(LSB)							

The Counter Value indicates the count of all posted errors to the interface during write operations.

Implementation:
If a write error is posted, it will force a save of all error log pages information.

- Total recoverable write errors posted to INIT (page 02, code 0003)

Table 4.49 Total recoverable write errors posted to INIT (page 02, code 0003)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0003' (Parameter code)							
5	(Total Posted Recoverable Errors) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'04' (Parameter Length)							
8	(MSB)							
9	Counter Value							
10								
11	(LSB)							

The Counter Value indicates the count of all posted recovered (01/xx/xx) errors to the interface during write operations.

- Total write bytes processed (page 02, code 0005)

Table 4.50 Total write bytes processed (page 02, code 0005)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0005' (Parameter code)							
5	(Total Bytes Processed) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'0A' (Parameter Length)							
8	(MSB)							
9								
~	Total Write Bytes Processed (10 bytes)							
16								
17	(LSB)							

The Total Write Bytes Processed indicates the total processed bytes during write operations.

- Total unrecoverable write errors posted to INIT (page 02, code 0006)

Table 4.51 Total unrecoverable write errors posted to INIT (page 02, code 0006)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0006' (Parameter code)							
5	(Total Posted Unrecoverable Errors) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'04' (Parameter Length)							
8	(MSB)							
9	Counter Value							
10								
11	(LSB)							

The Counter Value indicates the count of all posted unrecovered errors (03/xx/xx) to the interface during write operations.

(4) Read error count page (X'03')

Table 4.52 Read error count page (X'03')

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	1	1
1	X‘00’ (Reserved)							
2	Page Length (MSB)							
3	Page Length (LSB)							

All of the following parameters have this header.

Page Length will be defined based on the value of Parameter Pointer. (CDB 5-6)

- Read errors recovered without delays (page 03, code 0000)

Table 4.53 Read errors recovered without delays (page 03, code 0000)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0000' (Parameter code)							
5	(Errors Recovered Without Delays) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'04' (Parameter Length)							
8	(MSB)							
9	Counter Value							
10								
11	(LSB)							

The Counter Value indicates the count of all recovered read errors that would not be reported to the initiator during read operations, because no delay is incurred.

- Read errors recovered with possible delays (page 03, code 0001)

Table 4.54 Read errors recovered with possible delays (page 03, code 0001)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0001 (Parameter code)							
5	(Errors Recovered With Possible Delays) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'04' (Parameter Length)							
8	(MSB)							
9	Counter Value							
10								
11	(LSB)							

The Counter Value indicates the count of all recovered read errors that would not be reported to the initiator during read operations, because possible delay is incurred.

- Total read errors posted (page 03, code 0002)

Table 4.55 Total read errors posted (page 03, code 0002)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0002' (Parameter code)							
5	(Total Posted Errors) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'04' (Parameter Length)							
8	(MSB)							
9	Counter Value							
10								
11	(LSB)							

The Counter Value indicates the count of all posted errors to the interface during read operations. The value includes the count of all posted verify errors to the interface (page X'05', Parameter code X'0002').

Implementation:

If a read error is posted, it will force a save of all error log pages information.

- Total recoverable read errors posted to INIT (page 03, code 0003)

Table 4.56 Total recoverable read errors posted to INIT (page 03, code 0003)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB)							
5	X'0003 (Parameter code) (Total Posted Recoverable Errors)							(LSB)
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'04' (Parameter Length)							
8	(MSB)							
9	Counter Value							
10								
11								(LSB)

The Counter Value indicates the count of all posted recovered (01/xx/xx) errors to the interface during read operations. The value includes the count of all posted recovered verify errors (page X'05', Parameter code X'0003').

- Total read bytes processed (page 03, code 0005)

Table 4.57 Total read bytes processed (page 03, code 0005)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB)							
5	X'0005' (Parameter code) (Total Bytes Processed)							(LSB)
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'0A' (Parameter Length)							
8	(MSB)							
9								
~	Total Write Bytes Processed (10 bytes)							
16								
17								(LSB)

The Total Read Bytes Processed indicates the total processed bytes during read operation.

The bytes includes the total processed bytes during verify operation. (page X'05', Parameter code X'0005')

- Total unrecoverable read errors posted to INIT (page 03, code 0006)

Table 4.58 Total unrecoverable read errors posted to INIT (page 03, code 0006)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0006' (Parameter code)							
5	(Total Posted Unrecoverable Errors) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'04' (Parameter Length)							
8	(MSB)							
9	Counter Value							
10								
11	(LSB)							

The Counter Value indicates the count of all posted unrecovered errors (03/xx/xx) to the interface during read operations. The value includes the count of all posted unrecovered verify errors (page X'05', Parameter code X'0006').

(5) Verify error count page (X'05')

Table 4.59 Verify error count page (X'05')

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	0	1	0	1
1	X‘00’ (Reserved)							
2	Page Length (MSB)							
3	Page Length (LSB)							

All of the following parameters have this header.

Page Length will be defined based on the value of Parameter Pointer. (CDB 5-6)

- Verify errors recovered without delays (page 05, code 0000)

Table 4.60 Verify errors recovered without delays (page 05, code 0000)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0000' (Parameter code)							
5	(Errors Recovered Without Delays) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'04' (Parameter Length)							
8	(MSB)							
9	Counter Value							
10								
11	(LSB)							

The Counter Value indicates the count of all recovered verify errors that would not be reported to the initiator during verify operations, because no delay is incurred.

- Vefiry errors recovered with possible delays (page 05, code 0001)

Table 4.61 Vefiry errors recovered with possible delays (page 05, code 0001)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0001' (Parameter code)							
5	(Errors Recovered With Possible Delays) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'04' (Parameter Length)							
8	(MSB)							
9	Counter Value							
10								
11	(LSB)							

The Counter Value indicates the count of all recovered verify errors that would not be reported to the initiator during verify operations, because possible delay is incurred.

- Total verify errors posted (page 05, code 0002)

Table 4.62 Total verify errors posted (page 05, code 0002)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0002' (Parameter code)							
5	(Total Posted Errors) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'04' (Parameter Length)							
8	(MSB)							
9	Counter Value							
10								
11	(LSB)							

The Counter Value indicates the count of all posted errors to the interface during verify operations.

Implementation:
If a verify error is posted, it will force a save of all error log page information.

- Total recoverable verify errors posted to INIT (page 05, code 0003)

Table 4.63 Total recoverable verify errors posted to INIT (page 05, code 0003)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0003' (Parameter code)							
5	(Total Posted Recoverable Errors) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'04' (Parameter Length)							
8	(MSB)							
9	Counter Value							
10								
11	(LSB)							

The Counter Value indicates the count of all posted recovered (01/xx/xx) errors to the interface during verify operations.

- Total verify bytes processed (page 05, code 0005)

Table 4.64 Total verify bytes processed (page 05, code 0005)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0005' (Parameter code)							
5	(Total Bytes Processed) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'0A' (Parameter Length)							
8	(MSB)							
9								
~	Total Verify Bytes Processed (10 bytes)							
16								
17	(LSB)							

The Total Verify Bytes Processed indicates the total processed bytes during verify operation.

- Total unrecoverable verify errors posted to INIT (page 05, code 0006)

Table 4.65 Total unrecoverable verify errors posted to INIT (page 05, code 0006)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0006' (Parameter code)							
5	(Total Posted Unrecoverable Errors) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'04' (Parameter Length)							
8	(MSB)							
9	Counter Value							
10								
11	(LSB)							

The Counter Value indicates the count of all posted unrecovered errors (03/xx/xx) to the interface during verify operations.

(6) Non-medium error count page (X'06')

Table 4.66 Non-medium error count page (X'06')

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	0	1	1	0
1	X‘00’ (Reserved)							
2	X'00' (Page Length)							
3	X'08' (Page Length)							
4	(MSB) X'0000' (Parameter code)							
5	(Non-medium Error Count) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	0
7	X'04' (Parameter Length)							
8	(MSB)							
9	Counter Value							
10								
11	(LSB)							

The Counter Value indicates the count of all non-medium errors (01/xx/xx, 02/xx/xx, 04/xx/xx, 05/xx/xx, 06/xx/xx, 07/xx/xx, 09/xx/xx and 0B/xx/xx) posted to the interface.

Implementation:

If a non-medium error is posted, it will force a save of all error log pages information.

(7) Temperature page (X'0D')

Table 4.67 Temperature page (X'0D')

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	1	1	0	1
1	X‘00’ (Reserved)							
2	Page Length (MSB)							
3	Page Length (LSB)							

All of the following parameters have this header.

Page Length will be defined based on the value of Parameter Pointer. (CDB 5-6)

- Temperature (page 0D, code 0000)

Table 4.68 Temperature (page 0D, code 0000)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0000' (Parameter code)							
5	(Temperature)							(LSB)
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	1	0	0	0	0	1	1
7	X'02' (Parameter Length)							
8	X'00' (Reserved)							
11	Temperature (degrees Celsius)							

The Temperature sensed in the device at the time the LOG SENSE command is performed shall be returned in the parameter code 0000h. The one byte binary value specifies the temperature of the device in degrees Celsius. Temperatures equal to or less than zero degrees Celsius shall be indicated by a value of zero. If a valid temperature cannot be detected because of a sensor failure or other condition, the value returned shall be FFh. If EWASC (mode page 1C) is on, comparison is performed between the temperature value specified in parameter 0000h and the reference temperature specified in parameter 0001h.

- Reference temperature (page 0D, code 0001)

Table 4.69 Reference temperature (page 0D, code 0001)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0001' (Parameter code)							
5	(Temperature)							(LSB)
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	1	0	0	0	0	1	1
7	X'02' (Parameter Length)							
8	X'00' (Reserved)							
11	Reference Temperature (degrees Celsius)							

The Reference Temperature reflect the maximum reported sensor temperature in degrees Celsius at which the device can operate continuously without degrading the device's operation or reliability outside the limits specified by the manufacturer of the device.

(8) Start-stop cycle counter page (X'0E')

Table 4.70 Start-stop cycle counter page (X'0E')

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	1	1	1	0
1	X‘00’ (Reserved)							
2	Page Length (MSB)							
3	Page Length (LSB)							

All of the following parameters have this header.

Page Length will be defined based on the value of Parameter Pointer. (CDB 5-6)

- Date of manufacture (page 0E, code 0001)

Table 4.71 Date of manufacture (page 0E, code 0001)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0001' (Parameter code)							
5	(Date of Manufacture) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	1	0	0	0	0	0	1
7	X'06' (Parameter Length)							
8	(MSB)							
9	Year of manufacture (4 ASCII characters)							
10								
11	(LSB)							
12	(MSB) Week of manufacture (2 ASCII characters)							
13	(LSB)							

The year and week in the year that the device was manufactured shall be set in the parameter field defined by parameter code 0001h. The date of manufacture shall not be savable by the application client using the LOG SELECT command. The date is expressed in numeric ASCII characters (30h-39h) in the form YYYYWW, as shown above.

- Accounting date (page 0E, code 0002)

Table 4.72 Accounting date (page 0E, code 0002)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0002' (Parameter code)							
5	(Accounting Date) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	0	1
7	X'06' (Parameter Length)							
8	(MSB)							
9	Accounting date Year (4 ASCII characters)							
10								
11	(LSB)							
12	(MSB) Accounting date week (2 ASCII characters)							
13	(LSB)							

The Accounting date specified by parameter code 0002h is a parameter that may be savable using a LOG SELECT command to indicate when the device was placed in service. If the parameter is not yet set or is not settable, the default value placed in the parameter field shall be 6 ASCII blank characters (20h). The field shall not be checked for validity by the device server.

- Specified cycle count over device lifetime (page 0E, code 0003)

Table 4.73 Specified cycle count over device lifetime (page 0E, code 0003)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0003' (Parameter code)							
5	(Specified Cycle Count Over Device Lifetime) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	1	0	0	0	0	1	1
7	X'04' (Parameter Length)							
8	(MSB)							
9	Specified Cycle Count Over Device Lifetime							
10	(4-byte binary number)							
11	(LSB)							

The Specified cycle count over device lifetime is a parameter provided by the device sever. The specified cycle count over device lifetime parameter shall not be savable by the application client using the LOG SELECT command. The parameter value is a 4-byte binary number. The value indicates how operation or reliability outside the limits specified by the manufacture of the device.

- Start-stop cycle counter (page 0E, code 0004)

Table 4.74 Start-stop cycle counter (page 0E, code 0004)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0004' (Parameter code)							
5	(Accumulated Start-Stop Cycles)							(LSB)
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	1	0	0	0	0	1	1
7	X'04' (Parameter Length)							
8	(MSB)							
9	Accumulated Start-Stop Cycles (4-byte binary number)							
10								
11								(LSB)

The Accumulated start-stop cycles is a parameter provided by the device sever. The accumulated start-stop cycles parameter shall not be savable by the application client using the LOG SELECT command. The parameter value is a 4-byte binary number. The value indicates how many start-stop cycles the device has detected since its date of manufacture. For rotating magnetic storage device, a single start-stop cycle is defined as an operational cycle that begins with the disk spindle at rest, continues while the disk accelerates to its normal operational rotational rate, continues during the entire period the disk is rotating, continues as the disk decelerates toward a resting state, and ends when the disk is no longer rotating. The count is incremented by one for each complete start-stop cycle. No comparison with the value of parameter 0003h shall be performed by the device server.

(9) Application client page (X'0F')

Table 4.75 Application client page (X'0F')

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	0	1	1	1	1
1	X‘00’ (Reserved)							
2	Page Length (MSB)							
3	Page Length (LSB)							

All of the following parameters have this header.

Page Length will be defined based on the value of Parameter Pointer. (CDB 5-6)

- General usage application client parameter data (page 0F, code 0000-003F)

Table 4.76 General usage application client parameter data (page 0F, code 0000-003F)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0000'-X'003F' (Parameter code)							
5	(Application Client Parameter) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	1	0	0	0	0	0	1	1
7	X'FC' (Parameter Length)							
8	(MSB)							
9	General Usage Parameter Bytes							
258								
259	(LSB)							

The values stored in the General usage parameter bytes represent data sent to the device server in a previous LOG SELECT command. If a previous LOG SELECT command has not occurred, the data is zero.

(10) Self-test result page (X'10')

Table 4.77 Self-test result page (X'10')

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	0	1	0	0	1	0
1	X‘00’ (Reserved)							
2	Page Length (MSB)							
3	Page Length (LSB)							

All of the following parameters have this header.

Page Length will be defined based on the value of Parameter Pointer. (CDB 5-6)

- Self-test result parameter data (page 10, code 0001-0014)

Table 4.78 Self-test result parameter data (page 10, code 0001-0014)

Byte \ Bit	7	6	5	4	3	2	1	0
4	(MSB) X'0001'-X'0014' (Parameter code)							
5	(Self-Test Result Parameter) (LSB)							
6	DU	DS	TSD	ETC	TMC		LBIN	LP
	0	0	0	0	0	0	1	1
7	X'10' (Parameter Length)							
8	Self-Test Code			0	Self-Test Result Value			
9	Self-Test Segment Number							
10	(MSB) Time Stamp							
11	(LSB)							
12	(MSB) Address of First Failure							
~	~							
19	(LSB)							
20	0	0	0	0	Sense Key			
21	Additional Sense Code							
22	Additional Sense Code Qualifier							
23	X'xx' (Vendor-specific)							

When the self-test is initiated, the value specified in the SELF-TEST CODE field in the CDB is reported to the SELF-TEST CODE field by a SEND DIAGNOSTICS command.

The values reported to the "Self-Test Result Value" field are defined in Table 4.79.

Table 4.79 Self-test results values

Value	Description
0h	The self-test completed without error.
1h	The background self-test was aborted by the application client using a SEND DIAGNOSTICS command with the SELF-TEST CODE field set to 100b (Abort background self-test).
2h	The self-test routine was aborted by an application client using a method other than a SEND DIAGNOSTICS command with the SELF-TEST CODE field set to 100b (e.g., reception of the ABORT Task, RESET CONDITION.
3h	An unknown error occurred while the device server was executing the self-test and the device server was unable to complete the self-test.
4h	The self-test completed with a failure in a test segment, and the test segment that failed is not known.
5h	The first segment of the self-test failed.
6h	The second segment of the self-test failed.
7h	Another segment of the self-test failed (see the SELF-TEST SEGMENT NUMBER field).
8h - Eh	Reserved
Fh	The self-test is in grogress.

The number of the segment that failed during the self-test is shown in the "Self-Test Segment Number" field. When the self-test is completed without an error, 0 is shown in the field.

The accumulated power-on time (unit: hour) in the event of an error occurring in the drive is shown in the "Time Stamp" field.

Address information of the data block where that error occurred is shown in the "Address of First Failure" field.

The error information in the same format as that used by sense data is reported to the "Sense Key," "Additional Sense Code," and "Additional Sense Code Qualifier" fields.

(11) SMART status page (X'2F')

Table 4.80 SMART status page (X'2F')

[Fujitsu unique page]

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	1	0	1	1	1	1
1	X‘00’ (Reserved)							
2	Page Length (MSB)							
3	Page Length (LSB)							
4 ~ n	SMART Status Parameter							

This page contains parameters which allow the application client to check the predictive drive failure condition of the IDD. The application client can check whether the IDD has predicted a drive failure by periodically reading out this page.

The "Page Length" field indicates the length (byte length) after byte 4.

The "SMART Status Parameter" field is Fujitsu unique parameters. The details of this field are outside the scope of this manual.

(12) SMART data page (X'38')

Table 4.81 SMART data page (X'38')

[Fujitsu unique page]

Byte \ Bit	7	6	5	4	3	2	1	0
0	0	0	1	1	1	0	0	0
1	X‘00’ (Reserved)							
2	Page Length (MSB)							
3	Page Length (LSB)							
4 ~ n	Log Parameters							

This page reports data which the IDD collects for predicting drive failures.

The "Page Length" field indicates the length (byte length) after byte 4.

The "Log Parameters" field is Fujitsu unique parameters. The details of this field are outside the scope of this manual.

4.1.17 PERSISTENT RESERVE IN (5E) (not supported)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'5E'							
1	0	0	0	Service Action				
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	Allocation Length (MSB)							
8	Allocation Length (LSB)							
9	0	0	0	0	0	0	0	0

This command is used to obtain information about persistent reservations and reservation keys that are active within a device server. This command is used in conjunction with the PERSISTENT RESERVE OUT command (see 3.1.19).

The actual length of the PERSISTENT RESERVE IN parameter data is available in a parameter data field. The "Allocation Length" field in the CDB indicates how much space has been reserved for the returned parameter list. If the length is not sufficient to contain the entire parameter list, the first portion of the list shall be returned. This shall not be considered an error. If the remainder of the list is required, the application client should send a new this command with a "Allocation Length" field large enough to contain the entire list.

(1) PERSISTENT RESERVE IN service actions

The service action codes for the PERSISTENT RESERVE IN command are defined below.

Table 4.82 PERSISTENT RESERVE IN service actions

Code	Name	Description
00h	READ KEYS	Reads all registered Reservation Keys
01h	READ RESERVATION	Reads the current persistent reservations
02h-1Fh	Reserved	Reserved

- READ KEYS

  The READ KEYS service action requests that the device server return a parameter list containing a header and a list of each currently registered initiator's reservation key.

  If multiple initiators have registered with the same key, then that key value shall be listed multiple times, once for each such registration.

- READ RESERVATIONS

  The READ RESERVATIONS service action requests that the device server return a parameter list containing a header and the persistent reservation(s), if any, that is present in the device server. Multiple persistent reservations may be returned only if element reservations are present.

(2) PERSISTENT RESERVE IN parameter data for READ KEYS

The format for the parameter data provided in response to a PERSISTENT RESERVE IN command with the READ KEYS service action is shown in Table 4.83.

Table 4.83 PERSISTENT RESERVE IN parameter data for READ KEYS

	Byte \ Bit	7	6	5	4	3	2	1	0
Header	0	(MSB)							
	~	Generation							
	3								(LSB)
	4	(MSB)							
	~	Additional Length (n-7)							
	7								(LSB)
Reservation key list	8	(MSB)							
	~	First reservation key							
	15								(LSB)
	~								
	n-7	(MSB)							
	~	Last reservation key							
	n								(LSB)

The "Generation" field shall contain a 32-bit counter maintained by the device server that shall be incremented every time a PERSISTENT RESERVE OUT command requests a REGISTER, a REGISTER AND IGNORE EXISTING KEY, a CLEAR, a PREEMPT, or a PREEMPT AND ABORT service action. The counter shall not be incremented by a PERSISTENT RESERVE IN command, by a PERSISTENT RESERVE OUT command that performs a RESERVE or RELEASE service action, or by a PERSISTENT RESERVE OUT command that is not performed due to an error or reservation conflict. Regardless of the "APTPL" bit value the generation value shall be set to 0 as part of the power on reset process.

The "Additional Length" field contains a count of the number of bytes in the Reservation key list. If the allocation length specified by the PERSISTENT RESERVE IN command is not sufficient to contain the entire parameter list, then only first portion of the list (byte 0 to the allocation length) shall be sent to the application client. The incre-mental remaining bytes shall be truncated, although the "Additional Length" field shall still contain the actual number of bytes in the reservation key list without consideration of any truncation resulting from an insufficient allocation length. This shall not be considered an error.

The reservation key list contains the 8-byte reservation keys for all initiators that have registered through all ports with the device server.

(3) PERSISTENT RESERVE IN parameter data for READ RESERVATIONS

The format for the parameter data provided in response to a PERSISTENT RESERVE IN command with the READ RESERVATIONS service action is shown in Table 4.84.

Table 4.84 PERSISTENT RESERVE IN parameter data for READ RESERVATIONS

	Byte \ Bit	7	6	5	4	3	2	1	0
Header	0	(MSB)							
	~	Generation							
	3								(LSB)
	4	(MSB)							
	~	Additional Length (n-7)							
	7								(LSB)
	8	(MSB)							
	~	Reservation descriptor(s) (see below)							
	n								(LSB)

The "Generation" field shall be as defined for the PERSISTENT RESERVE IN READ KEYS parameter data (see 4.1.17 (2)).

The "Additional Length" field contains a count of the number of bytes to follow in Reservation descriptor(s). If the allocation length specified by the PERSISTENT RESERVE IN command is not sufficient to contain the entire parameter list, then only first portion of the list (byte 0 to the allocation length) shall be sent to the application client. The incremental remaining bytes shall be truncated, although the "Additional Length" field shall still contain the actual number of bytes of Reservation descriptor(s) and shall not be affected by the truncation. This shall not be considered an error.

The format of the Reservation descriptors is defined in Table 4.85. There shall be a Reservation descriptor for the persistent reservation, if any, present in the logical unit and a Reservation descriptor for each element, if any, having a persistent reservation.

Table 4.85 Format of reservation descriptors

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)							
~	Reservation Key							
7								(LSB)
8	(MSB)							
~	Scope-specific Address							
11								(LSB)
12	X'00' (Reserved)							
13	Scope				Type			
14-15	X'00' (Reserved)							

If a persistent reservation is present in the logical unit that does not contain elements, there shall be a single Reservation descriptor in the list of parameter data returned by the device server in response to the PERSISTENT RESERVE IN command with a READ RESERVATIONS service action. The Reservation descriptor for each reservation shall contain the RESERVATION KEY under which the persistent reservation is held. The "Type" and "Scope" of each persistent reservation as present in the PERSISTENT RESERVE OUT command that created the persistent reservation shall be returned.

If a persistent reservation is present in the logical unit that does contain elements, there shall be a Reservation descriptor in the list of parameter data returned by the device server in response to the PERSISTENT RESERVE IN command with a READ RESERVATIONS service action for the Logical Unit persistent reservation that is held, if any, and each element persistent reservation that may be held. The Reservation descriptor shall contain the RESERVATION KEY under which the persistent reservation is held. The "Type" and "Scope" of the persistent reservation as present in the PERSISTENT RESERVE OUT command that created the persistent reservation shall be returned.

If the "Scope" is an Element reservation, the "Scope-specific Address" field shall contain the element address, zero filled in the most significant bytes to fit the field. If the "Scope" is a Logical Unit reservation, the "Scope-specific Address" field shall be set to zero.

- Persistent reservations scope

  The value in the "Scope" field shall indicate whether a persistent reservation applies to an entire logical unit or to an element. The values in the "Scope" field are defined in Table 4.86.

Table 4.86 Persistent reservations scope

Code	Name	Description
0h	Logical Unit	Persistent reservation applies to the full logical unit
1h	Reserved	Reserved
2h	Element	Persistent reservation applies to the specified element
3h-Fh	Reserved	Reserved

a) Logical unit scope

   A "Scope" field value of LU shall indicate that the persistent reservation applies to the entire logical unit. The Logical Unit scope shall be implemented by all device servers that implement PERSISTENT RESERVE OUT.

b) Element scope (not supported)

   A "Scope" field value of Element shall indicate that the persistent reservation applies to the element of the logical unit defined by the "Scope-specific Address" field in the PERSISTENT RESERVE OUT parameter list. An element is defined by the SCSI-3 Medium Changer Commands (SMC) standard. The Element scope is optional for all device servers that implement PERSISTENT RESERVE OUT.

- Persistent reservations type

  The value in the "Type" field shall specify the characteristics of the persistent reservation being established for all data blocks within the element or within the logical unit. Table 4.87 defines the characteristics of the different type values. For each persistent reservation type, table 4.87 lists code value and describes the required device server support. In table 4.87, the description of required device server support is divided into two paragraphs. The first paragraph defines the required handling for read operations. The second paragraph defines the required handling for write operations.

Table 4.87 Persistent reservations type codes

Code	Name	Description
0h		Reserved
1h	Write Exclusive	Reads Shared: Any application client on any initiator may execute tasks that request transfers from the storage medium or cache of the logical unit to the initiator. Writes Exclusive: Any task from any initiator other than the initiator holding the persistent reservation that requests a transfer from the initiator to the storage medium or cache of the logical unit shall result in a reservation conflict.
2h		Reserved
3h	Exclusive Access	Reads Shared: Any task from any initiator other than the initiator holding the persistent reservation that requests a transfer from the storage medium or cache of the logical unit to the initiator shall result in a reservation conflict. Writes Exclusive: Any task from any initiator other than the initiator holding the persistent reservation that requests a transfer from the initiator to the storage medium or cache of the logical unit shall result in a reservation conflict.
4h		Reserved
5h	Write Exclusive-Registrants Only	Reads Shared: Any application client on any initiator may execute tasks that request transfers from the storage medium or cache of the logical unit to the initiator. Writes Exclusive: A task that requests a transfer to the storage medium or cache of the logical unit from an initiator that is not currently registered with the device server shall result in a reservation conflict.
6h	Exclusive Access-Registrants Only	Reads Exclusive: A task that requests a transfer from the storage medium or cache of the logical unit to an initiator that is not currently registered with the device server shall result in a reservation conflict. Write Exclusive: A task that requests a transfer to the storage medium or cache of the logical unit from an initiator that is not currently registered with the device server shall result in a reservation conflict.
7h-Fh		Reserved

4.1.18 PERSISTENT RESERVE OUT (5F) (not supported)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'5F'							
1	0	0	0	Service Action				
2	Scope				Type			
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	Parameter List Length (MSB)							
8	Parameter List Length (LSB)							
9	0	0	0	0	0	0	0	0

This command is used to request service actions that reserve a logical unit or element for the exclusive or shared use of a particular initiator. The command uses other service actions to manage and remove such reservations. The command shall be used in conjunction with the PERSISTENT RESERVE IN command and shall not be used with the RESERVE and RELEASE commands.

Initiators performing PERSISTENT RESERVE OUT service actions are identified by a reservation key provided by the application client. An application client may use the PERSISTENT RESERVE IN command to identify which initiators are holding a persistent reservation and use the PERSISTENT RESERVE OUT command to preempt that reservation if required.

If a PERSISTENT RESERVE OUT command is attempted, but there are insufficient device server resources to complete the operation, the device server shall return a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Insufficient registration resources [=55-04]).

The PERSISTENT RESERVE OUT command contains fields that specify a persistent reservation service action, the intended scope of the persistent reservation, and the restrictions caused by the persistent reservation. The "Type" and "Scope" fields are defined in 4.1.17 (3) "Persistent reservations scope" and “Persistent reservation type". If a "Scope" field specifies a scope that is not implemented, the device server shall return a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in CDB).

Fields contained in the PERSISTENT RESERVE OUT parameter list specify the information required to perform a particular persistent reservation Service action.

The parameter list shall be 24 bytes in length and the "Parameter List Length" field shall contain 24 (18h). If the parameter list length is not 24, the device server shall return a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Parameter list length error [=1A-00]).

(1) PERSISTENT RESERVE OUT service actions

When processing the PERSISTENT RESERVE OUT service actions, the device server shall increment the generation value as specified in 4.1.17 (2).

The PERSISTENT RESERVE OUT command service actions are defined in table 4.88.

Table 4.88 PERSISTENT RESERVE OUT service action codes

Code	Name	Description
00h	REGISTER	Register a reservation key with the device server.
01h	RESERVE	Creates a persistent reservation having a specified SCOPE and TYPE.
02h	RELEASE	Releases the selected reservation for the requesting initiator.
03h	CLEAR	Clears all reservation keys and all persistent reservations.
04h	PREEMPT	Preempts persistent reservations from another initiator.
05h	PREEMPT & ABORT	Preempts persistent reservations from another initiator and aborts the task set for the preempted initiator.
06h	REGISTER AND IGNORE EXISTING KEY	Register a reservation key with the device server.
07h-1Fh	Reserved	

The parameter list values for each service action are specified in 4.1.18 (2).

(2) PERSISTENT RESERVE OUT parameter list

The parameter list required to perform the PERSISTENT RESERVE OUT command are defined in Table 4.89.

All fields shall be sent on all PERSISTENT RESERVE OUT commands, even if the field is not required for the specified service action and scope values.

Table 4.89 PERSISTENT RESERVE OUT parameter list

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)							
~	Reservation Key							
7								(LSB)
8	(MSB)							
~	Service Action Reservation Key							
15								(LSB)
16	(MSB)							
~	Scope-specific Address							
19								(LSB)
20	Reserved							APTPL
21-23	X'000000' (Reserved)							

The "Reservation Key" field contains an 8-byte value provided by the application client to the device server to identify the initiator that is the source of the PERSISTENT RESERVE OUT command. The device server shall verify that the "Reservation Key" field in a PERSISTENT RESERVE OUT command matches the registered reservation key for the initiator from which the task was received, except for:

a) the REGISTER AND IGNORE EXISTING KEY service action where the "Reservation Key" field shall be ignored; and

b) the REGISTER service action for an unregistered initiator which shall have a reservation key value of zero.

Except as noted above, when a PERSISTENT RESERVE OUT command specifies a "Reservation Key" field other than the reservation key registered for the initiator the device server shall return a RESERVATION CONFLICT status. Except as noted above, the reservation key of the initiator shall be verified to be correct regardless of the "Service Action" and "Scope" field values.

The "Service Action Reservation Key" field contains information needed for four service actions; the REGISTER, REGISTER AND IGNORE EXISTING KEY, PREEMPT, and PREEMPT AND ABORT service actions. For the REGISTER and REGISTER AND IGNORE EXISTING KEY service action, the "Service Action Reservation Key" field contains the new reservation key to be registered. For the PREEMPT and PREEMPT AND ABORT service actions, the "Service Action Reservation Key" field contains the reservation key of the persistent reservations that are being preempted. The "Service Action Reservation Key" field is ignored for all other service actions.

If the scope is an Element reservation, the "Scope-specific Address" field shall contain the Element address, zero filled in the most significant bytes to fit the field. If the service action is REGISTER, REGISTER AND IGNORE EXISTING KEY, or CLEAR or if the scope is a Logical Unit reservation, the "Scope-specific Address" field shall be set to zero.

The "Activate Persist Through Power Loss (APTPL)" bit shall be valid only for the REGISTER, or the REGISTER AND IGNORE EXISTING KEY service action. In all other cases, the "APTPL" bit shall be ignored. Support for an "APTPL" bit equal to one is optional. If a device server that does not support the "APTPL" bit value of one receives that value in a REGISTER or a REGISTER AND IGNORE EXISTING KEY service action, the device server shall return a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in parameter list [=26-00]).

If the last valid "APTPL" bit value received by the device server is zero, the loss of power in the target shall release the persistent reservation for all logical units and remove all reservation keys. If the last valid "APTPL" bit value received by the device server is one, the logical unit shall retain any persistent reservation(s) that may be present and all reservation keys for all initiators even if power is lost and later returned

Table 4.6 summarizes which fields are set by the application client and interpreted by the device server for each service action and scope value. The "APTPL" bit PERSISTENT RESERVE OUT parameter is not summarized in table 4.6, since it is specified above.

Table 4.90 PERSISTENT RESERVE OUT service action and valid parameters

Service Action	Allowed Scope	type	Parameters		
			Reservation Key	Reservation Key	Service Action Scope-Specific Address
Register	ignored	ignored	valid	valid	ignored
Register And Ignore Existing Key	ignored	ignored	ignored	valid	ignored
Reserve	Logical Unit Element	valid valid	valid	ignored ignored	ignored valid(Element)
Release	Logical Unit Element	valid valid	valid	ignored ignored	ignored valid (Element)
Clear	ignored	ignored	valid	ignored	ignored
Preempt	Logical Unit Element	valid valid	valid	valid valid	ignored valid (Element)
Preempt & Abort	Logical Unit Element	valid valid	valid	valid valid	ignored valid (Element)

Note: MATxxx and MAUxxx series does not support Element Scope.

4.1.19 REPORT LUNS (A0)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'A0'							
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	Allocation Length (MSB)							
7	Allocation Length							
8	Allocation Length							
9	Allocation Length (LSB)							
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0

This command requests that the peripheral device logical unit inventory be sent to the application client.

This command normally operate under the reserve condition (RESERVE or PERSISTENT RESERVE).

The "Allocation Length" should be at least 16 bytes. If the "Allocation Length" is less than 16 bytes, the IDD reports the CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid Field in CDB [=24-00]). If the "Allocation Length" is not sufficient to contain the entire logical unit inventory, the device server shall report as many logical unit number values as fit in the specified allocation length. This shall not be considered an error.

The device server shall report those devices in the logical unit inventory using the format shown in Table 4.91.

Table 4.91 REPORT LUNS parameter list

	Byte \ Bit	7	6	5	4	3	2	1	0
Header	0	(MSB)							
	~	LUN List Length (N-7)							
	3								(LSB)
	4	(MSB)							
	~	Reserved							
	7								(LSB)
LUN List	8	(MSB)							
	~	First LUN							
	15								(LSB)
	~								
	n-7	(MSB)							
	~	Last LUN							
	n								(LSB)

The "LUN List Length" field shall contain the length in bytes of the LUN list that is available to be transferred. The "LUN list length" is the number of logical unit numbers in the logical unit inventory multiplied by eight. If the allocation length in the command descriptor block is too small to transfer information about the entire logical unit inventory, the LUN list length value shall not be adjusted to reflect the truncation.

4.1.20 REPORT DEVICE IDENTIFIER (A3)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'A3'							
1	0	0	0	Service Action (X' 05')				
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	Allocation Length (MSB)							
7	Allocation Length							
8	Allocation Length							
9	Allocation Length (LSB)							
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0

This command requests that the device server send device identification information to the application client.

The "Service Action" field can be specified only X'05'.

The "Allocation Length" field indicates how much space has been reserved for the returned parameter data. If the length is not sufficient to contain all the parameter data, the first portion of the data shall be returned. This shall not be considered an error. The actual length of the parameter data is available in the "Identifier Length" field in the parameter data. If the remainder of the parameter data is required, the application client should send a new REPORT DEVICE IDENTIFIER command with an "Allocation Length" field large enough to contain all the data.

The REPORT DEVICE IDENTIFIER parameter list are shown in Table 4.92.

Table 4.92 REPORT DEVICE IDENTIFIER parameter list

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)							
~	Identifier Length (n-4)							
3								(LSB)
4	(MSB)							
~	Identifier							
n								(LSB)

The "Identifier Length" field specifies the length in bytes of the "Identifier" field.

If the "Allocation Length" field in the CDB is too small to transfer all of the identifier, the length shall not be adjusted to reflect the truncation. The identifier length shall initially equal zero, and shall be changed only by a successful SET DEVICE IDENTIFIER command.

The "Identifier" field shall contain a vendor specific value. The value reported shall be the last value written by a successful SET DEVICE IDENTIFIER command. The value of the identifier shall be changed only by a SET DEVICE IDENTIFIER command. The identifier value shall persist through resets, power cycles, media format operations, and media replacement.

The target shall return the same Identifier to all initiators on all ports.

The execution of a REPORT DEVICE IDENTIFIER may require the enabling of a nonvolatile memory within the logical unit. If the nonvolatile memory is not ready, the device server shall return CHECK CONDITION status, rather than wait for the device to become ready. The sense key shall be set to NOT READY and the additional sense data shall be set as described in the TEST UNIT READY command.

4.1.21 SET DEVICE IDENTIFIER (A4)

Bit / Byte	7	6	5	4	3	2	1	0
0	X'A4'							
1	0	0	0	Service Action (X' 06')				
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	Allocation Length (MSB)							
7	Allocation Length							
8	Allocation Length							
9	Allocation Length (LSB)							
10	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0

This command requests that the device identifier information in the logical unit be set to the value received in the SET DEVICE IDENTIFIER parameter list.

On successful completion of this command a unit attention shall be generated for all initiators except the one that issued the service action. When reporting the unit attention condition the additional sense code shall be set to DEVICE IDENTIFIER CHANGED.

The "Service Action" field can be specified only X'06'.

The "Allocation Length" field specifies the length in bytes of the Identifier that shall be transferred from the application client to the device server. The maximum value for this field shall be 512 bytes. A parameter list length of zero indicates that no data shall be transferred, and that subsequent REPORT DEVICE IDENTIFIER commands shall return an Identifier length of zero. Logical units that implement this command shall be capable of accepting a parameter list length of 512 bytes or less. If the parameter list length exceeds 512 bytes and the logical unit is not capable of storing the requested number of bytes, then the device server shall return CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in CDB [=24-00]).

The SET DEVICE IDENTIFIER parameter lists are shown in Table 4.93.

Table 4.93 SET DEVICE IDENTIFIER parameter list

Byte \ Bit	7	6	5	4	3	2	1	0
0	(MSB)							
~	Identifier							
n								(LSB)

The "Identifier" field shall be a vendor specific value, to be returned in subsequent REPORT DEVICE IDENTIFIER commands.

4.2 Data Access Commands

4.2.1 READ (08)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘08’							
1	0	0	0	Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Transfer Block Count							
5	0	0	0	0	0	0	0	0

This command reads the number of blocks of data in continuous logical data blocks specified in the "Transfer block count" field with the logical data block on the disk media specified in the "Logical block address" field in the CDB as the top.

The transfer block count can be specified up to a maximum of 256 logical data blocks. When zero is specified in the "Transfer block count" field in byte 4 of the CDB, it specifies transfer of 256 logical data blocks and when a value other than zero is specified, it specifies the number of logical data blocks that should be transferred.

When transfer of multiple data blocks is instructed by this command, when the data blocks which are to be processed come to a track boundary, cylinder boundary or zone boundary, a head switch or cylinder switch is executed automatically and reading of the specified number of blocks is performed.

When the specifications in the "Logical block address" field and "Transfer block count" field in the CDB exceed the maximum logical block address in the IDD, that command is terminated with a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Logical block address out of range [=21-00]) and the reading of data from the disk media is not executed.

Error recovery processing during execution of this command can be specified by the MODE SELECT parameter. If retry processing and data correction processing are not prohibited, when this command is completed normally, or when it is completed with a "RECOVERED ERROR [=1]" sense key report, the data transferred to the INIT by this command are error free. When a correctable error check is detected, the IDD first corrects the data errors in the data buffer, then transfers those data to the INIT.

The starting timing for Loop OPEN processing in order to execute data transfer on the FC bus can be specified by the MODE SELECT parameter (buffer full ratio). Also, if the Look-Ahead cache feature is permitted, a caching operation is performed using the IDD's data buffer by this command. See Chapter 3, "Data Buffer Management," concerning details of data buffer operation and the Look-Ahead cache feature.

4.2.2 READ EXTENDED (28)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘28’							
1	0	0	0	×	FUA	0	0	0
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	0	0	0	0	0	0	0	0
7	Transfer Block Count (MSB)							
8	Transfer Block Count (LSB)							
9	0	0	0	0	0	0	0	0

This command reads the number of blocks of data in continuous logical data blocks specified in the "Transfer block count" field with the logical data block on the disk media specified in the "Logical block address" field in the CDB as the top.

The functions of this command are the same as those of the Group 0 READ command (Section 4.2.1) with the exception that it is possible to specify 4-byte logical block addresses and 2-byte transfer block counts. However, when zero is specified for the "Transfer block count," the command is terminated normally without seek and pre-fetch being performed.

- FUA (force unit access)

  When this bit is "0", it indicates that the IDD satisfy the command by accessing the cache memory. Any logical blocks that are contained in the cache memory may be transferred to the INIT directly from the cache memory.

  When this bit is "1", it indicated that the IDD shall access the media in performing the command prior to returning GOOD status. READ commands shall access the specified logical blocks from the media (i.e., the data is not directly retrieved from the cache).

4.2.3 WRITE (0A)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘0A’							
1	0	0	0	Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Transfer Block Count							
5	0	0	0	0	0	0	0	0

This command transfers the number of blocks of data specified in the "Transfer block count" field from the INIT and writes them in continuous logical data blocks with the logical data block on the disk media specified in the "Logical block address" field in the CDB as the top.

The transfer block count can be specified up to a maximum of 256 logical data blocks. When zero is specified in the "Transfer block count" field in byte 4 of the CDB, it specifies transfer of 256 logical data blocks and when a value other than zero is specified, it specifies the number of logical data blocks that should be transferred.

When transfer of multiple data blocks is instructed by this command, when the data blocks which are to be processed come to a track boundary, cylinder boundary or zone boundary, a head switch or cylinder switch is executed automatically and writing of the specified number of blocks is performed.

When the specifications in the "Logical block address" field and "Transfer block count" field in the CDB exceed the maximum logical block address in the IDD, that command is terminated with a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Logical block address out of range [=21-00]) and writing of data to the disk media is not executed.

The IDD performs the XFER-RDY frame transfer after receiving the CDB, but after performing Loop OPEN processing once, it executes pre-fetching of data. The IDD either completes transfer of all the data specified in the command or, at the point when the empty space in the data buffer runs out, Loop CLOSE processing is executed. Positioning of the specified data blocks is performed in parallel with this data transfer, and writing of data from the data buffer to the disk media is executed immediately after positioning is completed. See Section 2.1 "Data Buffer" for details of data buffer operation and control of the timing for starting reconnection processing by the MODE SELECT parameter (buffer empty ratio).

If the write cache function is enabled, the IDD reports a status byte at the point when reception of all the data transferred from the INIT is completed. If an error occurs while data are being written to the disk media, a CHECK CONDITION status is reported for the command to be executed next. If the write cache function is disabled, a status byte is reported after writing to the disk media of all the data transferred from the INIT is completed, then execution of the command is terminated.

IMPORTANT

Even when there is an error in the specification in the CDB, or when a write operation to the disk media cannot be executed normally due to various other causes, the transfer of data (data is pre-fetched to the data buffer) from the INIT to the IDD may be executed. In this case, the length of data transferred from the INIT to the IDD is undefined. Also, all the data transferred to the IDD will not necessarily be actually written to the disk media. However, if the command is terminated with a CHECK CONDITION status and the sense key of the sense data indicates "ILLEGAL REQUEST [=5]," the data from that command is not written to the disk media by a write operation.

4.2.4 WRITE EXTENDED (2A)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘2A’							
1	0	0	0	×	FUA	0	0	0
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	0	0	0	0	0	0	0	0
7	Transfer Block Count (MSB)							
8	Transfer Block Count (LSB)							
9	0	0	0	0	0	0	0	0

This command transfers the number of blocks of data specified in the "Transfer block count" field from the INIT and writes them in continuous logical data blocks with the logical data block on the disk media specified in the "Logical block address" field in the CDB as the top.

The functions of this command are the same as those of the Group 0 WRITE command (Section 4.2.3) with the exception that it is possible to specify 4-byte logical block addresses and 2-byte transfer block counts. However, when zero is specified for the "Transfer block count," the command is terminated normally without pre-fetch being performed.

In this device, specifications to the "FUA" bit in CDB byte 1 are invalid and operation is as if zero is specified.

The specification of bit 4 of CDB byte 1 is invalid and the specified value is disregarded.

4.2.5 WRITE AND VERIFY (2E)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'2E'							
1	0	0	0	×	0	0	BytChk	0
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	0	0	0	0	0	0	0	0
7	Transfer Block Count (MSB)							
8	Transfer Block Count (LSB)							
9	0	0	0	0	0	0	0	0

This command transfers the number of blocks of data specified in the "Transfer block count" field from the INIT and writes them in continuous logical data blocks with the logical data block on the disk media specified in the "Logical block address" field in the CDB as the top, then reads those data and performs a Verify check.

The functions of this command related to write operations are the same as those of the WRITE EXTENDED command (Section 4.2.4), with the exception that the write cache function and automatic alternate block allocation function cannot be applied. When zero is specified in the "Transfer block count," this command is terminated normally without performing seek or pre-fetch.

The specification in bit 4 of CDB byte 1 is disabled in the IDD and the specified value is disregarded.

The VERIFY check executed by this command is the only the ECC (data portion) normalcy check. Error recovery processing during execution of the VERIFY check conforms to the mode specified by the MODE SELECT parameter (Verify error recovery parameter). For example, when data correction processing is not prohibited, if a correctable data check is detected during the VERIFY check, the VERIFY check is regarded as having terminated successfully.

When “1” is set in bit 1 (BytChk bit) of CDB byte 1, the IDD reads data blocks from the disk and compares the data with the write data transferred from the INIT after terminating the write operation. This IDD does not support that function, however, so it performs the operation executed when “0” is set in bit 1 (BytChk bit) of CDB byte 1.

4.2.6 VERIFY (2F)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘2F’							
1	0	0	0	×	0	0	BytChk	0
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	0	0	0	0	0	0	0	0
7	Transfer Block Count (MSB)							
8	Transfer Block Count (LSB)							
9	0	0	0	0	0	0	0	0

This command reads the number of continuous logical data blocks specified in the "Block count" field with the logical data block on the disk media which is specified in the "Logical block address" field in the CDB as the top, then executes a VERIFY check on those data.

The "Block count" field in the CDB specifies the number of data blocks which is the object of the VERIFY check. When zero is specified in the "Transfer block count," the command is terminated normally without performing seek and pre-fetch.

Bit 4 of CDB byte 1 is disabled in the IDD and the specified value is disregarded.

If "1" is specified in bit 1 of CDB byte 1, the BytChk bit, the IDD performs a comparison check of the data read from the disk media and the data transferred from the INIT. If the data do not match during this mode, the command is terminated with a CHECK CONDITION status (MISCOMPARE [=E] / Miscompare during verify operation [=1D-00]).

If "0" is specified in bit 1 of CDB byte 1, the BytChk bit, an ECC (data portion) normalcy check is executed. Also, error recovery processing during execution of the verify check is according to the mode specified by the MODE SELECT parameter (verify error recovery parameter). For example, if data correction processing is not prohibited, even if a correctable data check is detected, it is regarded as if the verify check succeeded.

4.2.7 SEEK (0B)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'0B'							
1	0	0	0	Logical Block Address (MSB)				
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0

This command executes a seek operation of the cylinder/track where the logical data block specified in the "Logical block address" field in the CDB exists.

When disconnect processing is permitted, the IDD performs disconnect processing after receiving the CDB. After that, the IDD executes reconnect processing at the point when the seek operation is completed and reports the status.

When disconnect processing is not permitted, the IDD executes the seek operation while still connected to the FC interface and when it is completed, reports the status of this command.

4.2.8 SEEK EXTENDED (2B)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'2B'							
1	0	0	0	0	0	0	0	0
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0

This command executes a seek operation of the cylinder/track where the logical data block specified in the "Logical block address" field in the CDB exists.

The functions and operation of this command are the same as those of the Group 0 SEEK command (Section 4.2.7), except that it is possible to specify 4-byte logical block addresses.

4.2.9 SET LIMITS (33) (not supported)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'33'							
1	0	0	0	0	0	0	RdInh	WrInh
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	0	0	0	0	0	0	0	0
7	Transfer Block Count (MSB)							
8	Transfer Block Count (LSB)							
9	0	0	0	0	0	0	0	0

This command specifies the address range of logical data blocks on an ID which it is possible to access by commands which follow this command and which are linked to it, and to specify the type of operations which it is possible to execute. It is possible to issue this command once only in a group of commands which are linked in a series.

IMPORTANT

The specifications in this command are valid only for a series of linked commands which follow this command. When the link between the commands is cut, the specifications in this command lose their validity.

The "Logical block address" field in the CDB specifies the logical block address which is the staring point of the range where access is permitted. When an address in the User Space (X '00000000' or higher) is specified in the "Logical block address" field, access to the User Space only is permitted in linked commands which follow this command and CE space cannot be accessed. On the other hand, if an address in CE space (X '80000000' or higher) is specified, access to CE space only is permitted in linked commands which follow this command, and User Space cannot be accessed.

Also, the size of the range where access is permitted, specified in this command in the "Block count" field in the CDB, specifies the number of logical data blocks from that starting point. However, when zero is specified in the "Block count" field, access to the final logical data block of the specified data space (User Space or CE Space), with the logical data block specified in the "Logical block address" field as the starting point, is permitted. Figure 4.3 shows the method for specification of the range where access is permitted in this command.

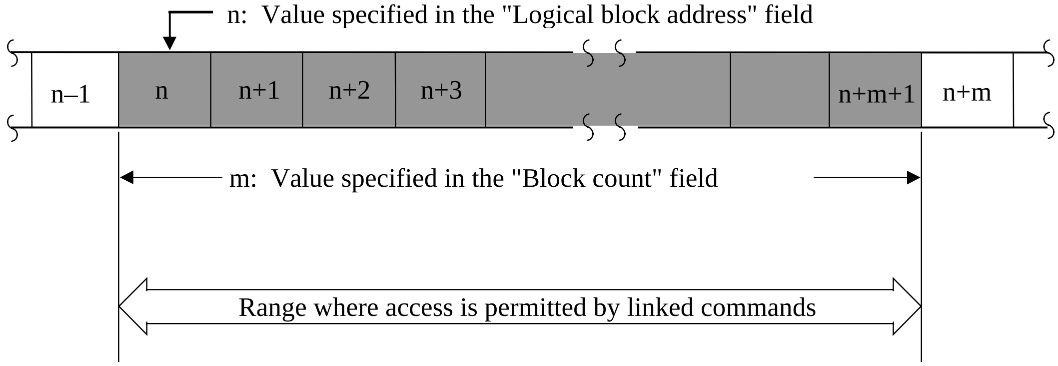

Figure 4.3 SET LIMITS command: specifying the range where access is permitted

If "1" is specified in bit 1 of CDB byte 1, "RdInh (read inhibit)" flag or in bit 0, "WrInh (write inhibit) flag, read operations or write operations is prohibited for linked commands following this command, as shown in Table 4.94.

Table 4.94 Combinations of RdInh and WrInh

RdInh	WrInh	Operation limits
0	0	Read/write operations are permitted in the specified range.
0	1	Read operations only are permitted in the specified range.
1	0	Write operations only are permitted in the specified range.
1	1	Both read and write operations are prohibited. Only access by the SEEK and SEEK EXTENDED commands is permitted within the specified range.

When access to logical data blocks outside the address range defined by this command by linked commands which follow this command is specified, or when a prohibited type of access operation is specified, that command is terminated with a CHECK CONDITION status without being executed. (When there is a violation of the (DATA PROTECT [=7] / Write protect [=27-00]: "WrInh" flag, or when there is a violation of the (DATA PROTECT [=7] / No additional sense information [=00-00]: "RdInh" flag.) When this command is issued again in a group of commands linked in a series, the 2nd SET LIMITS command is rejected and a CHECK CONDITION status (DATA PROTECT [=7] / Command sequence error [=2C-00]) is reported.

IMPORTANT

1. Commands which come under restrictions in read operations or write operations when "1" is specified in the "RdInh" (read inhibit) or "WrInh" (write inhibit) flag are as follows.

   "RdInh"

   – READ

   – READ EXTENDED (*)

   – READ LONG

   – VERIFY (*)

   – WRITE AND VERIFY (*)

   – PRE-FETCH

   "WrInh"

   – FORMAT UNIT

   – REASSIGN BLOCKS

   – WRITE

   – WRITE AND VERIFY (*)

   – WRITE EXTENDED (*)

   – WRITE LONG

   – WRITE SAME

   * When zero is specified in the processing block count, that command is not executed.

2. Even if a write operation is prohibited by this command, "0" is indicated in the "WP (write protect)" bit reported to the INIT in the MODE SENSE and MODE SENSE EXTENDED commands.

3. If "0" is specified in this command in the "WrInh" flag, execution of a FORMAT UNIT command or REASSIGN BLOCKS command issued in linked form following this command is permitted (the specification of the range where access is permitted is not applied.)

4.2.10 SYNCHRONIZE CACHE (35)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'35'							
1	0	0	0	0	0	0	Immed	0
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	0	0	0	0	0	0	0	0
7	Block Count (MSB)							
8	Block Count (LSB)							
9	0	0	0	0	0	0	0	0

This command matches the logical block data in the data buffer with the same logical block data recorded on the disk media. If the data in the logical block in the data buffer is newer than the data on the disk media, those data are written to the disk media.

When the write cache is used, unwritten data held in the data buffer which are written to the disk media are written using this command.

The values specified in the "Logical block address" field and "Block count" field in the CDB are disregarded and if any unwritten data exist in the data buffer, writing of all those data to the disk media is performed.

If bit 1 of CDB byte 1, the "Immed (immediate) bit, is "1," a GOOD status is reported immediately at the point when the legality of the CDB is confirmed and the command is terminated. If this bit is "0," a GOOD status is reported at the point when writing of the unwritten data in the data buffer is completed and the command is terminated.

4.3 Format Commands

4.3.1 FORMAT UNIT (04)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'04'							
1	0	0	0	FmtData	CmpLst	Defect List Format		
2	0	0	0	0	0	0	0	0
3	Interleave factor (MSB)							
4	Interleave factor (LSB)							
5	0	0	0	0	0	0	0	0

This command initializes (formats) the entire area of the disk media that can be accessed from the INIT (User Space). At the same time, the IDD also implements defect management processing, allocating alternate blocks for defective portions of the disk media in accordance with the specifications in this command.

Furthermore, when the disk media is initialized with any of the following format attributes changed, the INIT must issue the MODE SELECT or MODE SELECT EXTENDED command before issuing this command and specify those format attributes in advance.

- Logical data block length
- Logical data block count
- User space cylinder count
- Spare sector count for alternate blocks

(1) Defect list

In order to register or specify the positions of defects on the disk media in connection with defect management processing that can be specified from the INIT, the following types of “Defect List” are defined.

a. P List: primary defect list

   Defect position information (permanent defects) is registered in this list at the time the disk drive is shipped from the factory. The P List registers areas on the disk media which clearly cannot be accessed from the INIT. The INIT can refer to the contents of this list by the READ DEFECT DATA command only, but cannot change or erase it.

b. D List: data defect list

   The defect information in this list is defect position information transferred from the INIT when this command is executed. The IDD registers this defect information on the disk media as the G List.

c. C List: target certification list

   This defect list contains position information on defective data blocks detected in the data block verify operation (Certification) after initialization when the FORMAT UNIT command is executed. The IDD generates this list internally when the FORMAT UNIT command is executed and adds it to the G List.

d. G List: grown defect list

   The defect information in this list contains defect position information specified by the NIT and position information on defective data blocks detected by the IDD itself. The P List is not included in this defect list. The IDD stores the G List in an area on the disk media which clearly cannot be accessed from the INIT. The INIT can refer to the contents of this list by the READ DEFECT DATA command. the following defect position information is included in the G List.

   – Defect information transferred from the INIT as the D List.

   – Defect information detected in the Verify operation when this command was executed (C List)

   – Defect information specified from the INIT by the REASSIGN BLOCKS command.

   – Defect information on data blocks where alternate block allocation was performed among defective data blocks detected by the IDD when automatic allocation processing of alternate blocks is permitted.

(2) Specifying the initialization method

The INIT can specify the method of defect processing executed by this command in the “FmtData (format data)” bit and “CmpLst (complete list)” bit of CDB byte 1 and the “Defect List Format” field.

When “1” is specified in the “FmtData (format data) bit, it indicates that the format parameters (header and defect list), described later, are transferred from the INIT when this command is executed. When this bit’s specification is “0,” it indicates that the format parameters are not transferred.

When the “CmpLst (complete list)” bit is “1”, it indicates that the previously existing G List is replaced with the defect list (D List) transferred from the INIT when this command is executed. When this bit is “0,” the contents of the D List are added to those of the previously existing G List.

The “Defect List Format” field specifies the format of the defect list (D List) transferred from the INIT when the “FmtData (format data)” bit is “1.” Any one of the following formats can be specified for the defect list.

Table 4.95 Defect list format

Defect List Format			D List Format
0	0	0	Block Address Format
1	0	0	Byte Distance from the Index Format
1	0	1	Physical Sector Address Format

If (0,0,0) is specified in the Defect List Format field and a value other than 0 is specified in “Defect List Length” in the Format parameters, this command is terminated with a CHECK CONDITION status (ILLEGAL REQUEST / Invalid field in parameter list).

The “Interleave factor” field in the CDB specifies the method of positioning logical data blocks in physical sectors on the disk media. Whichever value is specified in this field, the IDD does not apply sector interleave, but physically positions logical data blocks continuously in continuous sectors.

(3) Format parameters

Table 4.96 lists the data format of the Format parameter transferred from the INIT when “1” is specified in the “FmtData (format data)” bit of the CDB.

Table 4.96 FORMAT UNIT command parameter list configuration

Header

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘00’							
1	FOV	DPRV	DCRT	STPF	0	0	Immed	0
	0	0	0	0				
	1	0/1	0/1	×				
2	Defect List Length (MSB)							
3	Defect List Length (LSB)							

Defect List (D List)

Byte \ Bit	7	6	5	4	3	2	1	0
0	Defect Descriptor 0							
1								
~								
x								
~								
xx								
xx+1	Defect Descriptor n							
~								
xx+x								

a. Header

The top of the format parameter transferred from the INIT is a 4-byte header. The INIT can specify the method used for defect processing that is executed by this command by control flags within the header.

– FOV (format option valid)

  0: Indicates that the INIT does not specially specify concerning the functions specified by the control flags in bits 6 to 4 of byte 1 (see following “DPRY” to “STPF”.). The IDD executes format processing in accordance with the default values of the various control flags. If the INIT specifies “0” in this bit, “0” must be specified in all the control flags in bits 6 to 4 of byte 1.

  1: Indicates that the INIT is clearly specifying the functions specified by the control flags in bits 6 to 4 of byte 1 (see following “DPRY” to “STPF”.). The IDD executes format processing according to the values specified in the various control flags.

– DPRY (disable primary): Default value: “0”

  0: Specifies execution of format processing using the P List. Alternate blocks are allocated as substitutes for sectors in which defects registered in the P List exist, and logical data blocks are not positioned there.

  1: Specifies use of the P List in defect processing. Even if this value is specified, the P List itself is saved without being erased.

IMPORTANT

When the disk media is being initialized for normal operation, the P List must by all means be used. Therefore, “0” should be specified in this bit.

– DCRT (disable certification): Default value: “0”

  0: Specifies that data block verification be performed after initialization of the disk media. The IDD confirms that all logical data blocks can be read from normally after initialization is completed. Any defective data blocks detected in this verify operation are registered as a C List and alternate blocks are allocated for those data blocks.

  1: Indicates that data block verify operations are prohibited after initialization of the disk media.

– STPF (stop format): Default value: “1”

When the defect list (P List or G List) necessary for executing the defect processing specified in this command, cannot be read from the disk media, this bit indicates whether to continue (“0” is specified) or terminate (“1” is specified) command processing, but in the IDD, this bit’s specification is disabled, and the specified value is disregarded. When the necessary defect list cannot be read, this command is terminated with a CHECK CONDITION status. The sense data at this time indicate “MEDIUM ERROR [=3] / Primary defect list not found [=1C-01]” or “MEDIUM ERROR [=3] / Defect list error in primary list [=19-02],” if the P List cannot be read and “MEDIUM ERROR [=3] / Grown defect list not found [=1C-02]” or “MEDIUM ERROR [=3] / Defect list error in grown list [=19-03],” if the G List cannot be read.

– Immed (Immediate)

“1”: If “1” is specified in the Immed (immediate) bit, at the point when the CDB’s legality is confirmed, or at the point when transfer of the defect list is completed, a “GOOD” status is reported.

“0”: If “0” is specified in the Immed (immediate) bit, the specified operation is executed and the status byte is reported at the point when that operation is completed, then the command is terminated.

– Defect list length

This field specifies the total number of bytes in the “Defect list” transferred from the INIT following the header. The byte length of the “Defect descriptor” which configures the defect list differs depending on its format and the value specified by this field must be a multiple of 4 when the defect descriptor is in the block address format, and must be a multiple of 8 when the defect descriptor is in the byte distance from the index format or the physical sector address format. When zero is specified in this field, it indicates that the defect list is not transferred.

IMPORTANT

The disk media defect processing method implemented during FORMAT UNIT command execution is specified by the CDB and by header of the format parameters transferred from the INIT. By specifying zero in the “Defect list length” field in the Format parameter header, the INIT can specify the control flags related to formatting processing without transferring the defect list (D List).

b. Defect list (D List)

The defect list (D List) contains defect position information about the disk media specified by the INIT and is configured from one or more "Defect descriptors." "Defect descriptors must be described in the format specified in the "Defect List Format" field of the CDB.

The configurations which it is possible to specify for the "Defect descriptors" in the defect list (D List), and their description formats, are shown below. Furthermore, it is possible only to specify User Space and CE Space address information on the disk media in the Defect list (D List).

– Byte distance from the index format defect descriptor

Table 4.97 lists this description format of the defect descriptor. Defect descriptor in this format specifies the cylinder number, head (track) number and byte distance to the top byte of those data (8 bytes), of the data which includes defective bits, on the disk media. One defect is treated as a defect with a length of 8 bytes (64 bits length). Therefore, for defects with a length which exceeds 8 bytes, 2 or more defect descriptors must be specified. When multiple defect descriptors are specified, the cylinder number must be specified in the top position, the byte distance from the index in the bottom position, and the defect positions listed in ascending order.

IMPORTANT

Even if X'FFFFFFFF' is specified as the byte distance from the index to the defect position, a whole track cannot be considered defective.

Table 4.97 Defect descriptor: byte distance from index format

Byte \ Bit	7	6	5	4	3	2	1	0
0	Cylinder No. (MSB)							
1	Cylinder No.							
2	Cylinder No. (LSB)							
3	Head No.							
4	Byte distance from index to defect position (MSB)							
5	Byte distance from index to defect position							
6	Byte distance from index to defect position							
7	Byte distance from index to defect position (LSB)							

– Physical sector address format defect descriptor

Table 4.98 lists this description format of the defect descriptor. A defect descriptor with this format specifies the physical sector number of the data block which includes the defect on the disk media together with the cylinder No. and the head (track) No. When specifying multiple defect descriptors, the cylinder No. must be specified in the top position and the physical sector No. in the bottom position, with the defect positions listed in ascending order.

IMPORTANT

Sector numbers described in this format are physical sector numbers which to not apply the "Track skew factor" and the "Cylinder skew factor."

Even if X'FFFFFFFF' is specified as the byte distance from the index to the defect position, a whole track cannot be considered defective.

Table 4.98 Defect descriptor: physical sector address format

Byte \ Bit	7	6	5	4	3	2	1	0
0	Cylinder No. (MSB)							
1	Cylinder No.							
2	Cylinder No. (LSB)							
3	Head No.							
4	Physical sector No. of defective block (MSB)							
5	Physical sector No. of defective block							
6	Physical sector No. of defective block							
7	Physical sector No. of defective block (LSB)							

– Cautions in specifying the D list

The P List, containing defect position information, is always recorded on the IDD when it is shipped from the factory. Also, information on defect positions for which alternate block processing has been implemented during operation are recorded as the G List. The function which specifies defect position information as the D List when the FORMAT UNIT command is executed, is prepared mainly to specify initial defect position information of the disk media which does not have the P List recorded on it. In the IDD, by specifying use of the P List and G List, advance notice of the defect positions can be specified during initialization, so ordinarily, it is not necessary to use the D List. When the D List is used for the IDD, caution should be exercised in the follow points.

1. The maximum number of defective sectors (total amount of 'sector slip' and 'alternate sectors') are calculated per :
   a) Current condition of reallocated sectors:
      (how many Slip Sectors have been allocated ? and so Alternate Sectors ? Since Defect table entry for Slip and Alternate are different size.)
   b) The maximum size of Defect Management Table (Fixed value)
   c) Current allocation condition of 'sector slip'
      (i.e. Up to 16 consecutive Slip Sector can be controlled by 1 Slip Defect entry. So the necessary table size are varied not only the number of Defects but also the number of consecutive Slips.)

   Consequently, the concrete Defect numbers cannot be described though the IDD guarantees 12,000 Slip Sectors and 3,000 Alternate Sectors at minimum. If defect processing which exceeds this limit is specified in the FORMAT UNIT command, that command is terminated with a CHECK CONDITION status (HARDWARE ERROR [=4] / No defect spare location available [=32-00]).

2. A defect descriptor specified as the D List are received normally if the specified defect position information is within a range which does not exceed the disk drive's physical boundaries (User Space), and is recorded as the G List, but formatting processing is executed only for the User Space in the range specified in the "Block descriptor" and "Format parameters" (Page 3), and the "Drive parameters" (Page 4) of the MODE SELECT parameter.

3. If a defect descriptor in the "Byte distance from the Index format" is specified in the D List, depending on the byte position of the specified defective byte, 2 sectors may be processed as defective sectors with one defect descriptor, or 1 sector may be processed as a defective sector with 2 or more defect descriptors. Also, if the specified defective byte position has no influence on data block read/write operations, that defect position information is disregarded and is not the object of defective sector processing, and thus is not recorded in the G List. Therefore, the defect position information specified in this command may not necessarily coincide with the defect position information read with the READ DEFECT DATA command after this command is terminated.

(4) Defect processing during initialization

Table 4.99 shows each combination of control flag specification values and the contents of processing executed by the IDD. Furthermore, see Chapter 3 “Data Format” of the “Product Manual” concerning alternate block allocation processing methods.

Table 4.99 FORMAT UNIT command defect processing (1/2)

CDB Byte 1			Header			Defect Processing Method
FmtData	CmpLst	Defect List Format	FOV	DPRY	Defect List Length	
0	– (Note 4)	– – –	(Format parameters not transferred)			1) Alternate block allocation is performed for defects registered in the P List. 2) The previously existing G List is erased.
1	0 (Note 1, Note 2, Note 3)	d d d	0 1	0 0	Zero	1) Alternate block allocation is performed for defects registered in the P List and the previously existing G List. 2) The previously existing G List is saved.
1	0 (Note 1, Note 2, Note 3)	d d d	1	1	Zero	1) Alternate block allocation is performed for defects registered in the previously existing G List. 2) The P List is saved, but it is not used in defect processing. 3) The previously existing G List is saved.
1	1 (Note 1, Note 2)	d d d	0 1	0 0	Zero	1) Alternate block allocation is performed for defects registered in the P List. 2) The previously existing G List is erased and it is not used in defect processing.
1	1 (Note 1, Note 2)	d d d	1	1	Zero	1) Neither the P List or the G List is used in defect processing (alternate block allocation processing is not performed.) 2) The P List is saved, but the previously existing G List is erased.
1	0 (Note 3)	1 0 0 1 0 1	0 1	0 0	>0	1) Alternate block allocation is performed for defects registered in the P List, in the previously existing G List and the defects described in the D List transferred from the INIT. 2) The D List is added to the previously existing G List.

Table 4.99 FORMAT UNIT command defect processing (2/2)

CDB Byte 1			Header			Defect Processing Method
FmtData	CmpLst	Defect list format	FOV	DPRY	Defect List Length	
1	0	1 0 0 1 0 1 (Note 1, Note 3)	1	1	>0	1) Alternate block allocation is performed for defects registered in the previously existing G List and the defects described in the D List transferred from the INIT. 2) The P List is saved, but it is not used in defect processing. 3) The D List is added to the previously existing G List
1	1	1 0 0 1 0 1	0 1	0 0	>0	1) Alternate block allocation is performed for defects described in the D List transferred from the INIT. 2) The previously existing G List is erased and it is not used in defect processing. 3) The D List is registered as the new G list.
1	1	1 0 0 1 0 1	1	1	>0	1) Alternate block allocation is performed for defects registered in the P List and the defects described in the D List transferred from the INIT. 2) The P List is saved, but it is not used in defect processing. 3) The previously existing G List is erased and it is not used in defect processing. 4) The D List is added to the previously existing G List.

Note 1) ddd: 0,0,0= D List in the block address format.
1,0,0= D List in the byte distance from the index format.
1,0,1= D List in the physical sector address format.

Note 2) The D List is not transferred from the INIT.

Note 3) If the data block length is changed and the disk media is initialized, the INIT cannot specify a combination defect processing method.

Note 4) When this combination of defect processing methods is specified, the IDD performs verification of the data blocks after initialization and creates the C List. In other combination defect processing methods, the INIT can clearly specify whether the verification operation is prohibited or permitted by the DCRT flag of the Format parameter.

4.3.2 REASSIGN BLOCKS (07)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'07'							
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0

This command allocates alternate data blocks for defective data blocks specified in the “Defect Data” list transferred form the INIT.

The INIT specifies the logical block address of one or more defective data blocks in the “Defect Data” list which it transfers to the IDD. The IDD searches for unused spare sectors for use as alternate blocks and allocates these alternate blocks for the specified logical data blocks. Also, in the case of data blocks for which alternate data blocks have already been specified, the IDD allocates other usable spare sectors as alternate blocks for those data blocks.

Using this command, copying of the contents of the data in the logical data blocks specified in the “Defect data” list to the allocated alternate data blocks is attempted. If the data in logical data blocks which are specified in the “Defect data” list are correctable by ECC correction, the corrected data are copied and those data which are not correctable by ECC are copied as is in the uncorrected state (including the errors) and in the case of other media errors, X ‘00’ is copied in all bytes. Furthermore, the contents of data in data blocks other than the logical data blocks specified in the “Defect Data” list are not influenced by the alternate allocation processing through this command.

IMPORTANT

Copying of the contents of data in the logical data blocks specified in the “Defect data” list to alternate blocks allocated by this command is attempted, but in some cases, copying cannot be done. Confirmation of the contents of the data in allocated alternate blocks, saving of data before issuing this command and restoring of data after this command is executed are the responsibility of the INIT.

The format of the “Defect Data” list transferred from the INIT by this command is shown in Table 4.100.

Table 4.100 REASSIGN BLOCK command: defect data list configuration

	Byte \ Bit	7	6	5	4	3	2	1	0
Header	0	X‘00’							
	1	X‘00’							
	2	Defect List Length (m) (MSB)							
	3	Defect List Length (m) (LSB)							
Defect Descriptor List	4	Defective Block Logical Block Address (MSB)							
	5	Defective Block Logical Block Address							
	6	Defective Block Logical Block Address							
	7	Defective Block Logical Block Address (LSB)							
	8	Defective Block Logical Block Address							
	~								
	n+3								

The “Defect data” list is configured from a 4-byte header and one or more defect descriptors which follow it. One defect descriptor has a length of 4 bytes.

The “Defect list length” field in the header indicates the total number of bytes (m) of the defect descriptor list transferred after the header, and must be a multiple of 4. Also, when zero is specified in this field, this command is terminated without transfer of the defect descriptor list and allocation processing of alternate blocks.

IMPORTANT

The Defect list length that can be specified for the IDD is 2,044 (X ‘7FC’) bytes or less. Therefore, a maximum of 511 defective blocks can be specified in the REASSIGN BLOCKS command.

The logical block address of defective data blocks is described in 4-byte format in the defect descriptor. When multiple defect descriptors are specified, it is best for the INIT to describe defect descriptors in the ascending order of the logical data block addresses.

Furthermore, if the addresses of logical data blocks specified in the defect descriptor list overlap each other, This command is terminated with a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in parameter list [=26-00] and none of the alternate block allocation processing in that command is executed.

The IDD allocates alternate blocks to the specified data blocks in order from the top of the defect descriptor list. When all the usable spare sectors have been used up, and it is impossible to allocate alternate blocks, execution of this command is terminated at that point and a CHECK CONDITION status is reported. The sense data at this time indicate the following contents.

- Sense key: 4 = HARDWARE ERROR
- Sense code/Sub-sense code: 32-00 = No defect spare location available
- “VALID” bit: “1”
- Information field — Logical block address specified in the defect descriptor at the point when alternate block allocation becomes impossible.
- Command inherent information field — (same as above)

Also, when this command is terminated abnormally with a CHECK CONDITION status due to any one of several other types of error besides the above error, the logical block address specified in the first defect descriptor which did not undergo alternate block allocation is reported in the “Command inherent information” field in the sense data. However, if alternate block allocation processing of the defect descriptors for which alternate block allocation has not been implemented cannot be specified, or if alternate block allocation of all the specified defect descriptors has been completed, the “Command inherent information” field indicates X ‘FFFFFFFF.’

When alternate block allocation processing is successful, the defect position information on the disk media related to the data blocks specified in the defect descriptor list is recorded on the disk media as the defect list (G List). The INIT can read the contents of the G List using the READ DEFECT DATA command. Also, this command has no influence on the contents of the primary defect list (P List).

IMPORTANT

The defect position information in the G List is physical block addresses (logical data block addresses are allocated when no defect exists on the disk media). Therefore, the values specified in this command’s defect descriptor list (logical block addresses) may not necessarily be the same as the contents of the G List read by the READ DEFECT DATA command after this command is terminated. For details, see the description of the READ DEFECT DATA command (Section 4.3.3).

IMPORTANT

If this command is terminated with a CHECK CONDITION status, the sense code/sub-sense code in the sense data is other than "No defect spare location available [=32-00], and a valid logical block address (other than X 'FFFFFFFF') is displayed in the "Command inherent information" field, it is necessary for the INIT to reissue this command by the following procedure after executing recovery processing (shown in Section 5.2) in accordance with the contents of the sense data.

1. Delete the defect descriptors which precede the defect descriptor that specifies the logical block address displayed in the "Command inherent information" field of the sense data from the defect descriptor list specified in this command, and leave that defect descriptor in the list.

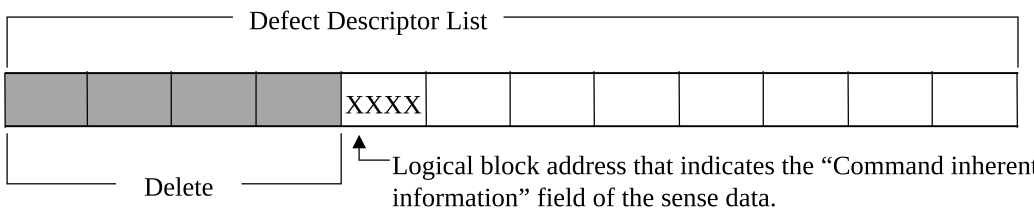

Figure 4.4 Correction of the defect descriptor

2. Change the "Defect List Length" in the header and add the new "Defect descriptor list" corrected in 1), then reissue the REASSIGN BLOCKS command.

4.3.3 READ DEFECT DATA (37)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'37'							
1	0	0	0	0	0	0	0	0
2	0	0	0	PList	GList	Defect List Format		
3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	Transfer Byte Length (MSB)							
8	Transfer Byte Length (LSB)							
9	0	0	0	0	0	0	0	0

This command transfers the list described in the defect position information of the disk media (defect data) to the INIT.

There are two types of defect data, the P List (primary defect list) and the G list (grown defect list). The P List indicates the defect position information at the time the disk drive was shipped from the factory. On the other hand, the G List shows the defect position information specified from the INIT by the REASSIGN BLOCKS command or automatic alternate block allocation processing, or when executing the FORMAT UNIT command, or defective data block positional information from alternate block allocation from Verify operation after initialization.

The INIT can specify the defect data type transferred to the INIT by the "P List (primary list)" bit and "G List (grown list)" bit in the CDB and can specify the defect data format by the "Defect List Format" field.

Table 4.101 Defect data type

PList	GList	Defect Data Type
1	1	P List and G List
1	0	P List only
0	1	G List only
0	0	4-byte header information only (described in this section)

Table 4.102 Defect data format

Defect List Format			Defect Data Format
0	0	0	Block Address Format
1	0	0	Byte Distance from the Index Format
1	0	1	Physical Sector Address Format

The "Transfer byte length" field in the CDB specifies the defect data length (number of bytes) that can be received by the INIT. The IDD terminates data transfer when transfer of the length of defect data specified in the "Transfer byte length" field is completed or when transfer of all the defect data of the specified type is completed. Also, when zero is specified in the "Transfer byte length" field, this command is terminated without execution of data transfer.

Table 4.103 lists the format of defect data transferred to the INIT by this command.

Table 4.103 READ DEFECT DATA command: defect data configuration

	Byte \ Bit	7	6	5	4	3	2	1	0
Header	0	X'00'							
	1	0	0	0	PList	GList	Defect List Format		
	2	Defect List Length (MSB)							
	3	Defect List Length (LSB)							
Defect Descriptor List	4	Defect Data							
	~								
	n								

(1) Header

a. P List (primary list) bit

When this bit is "1," it indicates that P List defect data are included in the defect descriptor list that is actually transferred to the INIT. When it is "0," it indicates that the P List defect data are not included. See 3) of item (2).)

b. G List (grown list) bit

When this bit is "1," it indicates that G List defect data are included in the defect descriptor list that is actually transferred to the INIT. When it is "0," it indicates that the G List defect data are not included. See 3) of item (2).)

c. Defect list format

This field indicates the description format of the defect descriptor list that is actually transferred to the INIT. It is possible for the IDD to transfer defect data in 3 different formats which it can specify in the CDB, and the values in this field are the same as the values specified in the "Defect List Format" field in the CDB.

d. Defect list length

This field follows the 4-byte header and indicates the total number of bytes of defect descriptor list that can be transferred. It has either 4 or 8 bytes, depending on the format of the defect descriptor. Also, the values shown in this field are the total number of bytes described in the "Defect List Format" which specifies the specified type (P List or G List) of defect data, regardless of the value specified in the "Transfer byte length" field in the CDB. The INIT should check whether the value shown in this field plus 4 is a smaller value than that specified in the "Transfer byte count" field in the CDB in order to confirm that all the defect data requested in this command have been transferred. Also, since the value shown in this field is divided by the number of bytes (4 or 8) per defect descriptor (quotient), the INIT can know the number of defects on the disk media.

(2) Defect descriptor list

The data transferred after the 4-byte header is the "Defect descriptor" list (Defect data) in which the defect position information are described with the type and format specified in the CDB. One "Defect descriptor" has a length of 4 bytes when in the "Block address format," and a length of 8 bytes when in the "Byte distance from the index format" and "Physical sector address format." The "Defect descriptors" do not necessarily transfer defect position information in ascending order.

See the description of the FORMAT UNIT command (Section 4.3.1) concerning the configuration and contents of the "Defect descriptor" in each format.

1. When "1" is specified in both the "P List" bit and the "G List" bit in the CDB, and transfer of both the P List and G List is requested, the IDD first of all transfers the P List, then transfers the G List afterward (merging of the defect information in the two lists is not performed).
2. When "0" is specified in both the "PList" bit and the "GList" bit in the CDB, only the header is transferred by that command, but the following information is shown in the header at this time.
   - PList bit: "0"
   - GList bit: "0"
   - Defect List Length field: The total number of bytes described in the "Defect List Format" specifying defect data included in the P List and G List.

3. Even if defect data of the type specified in the CDB do not exist in the defect list (P List or G List) (if the defect list is empty), “1” is displayed in the “PList” bit and the “GList” bit in the header transferred to the INIT corresponding to the specification in the CDB.

4. By the INIT issuing this command specifying “4” in the “Transfer Byte Length” field in the CDB, and by investigating the information in the header transferred by the IDD, it can know the length (number) of data included in the P List and G List.

5. Depending on the combination of defect data type specifications and format specifications, the following conditions exist concerning the transferred defect data, so caution is necessary.

Table 4.104 Defect data conditions

Defect List Format	PList	GList
Block Address Format	2)	2)
Byte Distance from the Index Format	1)	1), 3)
Physical Sector Address Format	1)	1)

1) Regardless of the size of the User Space, all the defect position information for the disk media other than the system space is reported. Defect position information is also reported for areas which cannot be clearly accessed from the INIT, such as the spare sectors for alternate blocks.

2) Logical data blocks which have undergone slip processing due to defective sectors, and logical data blocks which have undergone alternate processing, are reported. Defect position information is not reported for areas which cannot be clearly accessed from the INIT (areas which do not have logical block addresses) such as cylinders and sectors, etc. which are not used as User Space or CE Space.

3) The byte position which indicates the first byte in defective sector data is reported.

6. The number of defects reported by this command differs depending on the defect data format.

   – When data are in the "Block Address Format," defect position information is not reported for portions which cannot be clearly accessed from the INIT.

   – When data are in the "Block Address Format" or the "Physical Sector Address Format," even if defects exist in multiple locations within that sector, that defect information is reported by one defect descriptor.

   – When data are in the "Byte Distance from the Index Format," all the registered defect positions are reported when the P List is reported, but in the case of the "Block Address Format" and the "Physical Sector Address Format," the defect position information is not reported for defects which do not have an influence on data block read/write operations.

   – When data are in the "Byte Distance from the Index Format," when the P List is reported, multiple defect position information may be reported for a single sector, or 2 defective sectors may be reported as a single item of defect position information due to defects which extend across sector boundaries.

7. In defect data in the block address format, all the physical defect position information on the disk media cannot be described universally. For example, defect position information in areas without block addresses (spare sectors, or cylinders which are not being used as User Space or CE Space) cannot be described. The defect data in this format are provided in order to preserve continuity with previous specifications, but it is recommended that as much as possible, the INIT not use the "Block Address Format."

4.3.4 READ DEFECT DATA (B7)

Byte \ Bit	7	6	5	4	3	2	1	0	Remark
00	1	0	1	1	0	1	1	1	X'B7'
01	0	0	0	PList	GList	Defect List Format			
02	0	0	0	0	0	0	0	0	X'00'
03	0	0	0	0	0	0	0	0	X'00'
04	0	0	0	0	0	0	0	0	X'00'
05	0	0	0	0	0	0	0	0	X'00'
06	Transfer Byte Length (MSB)								
07	Transfer Byte Length								
08	Transfer Byte Length								
09	Transfer Byte Length (LSB)								
10	0	0	0	0	0	0	0	0	X'00'
11	0	0	0	0	0	0	0	Link	Control

This command transfers the list containing the defect position information of disk media (defect data) to the INIT.

The command is the same as the READ DEFECT DATA command (37) described in Section 4.3.3 except for the following: the transfer byte length can be specified in four bytes and the defect list length can be specified in four bytes in this command.

Table 4.105 lists the format of defect data that is transferred to the INIT by this command.

Table 4.105 READ DEFECT DATA command (B7): defect data configuration

	Byte \ Bit	7	6	5	4	3	2	1	0
Heade	0	X'00'							
	1	0	0	0	PList	GList	Defect List Format		
	2	Reserved							
	3	Reserved							
	4	Defect List Length (MSB)							
	~	:							
	7	Defect List Length (LSB)							
Defect Descriptor List	8	Defect Data							
	~								
	n								

4.4 Maintenance, Diagnostic Commands

4.4.1 SEND DIAGNOSTIC (1D)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'1D'							
1	SELF-TEST CODE			PF	0	SelfTest	DevOfl	UnitOfl
2	0	0	0	0	0	0	0	0
3	Parameter List Length (MSB)							
4	Parameter List Length (LSB)							
5	0	0	0	0	0	0	0	0

This command executes self-diagnosis tests which the IDD is equipped to perform and operation specified in the parameter list transferred from the INIT.

(1) Self-diagnosis test

When the “SelfTest (self test)” bit is “1,” and “Self-Test Code” field is “000” in the CDB, this command specifies execution of the self-diagnosis test which the IDD is equipped to perform. At this time, the “PF (page format)” bit and the “Parameter list length” field in the CDB have no meaning and the values specified there are disregarded. Also, the “DevOfl (device off-line)” bit specifies whether or not operations which have an influence on the status of logical units other than the logical unit specified in this command during the self-diagnosis test, but in the IDD, there is only 1 logical unit that exists. Therefore, the specification in this bit has no meaning and the specified value is disregarded.

The INIT can specify the type of self-diagnosis test to be executed through the “UnitOfl (unit off-line)” bit. When “1” is specified in the “SelfTest (self test)” bit, the IDD executes a series of self-diagnosis tests in accordance with the combination with the “UnitOfl (unit off-line)” bit, as shown in Table 4.106.

Table 4.106 Self-diagnosis test

Type of Self-diagnosis Test	UnotOfl = “0”	UnitOfl = “1”
1) Controller Function Test	×	×
2) Disk Drive Seek Test		×
3) Disk Media (CE Space) Write/Read/Data Comparison Test		×

×: Execution Object

When the IDD completes all the specified self-diagnosis tests normally, it reports a GOOD status. On the other hand, when an error is detected in any of the specified self-diagnosis tests, a CHECK CONDITION status is reported and information related to the detected error is shown in the sense data. For example, when an error is detected in the controller function test, the type of error is shown by HARDWARE ERROR [=4] in the sense key, and the sense code/sub-sense codes show “Diagnostic failure on component ‘nn’ [=40-nn].” (nn is the code in the range X ‘80’ to X ‘FF,’ which shows the type of error. This code is a Fujitsu unique definition for the purpose of analysis when there is a failure, and its meaning is not released to the public. The user should present the value displayed in this sense data as repair information to the Fujitsu representative.)

Furthermore, error recovery processing when diagnostic tests (seek tests and write/read/data comparison tests) related to the disk drive are executed are in accordance with the mode set in the MODE SELECT command’s parameters (Page code 1: Read/Write Error Recovery parameter, Page code 21: Additional Error Recovery parameter), except in the following special cases.

Special cases of MODE SELECT parameters during a self-diagnosis test are as shown below

- The AWRE, ARRE and TB flags are not applied.
- The PER and DTE flags are as shown in Table 4.107.

Table 4.107 Error recovery control flags during the self-diagnosis test

PER	DTE	Diagnostic test operation
0	0	The diagnostic test continues when error recovery is successful. The contents of recovered errors are not reported. When an error which cannot be recovered from is detected, the diagnostic test terminates at that point with an error.
0	1	– – – – – (Setting prohibited) – – – –
1	0	The diagnostic test continues when error recovery is successful. When an error which cannot be recovered from is detected, the diagnostic test terminates at that point with an error. Even when all the detected errors have been recovered, a CHECK CONDITION status (RECOVERED ERROR [=1]) is reported after the series of diagnostic tests is completed and the sense data show the contents of the last error to be successfully recovered from.
1	1	When error recovery is successful, or even when error recovery is impossible, the diagnostic test is terminated with an error at the point when the permitted error recovery processing is completed and a CHECK CONDITION status is reported. The sense data show the contents of the detected error.

IMPORTANT

When “1” is specified in the “SelfTest (self test)” bit in this command, the command execution results are reported by the status byte and the sense data. Therefore, even if the RECEIVE DIAGNOSTIC RESULTS command is executed after this command, the self-diagnosis test execution results are not reported as response data.

Remark:

The error recovery control flag is valid only for PER. Therefore, the only error recovery flag combination that is actually executed in the above self-diagnosis tests is the (PER, DTE) = (1, 0) combination.

(2) Parameter specification

When “0” is specified in the “SelfTest (self test) bit in the CDB, the IDD executes the operations specified in the parameter list transferred from the INIT by this command. In this case, the IDD reports a GOOD status and terminates this command at the point when preparation of the “response data” is completed after completing the specified operations. The INIT can read the execution results (response data) by the RECEIVE DIAGNOSTIC RESULTS command.

When the “PF (page format)” bit in the CDB is “1,” the parameter list transferred from the INIT by this command shows the page format, explained later, but the IDD disregards the value specified in this bit and always handles the page format according to the specifications in the parameter list when the parameter list is transferred by this command. Also, when the “SelfTest (self test)” bit is “0,” the specifications in the “DefOfl (device off-line)” bit and the “UnitOfl (unit off-line)” bit have no meaning and their specified values are disregarded.

The “Parameter list length” field in the CDB shows the length (number of bytes) of the parameter list that is transferred from the INIT when the “SelfTest (self test)” bit’s specification is “0.” When zero is specified in the “Parameter list length” field, this command is terminated without anything being executed. Also, when the value specified in the “Parameter list length” field does not reach the specified length for the parameter list, explained later, and as a result, not all the bytes in the parameter list can be received, that command is terminated with a CHECK CONDITION status (ILLEGAL REQUEST) [=5] / Invalid field in CDB [=24-00]).

Table 4.108 lists the format of the parameter list (called the parameter page) transferred from the INIT to the IDD by this command. The parameter page is configured from the 4-byte “Page Header” and the “Page Parameters” which follow it. Furthermore, the INIT can specify only a single parameter page by this command. Even when multiple parameter pages have been specified by the INIT, the IDD executes only the operation specified by the top parameter page.

IMPORTANT

1. When “0” is specified in the “SelfTest (self test)” bit in this command, the INIT can specify only a single parameter page.
2. In order to avoid loss of security to the execution results (response data) of this command due to another command issued by another INIT, when “0” is specified in the “SelfTest (self test)” bit, the INIT should issue this command linked to the RECEIVE DIAGNOSTIC RESULTS command or reserve the IDD before issuing this command, and should release the reserve status after executing the RECEIVE DIAGNOSTIC RESULTS command.
3. When a command other than the RECEIVE DIAGNOSTIC RESULTS command is linked to this command, the execution results (response data) may no longer be secure.

Table 4.108 SEND DIAGNOSTIC command: parameter list configuration

	Byte \ Bit	7	6	5	4	3	2	1	0
Header	0	Page Code							
	1	0	0	0	0	0	0	0	0
	2	Page Parameter Length (MSB)							
	3	Page Parameter Length (LSB)							
Page Parameter	4	Parameter							
	~								
	n								

- Page code

  This field specifies the code which identifies the type of parameter page being transferred from the INIT and the operation that should be executed. The parameter pages which can be specified by the INIT and their functions are as shown Table 4.109.

Table 4.109 Page code

Page Code (Hex)	Function
00	Reports a list of the supported page codes.
01	reserve SES page
02	Enclosure Control
03	reserve SES page
04	Enclosure String Out
05	Enclosure Threshold Out
06	Enclosure Array Control
07	reserve SES page
08	reserve SES page
09-0F	reserve SES page
40	Logical/Physical Address Conversion
80-8F	Vender specific SES page
A0	Fault LED page

- Page parameter length

  This field specifies the byte length of the page parameter after byte 4. The INIT must specify the same value as the length specified for each of the parameter pages, which will be explained later.

- Page parameter

  This field specifies each of the inherent parameters in each page code. Depending on the page code, this field may not be necessary (page parameter length = 0).

a. Page code list

This parameter page specifies transfer of the “Page code” list of the parameter page supported by the IDD in the SEND DIAGNOSTIC command and the RECEIVE DIAGNOSTIC RESULTS command to the INIT. Table 4.110 shows the format of this parameter page. The page code list supported by the IDD is transferred to the INIT by the RECEIVE DIAGNOSTIC RESULTS command which is issued following the SEND DIAGNOSTIC command that specifies this parameter page (shown in Section 4.4.2 (1))

Table 4.110 SEND DIAGNOSTIC parameters: page code list

Byte \ Bit	7	6	5	4	3	2	1	0
0	X ‘00’ (Page Code)							
1	0	0	0	0	0	0	0	0
2	X ‘00’ (Page parameter length)							
3	X ‘00’ (Page parameter length)							

b. Logical/physical address conversion

This parameter page specifies conversion of the address information expressed in either the “Logical Block Address,” “Physical Sector Address” or “Byte Distance from the Index” format to another expression format. Table 4.111 shows this parameter page format. The INIT can specify the address information that should be converted in this parameter page of the SEND DIAGNOSTIC command, and can read the conversion results by the RECEIVE DIAGNOSTIC RESULTS command (see Section 4.4.2 (2)).

Table 4.111 SEND DIAGNOSTIC parameters: logical/physical address conversion

Byte \ Bit	7	6	5	4	3	2	1	0
0	X '40' (Page Code)							
1	0	0	0	0	0	0	0	0
2	X '00' (Page Parameter Length)							
3	X '0A' (Page Parameter Length)							
4	0	0	0	0	0	Address Format Before Conversion		
5	0	0	0	0	0	Address Format After Conversion		
6	Logical or Physical Address							
7								
~								
13								

The "Address Format Before Conversion" field shows the format of the address information specified in bytes 6 to 13. The IDD converts that address information to the expression format specified in the "Address Format After Conversion" field. the following codes can be specified as Table 4.112.

Table 4.112 Specifying address format

Code	Address Format
0 0 0	Logical Block Address Format
1 0 0	Byte Distance from the Index Format
1 0 1	Physical Sector Address Format

The description format of the address information specified in bytes 6 to 13 is the same as the description specification of the D List transferred from the INIT by the FORMAT UNIT command. For details, see the description of the FORMAT UNIT command (Section 4.3.1). furthermore, when the logical block address format is specified, it must be described in bytes 6 to 9 and zero must be specified in the remaining byte positions.

When a logical data block address which does not exist (outside the range of the MODE SELECT parameter) is specified in the logical block address format, or when an area which cannot be allocated as User Space on the disk drive (cylinders which physically do not exist) is specified in the "Byte Distance from the Index" format or the "Physical Sector Address" format, that command is terminated with a CHECK CONDITION status (ILLEGAL

REQUEST [=5] / Invalid field in parameter list [=26-00]) and address conversion is not executed.

Details of the address conversion algorithm executed when this parameter page is specified and the data format, etc. of the conversion results reported to the INIT are explained in RECEIVE DIAGNOSTIC RESULTS command (Section 4.4.2).

(3) Logical unit Self-Test

When "0" is specified in the "SelfTest" bit and the values other than zero is specified in the "SELF-TEST Code" field in CDB, the IDD executes the Self-Test specified in CDB. In this case, the INIT can read the executed results (page code= x10 : Self-Test Result Log Page) by the LOG SENSE command.

The specified values in "PF" bit, "DevOffL" bit and "UnitOffL" bit in CDB are ignored.

The "Parameter List length" field shall contain zero. If the value other than zero is specified in this field, this command is terminated with a CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in CDB [=24-00]).

The "SELF-TEST Code" field specifies the type of executing Self-Test by this command, as Table 4.113.

Table 4.113 SELF-TEST

Page code (Hex)	Function
0,0,0	Refer to clause (2), Parameter Specification.
0,0,1	The device server shall start its short self-test routine in the background mode.
0,1,0	The device server shall start its extended self-test routine in the background mode.
0,1,1	Reserved
1,0,0	Abort the current self-test running in background mode. This value is only valid if a previous this command specified a Background self-test function and that function has not completed. If either of these conditions is not true, then the device server shall it respond by returning a CHECK CONDTION status.
1,0,1	The device server shall start its short self-test routine in the foreground mode.
1,1,0	The device server shall start its extended self-test routine in the foreground mode.
1,1,1	Reserved

The Self-Test executes the following test segments in ascending order by number:

1. Buffer RAM test
2. Flash ROM test
3. Pre-SMART test
4. Low Level Format test
5. Random seek test
6. Sequential seek test
7. Data compare test
8. Random read test
9. Sequential read test
10. SMART test

(4) ESI page

When it is connected to SFF-8067 Enclosure via the SCA connector, it is possible that an ESI page code is sent out by using this command.

It is finished with a “CHECK CONDITION” status (ILLEGAL REQUIST [=5]/Unsupported Enclosure Function [=35-01]) when this command is issued when it is connected to SFF-8045 Enclosure.

The page code which can be specified with this command is limited to the following page. It is finished with a “CHECK CONDITION” status (ILLEGAL REQUIST [=5]/Invalid Field in Parameter List [=26-00]) when a page code except for the following is specified and when a page parameter head inside the number of transfers of CDB and the parameter page header is inconsistent.

Attention: As for the page code 0x09-0x0F, it is issued as an ESI command in Enclosure then it is issued though it is RESERVE in standard. Data transmission is possible if Enclosure copes with it. If Enclosure copes with it in the same way, as for 0x80-0x8F as well, data transmission is possible.

Refer to those specifications for the contents of each page and the length because it is prescribed with each Enclosure.

Table 4.114 ESI page

Page Code (Hex)	Function
01	reserve SES page
02	Enclosure Control
03	reserve SES page
04	Enclosure String Out
05	Enclosure Threshold Out
06	Enclosure Array Control
07	reserve SES page
08	reserve SES page
09-0F	reserve SES page
80-8F	Vender specific SES page

Table 4.115 ESI page format

Byte \ Bit	7	6	5	4	3	2	1	0	
0	Page Code								
1									<=No check
2	Page parameter length								
3	Page parameter length								
~	~								

SES A header the byte 1 of page's isn't checked by firmware.

(5) Fault LED test page

Table 4.116 Fault LED test page

Byte \ Bit	7	6	5	4	3	2	1	0
0	X 'A0' (Page Code)							
1	reserved							
2	X '00' (Page parameter length)							
3	X '02' (Page parameter length)							
4	reserved							
5	reserved							FLTLED

This page is a page of the Fault LED test

The value of that bit isn't confirmed with firmware in reserved in the parameter and the written territory. (Taking usually "0" is recommended.)

This page is to be only for the Send Diagnostic command, and don't specify this page with a Receive Diagnostic Results command. And, the movement when it is specified isn't assured.

After executing the operation for turning on the Fault LED using this page, be sure to turn off the Fault LED by executing the operation for turning it off. The condition of Fault LED isn't assured when download of Firmware and Reset from the interface are carried out with turning it on.

a. FLTLED bit

1: Fault LED is turned on when '1' is set up to this bit

0: Fault LED turns off the lights when '0' is set up to this bit

4.4.2 RECEIVE DIAGNOSTIC RESULTS (1C)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘1C’							
1	0	0	0	0	0	0	0	PCV
2	0	0	0	0	0	0	0	0
3	Transfer Byte Length (MSB)							
4	Transfer Byte Length (LSB)							
5	0	0	0	0	0	0	0	0

This command transfers data (response data) which show the results of executing the SEND DIAGNOSTIC command from the IDD to the INIT. The format and content of response data are determined by the parameter list (page code) specified by the INIT in the SEND DIAGNOSTIC command.

The “Transfer byte length” field in the CDB shows the maximum number of bytes of response data that can be received by the INIT by this command. The IDD transfers the number of bytes of data specified by this field or all the bytes of the effective response data, whichever is smaller in length. Also, when zero is specified in this field, this command is terminated without anything being transferred.

IMPORTANT

Exercise caution in the following points when using this command.

1. In order to avoid damage to the results of SEND DIAGNOSTIC command execution (response data) from a command issued by another INIT during the interval until this command is issued, either this command should be linked to the SEND DIAGNOSTIC command when it is issued or the SEND DIAGNOSTIC command and this command should be executed after the IDD is reserved.
2. Response data are valid only when “0” is specified in the “SelfTest (self test)” bit and after a SEND DIAGNOSTIC command which specifies a specific operation in the parameter list is executed, with the IDD transferring response data showing the execution results of the latest SEND DIAGNOSTIC command. Also, even if this command is executed, the response data in not cleared, and remains valid until the next SEND DIAGNOSTIC command is executed.
3. If this command is issued when valid response data do not exist, the IDD transfers a maximum of 4 bytes of X ‘00’ data to the INIT.

Table 4.117 lists the format of response data transferred to the INIT from the IDD by this command. The response data are configured from a 4-byte "Page header" and the "Page parameters" which follow it.

Table 4.117 RECEIVE DIAGNOSTIC RESULTS command: response data configuration

	Byte \ Bit	7	6	5	4	3	2	1	0
Header	0	Page Code							
	1	0	0	0	0	0	0	0	0
	2	Page Parameter Length (MSB)							
	3	Page Parameter Length (LSB)							
Page Parameters	4	Parameter							
	5								
	~								
	n								

- Page code

  This field is the same value as the page code specified in the parameter list transferred form the INIT by the SEND DIAGNOSTIC command executed last, and shows a code which identifies the type of response data reported in this command.

- Page parameter length

  This field shows the byte length of the page parameter after byte 4.

- Page parameter

  Data which show the execution results of the operation specified by the SEND DIAGNOSTIC command are reported in this field.

(1) Page code list

This response data reports the "Page code" list of the parameter page supported by the IDD in the SEND DIAGNOSTIC command and the RECEIVE DIAGNOSTIC RESULTS command after byte 4. The format and contents of this response data are shown in Table 4.118.

Table 4.118 RECEIVE DIAGNOSTIC RESULTS response data: page code list

Byte \ Bit	7	6	5	4	3	2	1	0
0	X '00' (Page Code)							
1	0	0	0	0	0	0	0	0
2	X '00' (Page parameter length)							
3	X '22' (Page parameter length)							
4	X '00' [Page Code List]							
5	X '01' [Enclosure Configuraton]							
6	X '02' [Enclosure Control/Status]							
7	X '03' [Enclosure Help Text]							
8	X '04' [Enclosure String In/Out]							
9	X '05' [Enclosure Threshold In/Out]							
10	X '06' [Enclosure Array Control/Status]							
11	X '07' [Enclosure Elemaent Descriptor]							
12	X '08' [Enclosure Short Status]							
13	X '09' [reserve]							
:	: :							
19	X '0F' [reserve]							
20	X '40' [Logical/Physical Address Conversion]							
21	X '80' [Vender Specific SES page]							
:	: :							
36	X '8F' [Vender Specific SES page]							
37	X 'A0' [Fault LED test]							

(2) Logical/physical address conversion

This response data reports the execution results of address conversion specified in the “Logical/Physical Address Conversion” parameter in the SEND DIAGNOSTIC command in bytes after byte 4. The format and contents of this response data are shown in Table 4.119.

Table 4.119 RECEIVE DIAGNOSTIC RESULTS response data: logical/physical address conversion

Byte \ Bit	7	6	5	4	3	2	1	0
0	X ‘40’ (Page Code)							
1	0	0	0	0	0	0	0	0
2	X ‘00’ (Page Parameter Length)							
3	X ‘0A’ (Page Parameter Length)							
4	0	0	0	0	0	Address Format Before Conversion		
5	0	0	0	0	0	Address Format After Conversion		
6	Logical or Physical Address							
7								
~								
13								

IMPORTANT

The value of the “Page Parameter Length” field in this response data is a variable length within the range of [2 + 8n] in the FC specifications. For example, If multiple logical data blocks are located in 1 physical sector, or if 1 logical data block is located in multiple physical sectors, n address information items are reported as the address conversion results.

In the current IDD specifications, multiple address information items are not reported in this response data, but the “Page parameter length” always shows X ‘000A.’ However, considering expanded specifications in the future, the INIT should make it possible to correspond to variable lengths for the “Page parameter length.”

The "Address Format Before Conversion" field in byte 4 and the "Address Format After Conversion" field in byte 5 are the same values as the codes which show the expression format for address information specified by the SEND DIAGNOSTIC command parameters. The "Address Format After Conversion" field shows the expression format of the address information reported in bytes 6 to 13 of this response data. "Address format" codes are as shown in Table 4.120.

Table 4.120 Address format

Code	Address Format
0 0 0	Logical Block Address Format
1 0 0	Byte Distance from the Index Format
1 0 1	Physical Sector Address Format

The description of address information shown in bytes 6 to 13 is the same as the description specifications in the D List transferred from the INIT by the FORMAT UNIT command. For details, see the description of the FORMAT UNIT command (Section 4.3.1). Furthermore, When the logical block format is used, the address is shown in bytes 6 to 9 and zero is reported in the remaining byte positions. However, when the address information specified in the "SEND DIAGNOSTIC command points to a position on the disk media which is not used as physical data blocks, X 'FFFFFFFF 00000000' is reported as the logical block address after conversion.

(3) ESI (Enclosure Services Information)

Connection to SFF-8067-compliant Enclosure enables information acquisition from Enclosure by specifying the page codes in Table 4.121.

Table 4.121 ESI page code

Page Code (Hex)	Function
01	Enclosure Configuration
02	Enclosure Control/Status
03	Enclosure Help Text
04	Enclosure String Out/In
05	Enclosure Threshold Out/In
06	Enclosure Array Control/Status
07	Enclosure Element Descriptor
08	Enclosure Short Status
09-0F	Reserved
80-8F	Vender specific SES page

Be sure to set up PCV in 1 when you transfer information on ESI. PCV works supposing that it is ignored and 00 is set up in the page code even if any page code is specified when 0 is set up.

Information from Enclosure is transferred to INIT by specifying the above page code with CDB with the designation of PCV=1 by the following page format.

Remark:

The page code 0x09-0x0F is a reserve in the specification of SES/ESI. It is issued as an ESI command to Enclosure at present without taking an error when the 0x09-0x0F is specified in the page code.

When it has the 0x80-0x8F specified, it is issued as Vendor unique Page as an ESI command to Enclosure.

Table 4.122 ESI page format

	Byte \ Bit	7	6	5	4	3	2	1	0
Header	0	Page Code							
	1	0	0	0	0	0	0	0	0
	2	Page Parameter Length (MSB)							
	3	Page Parameter Length (LSB)							
Page parameters	4	Parameter							
	5								
	~								
	n								

When it is connected to Enclosure of the SFF-8045 conformity, it is finished with a “CHECK CONDITION” status (ILLEGAL REQUEST [=5] / Unsupported Enclosure Function [=35-01]). Short Enclosure Status (Table 4.123) in SFF-8045 form is reported in the case of “SFF-8045” with parallel ESI”.

Table 4.123 Short enclosure status

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'08' (Page Code)							
1	8045	EFW	P_ESI5	P_ESI4	P_ESI3	P_ESI2	P_ESI1	P_ESI0
2	X'00' (Page Parameter Length)							
3	X'00' (Page Parameter Length)							

4.4.3 WRITE BUFFER (3B)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘3B’							
1	0	0	0	0	Mode			
2	Buffer Address (MSB)							
3	Buffer Address							
4	Buffer Address							
5	Buffer Address (LSB)							
6	Transfer Byte Length (MSB)							
7	Transfer Byte Length							
8	Transfer Byte Length (LSB)							
9	0	0	0	0	0	0	0	0

This command is used in combination with the READ BUFFER command to diagnose the normality of the IDD’s data buffer memory or the FC bus, or to download microcode to the IDD.

The IDD stores data transferred from the INIT in accordance with the specifications in this command's CDB to in the data buffer in the IDD. The IDD have 6,733 K (6,895,200) byte data buffers. This command, using buffer addresses with a range of X'000000' to X'693660', must specify data storage positions in 1-byte units, and with 4-byte units addresses. The INIT can know the IDD's buffer configuration and the units which addresses can be specified in by issuing the READ BUFFER command.

The functions of this command and the format of data transferred from the INIT are specified in the “Mode” field in byte 1 of the CDB and any of the transfer modes shown in Table 4.124 can be selected.

Table 4.124 WRITE BUFFER transfer mode

"Mode Bit"	3	2	1	0	Transfer Mode
	0	0	0	0	Header + Data, without Address Specification
	0	0	0	1	Header + Data, with Address Specification
	0	0	1	0	Data Only, with Address Specification
	0	1	0	0	Microcode Download, without Saving
	0	1	0	1	Microcode Download, with Saving
	0	1	1	0	Microcode Download with offset, without Saving
	0	1	1	1	Microcode Download with offset, and Saving
	1	0	1	0	Echo buffer

(1) Mode = 0, 0, 0, 0: Header + data, without address specification

In this mode, a 4-byte header (with all zero's specified for the contents) must be added to the top of the data transferred from the INIT. Also, zero must be specified in the "Buffer address" field of the CDB.

The "Transfer byte length" field specifies the total number of bytes of data transferred form the INIT. The transfer byte count specification includes the 4 bytes of the header. The IDD stores the data transferred from the INIT with the header omitted ("Transfer byte length" – 4 bytes) in the data buffer beginning in order from the top of the data buffer (Address: X '000000').

Furthermore, a value which is less than the [IDD's buffer size + 4 bytes] must be specified in the "Transfer byte length" field in the CDB. When a value that is larger than this is specified, no data transfer with the INIT is executed. Also, when zero is specified in the "Transfer byte length" field, this command is terminated without data being transferred.

Table 4.125 lists the format of data transferred from the INIT when this mode is specified.

Table 4.125 WRITE BUFFER command: buffer data (mode = 000, 001)

	Byte \ Bit	7	6	5	4	3	2	1	0
Header	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0
Data	4	Buffer Data (Byte 0)							
	5	Buffer Data (Byte 1)							
	~	~							
	n	Buffer Data (Byte n–4)							

(2) Mode = 0, 0, 0, 1: Header + data, with address specification

The format of data transferred from the INIT in this mode must be the same as in the case of Mode = 0, 0, 0, 0, and the 4-byte header (with zero specified in all its contents) must be added to them.

In this mode, the top address of the data buffer where the data transferred from the INIT are stored can be specified in the "Buffer address" field in the CDB.

The "Transfer byte length" field in the CDB specifies the total number of bytes of data transferred by the INIT. The transfer byte count specification includes the 4 bytes of the header. The IDD stores data transferred from the INIT, in a length in which the number of bytes in the header has been deleted from the data ("Transfer byte length" – 4 bytes) in the data buffer beginning at the byte position specified in the "Buffer address" field in the CDB.

Furthermore, a value less than the ["IDD's buffer size" – value specified in the "Buffer address" field – 4 bytes] must be specified in the "Transfer byte length" field in the CDB. When a value larger than that is specified, data transfer is not executed with the INIT. Also, when zero is specified in the "Transfer byte length" field, this command is terminated without data transfer being executed.

(3) Mode = 0, 0, 1, 0: Data only, with address specification

In this mode, data transfer from the INIT includes buffer data only without the 4-byte header being added.

The top address of the data buffer where the data transferred from the INIT are to be stored can be specified in the “Buffer address” field.

The “Transfer byte length” field in the CDB specifies the total number of bytes of data transferred by the INIT. The IDD stores data transferred from the INIT in the data buffer beginning at the byte position specified in the “Buffer address” field in the CDB.

Furthermore, a value less than the [“IDD’s buffer size” – value specified in the “Buffer address” field] must be specified in the “Transfer byte length” field in the CDB. When a value larger than that is specified, data transfer is not executed with the INIT. Also, when zero is specified in the “Transfer byte length” field, this command is terminated without data transfer being executed.

(4) Mode = 0, 1, 0, 0: Microcode download, without saving

In this mode, the controller’s microcode or control information is transferred to the IDD’s control memory area. “0” must be specified in the “Buffer ID” field and the “Buffer address” field.

The "Transfer byte length" field specifies the total number of transfer bytes of data transferred from the INIT.

When downloading of microcode is completed, the IDD generates a UNIT ATTENTION condition for all the INITs. At this time, the IDD performs microprogram reboot and generates sense code.

The IDD operates according to this microcode until its power is switched off. If the power is switched on again, the IDD’s operation returns to the existing microcode saved previously on the disk.

IMPORTANT

Depending on the setting in the IDD, if done using the START/STOP command, it is necessary to issue the START command after issuing his command.

(5) Mode = 0, 1, 0, 1 : Microcode download, with saving

In this mode, the controller's microcode or control information is transferred to the IDD's control memory area and written to the disk. "0" must be specified in the "Buffer ID" field and the "Buffer address" field.

The "Transfer byte length" field specifies the total number of transfer bytes of data transferred from the INIT.

When all the data have been received, the IDD writes the new microcode to the disk's system area and operates in accordance with this microcode until new microcode is downloaded.

IMPORTANT

When abnormal termination for reasons other than ILLEGAL REQUEST [=5] / Invalid field in CDB [=24-00] or ILLEGAL REQUEST [=5] / Invalid field in parameter list [=26-00] occurs, the IDD indicates that downloading of the new microcode failed, and it is therefore necessary for the INIT to quickly download the new microcode.

When downloading of microcode is completed, the IDD generates a UNIT ATTENTION condition for all the INITs except the INIT that issued the WRITE BUFFER command. At this time, the sense code indicates "Microcode has been changed [=3F-01]."

When the IDD is checked and downloading of the microcode is judged to be possible, the IDD may be in the Not Ready state (the state in which the spindle motor is not rotating). In this event, the IDD starts the motor, then saves the microcode to flash ROM and the system area to disk media. Then, the IDD stops the motor and returns to the Not Ready state.

IMPORTANT

During downloading of microcode, the supply of power to the drive must not be cut off (such as an instantaneous power failure). If a power failure occurs, for instance, while downloading the microcode to the FLASH-ROM, the IDD may be severely damaged. The worst-case scenario in this event would be an inoperable drive. In addition, any operation (e.g., command, link service, or reset) from the interface during that time is not recommended. Such an operation may result in the following phenomena:

- A microcode download failure, or
- The drive with new microcode does not respond to operations after being rebooted. In such cases, the host probably detects the timeouts of operations.

For the same reasons, any operation from another port during that time is not recommended.

(6) Mode = 0, 1, 1, 0 : Microcode Download with offsets, without saving

In this mode the INIT may split the transfer of the controller's microcode or control information over two or more WRITE BUFFER commands.

If the last WRITE BUFFER command of a set of one or more commands completes successfully, the microcode or control information shall be transferred to the control memory space of the IDD.

Since the download microcode or control information may be sent using several commands, when the IDD detects the last download microcode with offsets, the IDD shall perform the verification of the complete set of downloaded microcode or control information prior to returning GOOD status for the last command. After the last command completes successfully the IDD generates a unit attention condition for all INITs except the one that issued the set of WRITE BUFFER commands. When reporting the unit attention condition, the IDD sets the additional sense code to MICROCODE HAS BEEN CHANGED.

"0" must be specified in the "Buffer ID" field.

The microcode or control information is written to the logical unit buffer starting at the location specified by the BUFFER Address field. If the IDD is unable to accept the specified buffer address, it shall return CHECK CONDITION status and it shall set the sense key to ILLEGAL REQUEST [=5] with an additional sense code of INVALID FIELD IN CDB [=24-00].

The "Transfer Byte Length" field specifies the maximum number of bytes that shall be present in the Data-Out Buffer to be stored in the specified buffer beginning at the buffer offset. The INIT should attempt to ensure that the parameter list length plus the buffer offset does not exceed the capacity of the specified buffer. (The capacity of the buffer may be determined by the BUFFER CAPACITY field in the READ BUFFER descriptor.) If the BUFFER Address and Transfer Byte Length fields specify a transfer in excess of the buffer capacity, the IDD shall return CHECK CONDITION status and shall set the sense key to ILLEGAL REQUEST [=5] with an additional sense code of INVALID FIELD IN CDB [=24-00].

(7) Mode = 0, 1, 1, 1 : Microcode Download with offset, with saving

In this mode the INIT may split the transfer of the controller's microcode or control information over two or more WRITE BUFFER commands.

If the last WRITE BUFFER command of a set of one or more commands completes successfully, the microcode or control information shall be saved in a non-volatile memory space.

Since the downloaded microcode or control information may be sent using several commands, when the IDD detects the last download microcode with offsets and save mode WRITE BUFFER command has been received, the IDD shall perform the verification of the complete set of downloaded microcode or control information prior to returning GOOD status for the last command. After the last command completes successfully the IDD generates a unit attention condition for all INITs except the one that issued the set of WRITE BUFFER commands. When reporting the unit attention condition, the IDD sets the additional sense code to MICROCODE HAS BEEN CHANGED.

The microcode or control information is written to the logical unit buffer starting at the location specified by the BUFFER Address field. If the IDD is unable to accept the specified buffer offset, it shall return CHECK CONDITION status and it shall set the sense key to ILLEGAL REQUEST [=5] with an additional sense code of INVALID FIELD IN CDB [=24-00].

IMPORTANT

During downloading of microcode, the supply of power to the drive must not be cut off (such as an instantaneous power failure). If a power failure occurs, for instance, while downloading the microcode to the FLASH-ROM, the IDD may be severely damaged. The worst-case scenario in this event would be an inoperable drive. In addition, any operation (e.g., command, link service, or reset) from the interface during that time is not recommended. Such an operation may result in the following phenomena:

- A microcode download failure, or

4.4.4 READ BUFFER (3C)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘3C’							
1	0	0	0	0	Mode			
2	X‘00’ (Buffer ID)							
3	Buffer Offset (MSB)							
4	Buffer Offset							
5	Buffer Offset (LSB)							
6	Transfer Byte Length (MSB)							
7	Transfer Byte Length							
8	Transfer Byte Length (LSB)							
9	0	0	0	0	0	0	0	0

This command is used in combination with the WRITE BUFFER command to diagnose the normalcy of the IDD’s data buffer memory and the FC interface.

The IDD have a 6,733 K (6,895,200) byte size data buffer. In this command, each data byte position in the data buffer must be specified in 4-byte units using buffer addresses within the range X'000000' to X'693660'.

The functions of this command and the contents of the data transferred to the INIT are specified by the “Mode” field in the CDB and one of the transfer modes shown in Table 4.126 can be selected.

Table 4.126 READ BUFFER transfer mode

“Mode” Bit	3	2	1	0	Transfer Mode
	0	0	0	0	Header + Data, without Address Specification
	0	0	0	1	Header + Data, with Address Specification
	0	0	1	0	Data Only, with Address Specification
	0	0	1	1	Buffer Descriptor
	1	0	1	0	Echo buffer
	1	0	1	1	Echo buffer descriptor

(1) Mode = 0, 0, 0, 0: Header + data, without address specification

When this mode is specified, the data stored in the IDD's data buffer are transferred to the INIT after the 4-byte header. Zero must be specified in the "Buffer offset" field in the CDB.

The "Transfer byte count" field in the CDB specifies the total number of bytes of the header and buffer data which can be received by the INIT. The IDD reads the data from the data buffer from the top (Address X '000000'), then adds the 4-byte header to it and transfers it to the INIT. Data transfer is completed at the point when the number of bytes of the header and data from the IDD's data buffer, specified in the "Transfer byte length" field, has been transferred, or at the point when transfer of the header and all the data in the IDD's data buffer, to the final byte position, has been completed. When zero is specified in the "Transfer byte length" field, this command is terminated without executing a data transfer.

The format of the data transferred to the INIT when this mode is specified is shown in Table 4.127

Table 4.127 READ BUFFER command: buffer data (mode = 0000, 0001)

	Byte \ Bit	7	6	5	4	3	2	1	0
Header	0	0	0	0	0	0	0	0	0
	1	Effective Buffer Data Length (MSB)							
	2	Effective Buffer Data Length							
	3	Effective Buffer Data Length (LSB)							
Data	4	Buffer Data (Byte 0)							
	5	Buffer Data (Byte 1)							
	~	~							
	n	Buffer Data (Byte n–4)							

The "Effective buffer data length" field in the header indicates the size of the data buffer (byte length). This value indicates the size of the IDD's data buffer that can be used by the WRITE BUFFER and READ BUFFER commands without relation to the length specified in the "Transfer byte length" field in the CDB or the length of the data actually stored in the data buffer by the WRITE BUFFER command. When this mode is specified, the "Effective buffer data length" shows the size (cache segment volume) of the IDD's entire data buffer area. Also, the length of the buffer data transferred to the INIT by this command is the value for the number of bytes in the ["Transfer byte length" field in the CDB – 4 bytes] or the value indicated in the "Effective buffer data length" field in the header, whichever is smaller.

(2) Mode = 0, 0, 0, 1: Header + data, with address specification

The format of the data transferred to the INIT when this mode is specified is the same as the format of the data in the case of Mode = 0, 0, 0, 0, with the data stored in the IDD's data buffer transferred to the INIT following the 4-byte header. In this mode, the address in the data buffer can be specified in the "Buffer offset" field in the CDB.

The "Transfer byte length" field in the CDB specifies the total number of bytes of header and buffer data that can be received by the INIT. The IDD reads the data from the data buffer beginning from the byte position in the data buffer specified in the "Buffer offset" field of the CDB and continuing in order, then adds the 4-byte header to it and transfers it to the INIT. Data transfer is completed at the point when the number of bytes of the header and data from the IDD's data buffer, specified in the "Transfer byte length" field, has been transferred, or at the point when transfer of the header and all the data in the IDD's data buffer, to the final byte position, has been completed. When zero is specified in the "Transfer byte length" field, this command is terminated without executing a data transfer.

The format and contents of the 4-byte header transferred in this mode are the same as in the case of Mode = 0, 0, 0, 0. However, the "Effective buffer data length" field in the header indicates the size (byte length) of the data from the byte position in the data buffer specified in the "Buffer offset" field in the CDB to the final byte position in the data buffer, including that byte. Also, the length of the buffer data transferred to the INIT by this command is the value for the number of bytes in the ["Transfer byte length" field in the CDB – 4 bytes] or the value indicated in the "Effective buffer data length" in the header, whichever is smaller.

(3) Mode = 0, 0, 1, 0: Data only, with address specification

The data transferred to the INIT when this mode is specified is only the data which the IDD reads from the data buffer. The header is not transferred as it is in Mode = 0,0,0,0 and Mode = 0,0,0,1. In this mode, address in the data buffer can be specified in the "Buffer offset" field in the CDB.

The "Transfer byte length" field in the CDB specifies the total number of bytes of buffer data that can be received by the INIT. The IDD reads the data in order beginning from the byte position in the data buffer specified in the "Buffer address" field and transfers it to the INIT. Data transfer is completed at the point when the number of bytes of buffer data specified in the "Transfer byte length" field has been completed or transfer of the buffer data to the final byte position of the IDD's data buffer is completed. When zero is specified in the "Transfer byte length" field, this command is terminated without executing a data transfer.

(4) Mode = 0, 0, 1, 1: Buffer descriptor

When this mode is specified, the IDD transfers only the 4-byte buffer descriptor to the INIT. the IDD's data buffer attributes are indicated in the 4-byte buffer descriptor. Zero must be specified in the "Buffer offset" field in the CDB when this mode is specified. The IDD transfers the data length specified in the "Transfer byte length" field in the CDB or 4 bytes, whichever portion of data is smaller, to the INIT. When zero is specified in the "Transfer byte length" field, this command is terminated without executing a data transfer.

Table 4.128 READ BUFFER command: buffer descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'02' Addressing Boundary							
1	X'69' Buffer Capacity (MSB)							
2	X'36' Buffer Capacity							
3	X'60' Buffer Capacity (LSB)							

The "Addressing boundary" field in the buffer descriptor indicates the addressing boundary in the data buffer which can be specified in the WRITE BUFFER Command and the READ BUFFER Command as a "Power" when expressed as a "Power of 2." The IDDs report X'02' ($=2^2$), indicating that it is possible to specify the address in 4-byte units. Also, the "Buffer capacity" field indicates the byte length of the size of the data buffer which can be operated by the WRITE BUFFER and READ BUFFER commands.

IMPORTANT

Exercise caution regarding the following points when using this command.

If the WRITE BUFFER command or READ BUFFER command is used under a multi-initiator or multitask environment, it is necessary to be careful of the contents of the data buffer being changed by another initiator or a command that issues another task during the interval between completion of WRITE BUFFER command execution and execution of the READ BUFFER command.

(5) Mode = 1, 0, 1, 0 : Echo buffer

In this mode the IDD transfers data to the INIT from the echo buffer. The echo buffer shall transfer the same data as when the WRITE BUFFER command with the mode field set to echo buffer was issued. The BUFFER ID and BUFFER OFFSET fields are ignored in this mode.

(6) Mode = 1, 0, 1, 1 : Echo buffer descriptor

In this mode, a maximum of four bytes of READ BUFFER descriptor information is returned. The device server shall return the descriptor information for the echo buffer. The "Buffer Offset" field is reserved in this mode. The allocation length should be set to four or greater. The device server shall transfer the lesser of the allocation length or four bytes of READ BUFFER descriptor. The READ BUFFER descriptor is defined as shown in Table 4.129.

Table 4.129 READ BUFFER command: echo buffer descriptor

Byte \ Bit	7	6	5	4	3	2	1	0
0	Reserved							EBOS
1	Reserved							
2	Reserved				Echo Buffer Capacity (MSB)			
3	Echo Buffer Capacity (LSB)							

The IDD return one in EBOS field, and the IDD verifies that echo buffer data from each initiator is the same as that previously written by the same initiator.

The "Buffer Capacity" field returns the size of the echo buffer X'01FC' in bytes aligned to a four-byte boundary.

4.4.5 READ LONG (3E)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X'3E'							
1	0	0	0	0	0	0	CORRCT	0
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	0	0	0	0	0	0	0	0
7	Transfer Byte Length (MSB)							
8	Transfer Byte Length (LSB)							
9	0	0	0	0	0	0	0	0

This command reads the logical data block data and its ECC byte, specified in the "Logical block address" field in the CDB, from the disk media and transfers it to the INIT. Normally, this command is used in combination with the WRITE LONG command to perform checks of the ECC function. The operation object in this command is 1 data block only.

Remark The Pad Byte and Sync Byte patterns are not included in the transfer data.

When "0" is specified in bit 1 of CDB byte 1, the "CORRCT (Corrected)" bit, the IDD does not implement ECC correction processing of data read from the disk media. When "1" is specified in the "CORRCT (Corrected)" bit, data errors that can be corrected by ECC are transferred to the INIT after being corrected in the IDD's data buffer.

When the "Transfer byte length" specifies zero, this command executes a seek operation of the cylinder/track existing in the logical data block which is specified in the "Logical block address" field in the CDB., then is terminated without data being transferred to the INIT.

When a length (other than zero) which does not match the data format on the disk media is specified in the "Transfer byte length" field in the CDB, this command is terminated with a CHECK CONDITION status without executing a data transfer to the INIT. At this time, the sense data indicate the following contents and the INIT can determine the correct "Transfer byte length" from their contents.

- Sense Key : 05 = ILLEGAL REQUEST
- Sense Code/Sub-sense Code : 24-00 = Invalid field in CDB
- "VALID" Bit : "1"
- "ILI" bit : "1"
- Information Field: ("Transfer byte length in the CDB) – (Original "Transfer byte length")

Remark: The calculation formula for the information field expresses 1 logical data block as n physical sectors, and when negative, as a complement of 2.

Error recovery processing during execution of this command is in accordance with the specifications in (Page code 1: Read/Write Error Recovery Parameter, Page code 21: Additional error recovery parameters).

- The ARRE flag and the DTE flag are not applied.
- The TB flag is treated as if "1" was specified.

4.4.6 WRITE LONG (3F)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘3F’							
1	0	0	0	0	0	0	0	0
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	0	0	0	0	0	0	0	0
7	Transfer Byte Length (MSB)							
8	Transfer Byte Length (LSB)							
9	0	0	0	0	0	0	0	0

This command writes the data block data transferred from the INIT, together with the ECC to form bytes, in the logical data blocks on the disk media specified in the “Logical block address” field in the CDB. Normally, this command is used for checking the ECC function in combination with the READ LONG command.

The object of this command’s operation is only 1 data block. Also, the data transferred from the INIT by this command must have the same order and the same length as the data transferred to the INIT from the IDD by the READ LONG command.

The “Transfer byte length” field in the CDB indicates the number of bytes of data transferred from the INIT by this command. When the “Transfer byte length” specification is zero, this command is terminated normally without performing anything.

If a value specifying a length (other than zero) that does not match the data format on the disk media is specified in the “Transfer byte length” field in the CDB, that command is terminated with a CHECK CONDITION status without data being transferred to the INIT. The sense data at this time indicate the following contents and the INIT can determine the correct “Transfer byte length” from their contents.

- Sense Key : 05 = ILLEGAL REQUEST
- Sense Code/Sub-sense Code : 24-00 = Invalid field in CDB
- “VALID” Bit : “1”
- “ILI” bit : “1”
- Information Field: (“Transfer byte length in the CDB) –
  (Original “Transfer byte length”)

Remark: The calculation formula for the information field expresses 1 logical data block as n physical sectors and n sub-sectors, and when negative, as a complement of 2.

Error recovery processing during execution of this command is performed in accordance with the specifications in the MODE SELECT parameters (Page code 1: Read/Write Error Recovery Parameter, Page Code 21: Additional Error Recovery Parameter, but the AWRE flag and DTE flag are not applied.

4.4.7 WRITE SAME (41)

Byte \ Bit	7	6	5	4	3	2	1	0
0	X‘41’							
1	0	0	0	0	0	PBdata	LBdata	RelAdr
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	0	0	0	0	0	0	0	0
7	Number of Blocks (MSB)							
8	Number of Blocks (LSB)							
9	0	0	0	0	0	0	0	0

This command requests that the device server write the single block of data transferred by the application client to the medium multiple times to consecutive multiple logical blocks.

A "Logical Block data (LBdata)" bit of zero and a "Physical Block data (PBdata)" bit of zero indicates that the single block of data transferred by the application client shall be used without modification. A "LBdata" bit of one requests that the device server replace the first four bytes of the data to be written to the current logical block with the logical block address of the block currently being written.

A "PBdata" bit of one requests that the device server replace the first eight bytes of the data to be written to the current physical sector with the physical address of the sector currently being written using the physical sector format.

The IDD is not supported a "PBdata" bit. Therefore, if "PBdata" bit is one, this command is terminated with CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in CDB [=24-00]).

A "Relative Address (RelAdr)" bit of zero indicates that the "Logical Block Address" field specifies the first logical block of the range of logical blocks for this command.

A "RelAdr" bit of one indicates that the "Logical Block Address" field is a two's complement displacement. But the IDD is not supported this bit. Therefore, if this bit is one, this command is terminated with CHECK CONDITION status (ILLEGAL REQUEST [=5] / Invalid field in CDB [=24-00]).

The "Number of Blocks" field specifies the number of contiguous logical blocks to be written. A "Number of Blocks" field of zero requests that all the remaining logical blocks on the medium be written.

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CHAPTER 5 Sense Data and Error Recovery Methods

In this chapter, the configuration and contents of sense data reported to the INIT (initiator) when an error occurs, etc., key information for interpreting error states, recommended procedures for error recovery processing that should be executed by software in the INIT and error recovery processing executed internally by the IDD are described.

5.1 Sense Data

When the IDD reports a CHECK CONDITION status, or in cases when some fatal error is detected in connection with the FC interface, and as a result, the command that is currently being executed, or the commands in the stack are cleared, it generates sense data for the INIT that issued that command. Sense data are returned to the INIT at the same time as the status is sent in response to the command.

5.1.1 Sense data format

The IDD's sense data is in the so-called "Expanded Sense Data" format. The expanded sense data format supported by the IDD is shown in Table 5.1.

IMPORTANT

1) In the specifications, each device is permitted to define whatever it chooses after byte 18 of the expanded sense data, and the length and format differ for each device. The length of expanded sense data is displayed in the sense data, so by analyzing the sense data which it receives, the INIT can know its effective length.

2) In the REQUEST SENSE command, even if a Transfer byte length that is shorter than the length of the sense data supported by the device which is the object of the command, the command will terminate normally, but in that case, some of the sense data only will be received and the remaining information will be lost. Sufficient caution should be exercised with regard to the devices connected to the INIT and all the sense data of those devices should be read.

Table 5.1 Expanded sense data format

	Byte \ Bit	7	6	5	4	3	2	1	0
Basic Information	0	Valid	X '70' or X '71' (Error Code)						
	1	X'00'							
	2	0	0	ILI	0	Sense Key			
	3	MSB	Information						
	4								
	5								
	6								LSB
	7	X '28' (Additional Sense Data Length)							
	8	MSB	Command Inherent Information						
	9								
	10								
	11								LSB
	12	Additional Sense Code							
	13	Additional Sense Code Qualifier							
	14	X'00'							
	15	SKSV	Sense Key Inherent Information						
	16								
	17								
Additional Information	18	0	0	0	Port	0	Link Rate		
	19	CDB Operation Code							
	20	Detailed Information							
	~								
	47								

5.1.2 Sense data basic information

Bytes 0 to 17 of the sense data are basic information which show the contents of the error that has occurred. The INIT can know the contents of the error and the key information that is necessary for recovery processing by analyzing this basic information. Each field and the meanings of bits in the sense data basic information are explained below.

(1) Valid

When this bit is “1,” it indicates that the values shown in the information field (bytes 3 to 6) are valid. On the other hand, when this bit is “0”, it indicates that the information field does not contain valid information.

(2) Error code

This field shows the format and type of sense data. The IDD always displays X ‘70’ (current error) or X ‘71’ (deferred error), which has the meaning “expanded sense data format” in this field.

(3) ILI (incorrect length indicator)

When this bit is “1,” it indicates that the transfer byte length requested in the command did not coincide with the data block length on the disk media. In the IDD, the only commands that it reports “1” in this bit for are the READ LONG command and the WRITE LONG command. For details, refer to the descriptions of these commands (Sections 4.4.5 and 4.4.6).

(4) Sense key

This field shows the cause of the sense data being generated. More details reasons are indicated in the sense code field (Byte 12) and the sub-sense code field (Byte 13). Table 5.3 shows a list of the meanings of sense keys.

(5) Information

This field shows information related to the error that has been detected and is valid only when the Valid bit is “1.” Depending on the command where the error occurred, additional information other than the information in this field may be indicated in the command inherent information field. The information shown in this field has the following meanings depending on the value of the “ILI” bit.

a) When the “ILI” bit is “0,” the logical block address of the data block where the error occurred is indicated.

b) When the “ILI” bit is “1,” the difference between the transfer byte length requested by the command and the actual data block length on the disk media is indicated. If the difference is a minus value, (if the request transfer byte count is smaller), it is expressed as a complement of 2. In the IDD, only the READ LONG command and the WRITE LONG command display this information. For details, see the descriptions of these commands (Sections 4.4.5 and 4.4.6).

(6) Additional sense data length

This field indicates the length (number of bytes) after byte 8 of the sense data. The value shown in this field shows the length of sense data provided by the IDD without relation to the value specified in the “Transfer byte length” in the CDB of the REQUEST SENSE command. The length of the IDD’s sense data is fixed at 48 bytes and this field always indicates X ‘28’ (40 bytes).

(7) Command inherent information

This field indicates information that is inherent to the command where the error occurred. The only command for which the value in this field is valid in the IDD is the REASSIGN BLOCKS command. See the description of the REASSIGN BLOCKS command (Section 4.3.2) concerning details of the information shown in this field.

(8) Additional Sense code, Additional Sense code Qualifier

The codes which indicate the reason for the error displayed by the sense key in detail are reported in these fields. The INIT can decide procedures for error recovery according to the sense key and these fields. The sense code and sub-sense code are defined in Table 5.4.

(9) SKSV (sense key specific valid) , sense key inherent information

When the sense key indicates one of “RECOVERED ERROR [=1],” “MEDIUM ERROR [=3]” or “HARDWARE ERROR [=4],” and the “SKSV” bit indicates “1,” indicates the number of times the IDD has attempted to recover from the detected error as shown in Table 5.2 (a).

When the sense key indicates “NOT READY [=2]” and the “SKSV” bit indicates “1”, indicates the progressing rate of the formatting operation by the FORMAT UNIT command with [n/65536] as shown in Table 5.2 (b), or the progressing rate of the drive self-test operation by the SEND DIAGNOSTICS Command (Self-Test = 0)

Table 5.2 Sense key inherent information

(a)

Byte \ Bit	7	6	5	4	3	2	1	0
15	SKSV	0	0	0	0	0	0	0
16	X'00'							
17	Number of retries executed							

(b)

Byte \ Bit	7	6	5	4	3	2	1	0
15	SKSV	0	0	0	0	0	0	0
16	Progressing rate of formatting or Progressing rate of Self-Test operation [MSB]							
17	[LSB]							

Table 5.3 Sense key

Sense Key	Name	Explanation
0	NO SENSE	The specific sense key does not exist.
1	RECOVERED ERROR	1) Indicates that the command which was executed last was terminated normally with a recovery operation by the IDD. If multiple errors which were successfully recovered from during processing of a single command occurred, the last error to have occurred is reported. 2) Rounding processing of the MODE SELECT parameter was performed.
2	NOT READY	The disk drive is not in a state where it can be accessed.
3	MEDIUM ERROR	An irrecoverable error was detected due to a defect in the disk media or an error in the recorded data.
4	HARDWARE ERROR	The IDD detected an error in the hardware for which recovery processing is impossible during command execution or self-diagnosis.
5	ILLEGAL REQUEST	An illegal value was detected in the parameter transferred in the CDB or the specification in the command. Also, an error in the LUN specification. If the IDD detects an illegal parameter in the CDB, it terminates the command without changing the contents of the disk media. If an illegal parameter is detected in the parameters transferred from the INIT, the contents of the disk media may be changed by that command.
6	UNIT ATTENTION	A UNIT ATTENTION condition occurred.
7	DATA PROTECT	1) An illegal operation was attempted in an area where a read or write operation is prohibited. In this case, that command is not executed. 2) A SET LIMITS command was issued 2 times in a group of commands linked in a series.
8	BLANK CHECK	Not Used
9	(Reserved)	Not Used
A	COPY ABORTED	Not Used
B	ABORTED COMMAND	The IDD terminated a command abnormally during execution. Normally, the INIT can attempt to recover by reissuing that command.
C	EQUAL	Not Used
D	VOLUME OVERFLOW	Not Used
E	MISCOMPARE	During execution of a Byte Check with the VERIFY command, the data transferred from the INIT were compared to the data read from the disk drive, but they did not match.
F	(Reserved)	Not Used

Table 5.4 Additional Sense Code and Additional Sense Code Qualifier (1/6)

C*	Q*	Name	Explanation	Sense key
00	00	No additional sense information	No specific sense code exists.	0
01	00	No index/sector signal	The target sector was not detected by the sector counter within the specified time.	4
03	00	Peripheral device write fault	A write operation to the disk media was terminated abnormally. • Off track during write.	1, 3, B
	80	Peripheral device write fault	A write operation to the disk media was terminated abnormally. • Write current abnormality	4, B
	82	Peripheral device write fault	A write operation to the disk media was terminated abnormally. • Servo mark not found during write.	1, 3, B
	83	Peripheral device write fault	A write operation to the disk media was terminated abnormally. • Servo cell detected was detected during write. • Write gate and sector pulse were activated at the same time during write.	4, B
	87	Peripheral device write fault	A write operation to the disk media was terminated abnormally. • No write gate detected	1, 4, B
04	01	Logical unit in process of becoming ready	Disk drive is getting ready. (The spindle motor is not at its regular rotation speed or has reached its regular rotation speed but is still reading the information)	2
	02	Logical unit not ready	Disk drive is in start command waiting state. (initializing command required)	2
	04	Logical unit not ready, format in progress	The drive cannot be accessed since it is being formatted.	2
	09	Logical unit not ready, Self-Test in progress	The drive cannot be accessed since it is being Self-Test.	2
0B	01	Specified temperature exceeded	Temperature exceeded established value.	0, 1, 6
0C	01	Write error recovered with auto reallocation	A write error was recovered with auto reallocation.	1
	02	Write error – auto reallocation failed	Write auto reallocation or the write that was applied to auto reallocation was failed.	3
	03	Write Error	Unrecovered Write Offtrack Error • Write retries are exhausted in case of AWRE = 0	3
	80	Write Error (Unrecovered Write Offtrack Error Write offtrack retries are exhausted.	Reported if a write offtrack occurred during the Format unit command execution.	3

* C: Additional Sense Code, Q: Additional Sense Code Qualifier

Table 5.4 Additional Sense Code and Additional Sense Code Qualifier (2/6)

C*	Q*	Name	Explanation	Sense key
11	00	Unrecovered Read Error	Unrecovered read error occurs during reading data field (LBA Miscompare Error detected by SCSI portion)	3
	01	Read retries exhausted	Unrecovered error was detected during data read (retry out).	3, B
	02	Error too long to correct	Unrecovered error was detected during data read (BCRC error detected by SCSI)	3, B
	04	Unrecovered read error, auto reallocation failed	Auto allocation failed during read.	3
13	00	Sync Byte not found for Data field	SB (Sync Byte) could not be detected in the Data area.	1, 3, B
14	00	Record entity not found	Expected data from a sector was undetected. (LBA compare error detected by FMT)	1, 3, B
	01	Record not found	The target data block (sector) could not be detected.	1, 3, B
15	01	Mechanical positioning Error	A seek error occurred in the drive.	1, 3, B
	02	Positioning Error detected by read of medium	LBA did not match due to Cylinder number's mismatch.	1, 3, B
17	01	Recovered data with retries	A data error was recovered from by reading was retried.	1
	02	Recovered data with positive head offset	A data error was recovered by read retry with offsetting head to positive direction.	1
	03	Recovered data with negative head offset	A data error was recovered by read retry with offsetting head to negative direction.	1
	06	Recovered data without ECC: data auto-reallocated	Automatic alternate allocation was applied without ECC correcting a data error.	1
	08	Recovered data without ECC: recommended rewrite	Rewriting to the same sector was performed without ECC correcting a data error.	1
18	00	Recovered Data with Error Correction Applied	A data error was recovered by read retry with ECC corrercting.	1
19	02	Defect list error in primary list	An error was detected during reading of the defect list (P List).	3
	03	Defect list error in grown list	An error was detected during reading of the defect list (G List).	3
	80	Log information read error	An error was detected during reading of statistical information.	3
	81	Log information write error	A write error was detected during writing of statistical information.	3
	84	Mode Select SA write Error	An error was detected during writing of SA information (Mode Select Paramenter)	3
	Ax	Drive Parameter SA write Error	An error was detected during writing of SA information (Device Information)	3
	Bx	Drive Parameter SA write Error	An error was detected during writing of SA information (Device Information)	3
1A	00	Parameter list length error	There is a mistake in the indication of the parameter list page length.	5

* C: Additional Sense Code, Q: Additional Sense Code Qualifier

Table 5.4 Additional Sense Code and Additional Sense Code Qualifier (3/6)

C*	Q*	Name	Explanation	Sense key
1C	01	Primary defect list not found	The defect list (P List) header is incorrect.	3
	02	Grown defect list not found	The defect list (G List) header is incorrect.	3
	90	SA information list not found	The SA information (MODE SELECT parameter) header is incorrect.	3
1D	00	Miscompare during verify operation	Comparison of data transferred from the INIT by a VERIFY command (when the Byte Check mode was specified) with data read from the disk media was terminated unsuccessfully.	E
	80	Miscompare during self-configuration	There is an unmatch to compare read data with write data during self-configuration.	E
1F	00	Partial Defect List Transfer	Read Defect Data command (37h) cannot transfer all the Defect data in the target because the numbers of defect exceeded the maximum.	1
20	00	Invalid command operation code	CDB byte 0 (operation code) is illegal.	5
21	00	Logical block address out of range	A logical block address which exceeds the drive's maximum value was specified.	5
24	00	Invalid field in CDB	There is an error in a specification in the CDB.	5
25	00	Logical unit not supported	An illegal LUN was specified.	5
26	00	Invalid field in parameter list	There is an error in the parameter list specifications transferred from the INIT during command execution.	5
27	00	Write protected	A write operation was attempted in a write protected area. Or a write operation is prohibited at the external operation panel.	7
29	01	Power on occurred	Microcode was downloaded immediately after power on.	6
	03	TARGET RESET message occurred	A TARGET RESET was received.	6
2A	01	Mode parameter changed	The MODE SELECT parameter values were changed by another INIT.	6
	03	Reservations preempted	A persistent reserve state was cleared by another INIT.	6
	04	Reservations released	A persistent reserve state was released	6
	05	Registrations preempted	A persistent reserve state was preempted by another INIT.	6
2F	00	Command cleared by another INIT	A command was forcibly terminated by another INIT during execution or queuing. • By a CLEAR TASK • The sense hold state was entered when the QErr bit was set on "1." • The DQue bit was changed from "0" to "1."	6

* C: Additional Sense Code, Q: Additional Sense Code Qualifier

Table 5.4 Additional Sense Code and Additional Sense Code Qualifier (4/6)

C*	Q*	Name	Explanation	Sense key
31	00	Medium format corrupted	The media format is different from the original format. (The media was not formatted after the data format specification was changed by the MODE SELECT command.)	3
	01	FORMAT command failed	For some reason, formatting cannot be completed and reformatting is necessary.	3
32	00	No defect spare location available	No usable alternate block area exists. Or alternate block processing cannot be performed due to control table overflow.	4
	01	Defect list update failure	Updating of the defect list (G List) failed.	4
35	01	Unsupported Enclosure Function	An attempt was made to use a function not supported by the enclosure service.	5
	02	Enclosure Services Unavailable	The enclosure service currently cannot be used.	2, 4
	03	Enclosure Transfer Failure	A transfer to or from the enclosure service failed.	4
	04	Enclosure Transfer Refused	An error or incorrect format was detected during a transfer to or from the enclosure service.	4, 5
37	00	Rounded parameter	Rounding processing of the MODE SELECT parameter specified by the command was performed.	1
3E	03	Logical unit failed Self-Test	The test segment error occurred during the Self-Test	4
	04	Logical unit unable to update	The IDD failed to update the Self-Test result log	4
3F	01	Microcode has been changed	Microcode was changed by another INIT.	6
	02	Changed operating definition	Operating definition was changed.	6
	05	Device identifier changed	Device identifier was changed.	6
40	nn	Diagnostic failure on component "nn"	An error was detected in self-diagnosis. ("nn" is a Fujitsu unique code) • 81: Buffer RAM compare error/bus error • 82: Program RAM compare error/bus error • 83: HDC register check error • 84: Firmware header/check sum error • 85: Firmware type unmatch • 86: Parameter header/check sum error • 88: Drive Serial No. unmatch • 89: DE type unmatch • 8F: Other MPU peripheral circuit diagnostic error • 92: Spindle motor firmware initialize error	4

* C: Additional Sense Code, Q: Additional Sense Code Qualifier

Table 5.4 Additional Sense Code and Additional Sense Code Qualifier (5/6)

C*	Q*	Name	Explanation	Sense key
44	nn	Internal target failure	An error was detected in self-diagnosis. ("nn" is a Fujitsu unique code) • 90: Next sector IDD compare error • 91: WCS RAM parity error • 92: Unexpected FMT interrupt • 94: NRZ parity error during Write (MAS3*** Series only) • 99: Overflow error occurred at SPC FIFO • 9A: Unexpected SPC interrupt • 9B: SPC detected illegal command interrupt • 9C: SPC detected illegal write interrupt • 9D: SPC detected Sync offset error interrupt • A0: Error interription from DBM • A3: DBM buffer CRC error • A4: DBM internal parity error • A8: Data late error • B0: Flash ROM erase operation failed. • B1: Flash ROM write operation failed. • C0: RDCLK error (FMT hang up) • D1: DSP downloading failed • D2: DSP overrun (watch dog time out, DRV hard error) • D3: Servo Gate Window error • D4: Illegal error was reported from DSP	4, B
47	00	SCSI parity error	A parity error was detected on the SCSI data bus.	B
48	00	INITIATOR DETECTED ERROR message received	The INITIATOR DETECTED ERROR message was received from the INIT.	B
4C	nn	Logical unit failed self-configuration	The IDD's initial setup failed. ('nn' is a Fujitsu unique code) • 91: Microcode Read error (any 3/11/** error during microcode read) • 93: Microcode Read error (any 3/13/** NOSB error) • 94: Microcode Read error (any 3/14/** NRF error) • 95: Microcode Read error (any 3/15/** error during seek) • 97: Microcode Read error (any 4/44/** or other errors during microcode read) • 98: Invalid microcode (Header/Check Sum) • A1: SA Read error (any 3/11/** error during SA read) • A3: SA Read error (any 3/13/** error during SA read) • A4: SA Read error (any 3/14/** error during SA read) • A5: SA Read error (any 3/15/** error during SA read) • A7: SA Read error (any 4/44/** error during SA read) • A8: Invalid SA (Header/Check Sum) • A9: SA Read error (DSP downloading failed) • AA: SA Read error (DSP overrun/DRV hardware error) • AB: SA Read error (abnormal rotation of spindle motor) • AC: SA Read error (on-track failure) • E0: Initial calibration failed	4

* C: Additional Sense Code, Q: Additional Sense Code Qualifier

Table 5.4 Additional Sense Code and Additional Sense Code Qualifier (6/6)

C*	Q*	Name	Explanation	Sense key
4E	00	Overlapped commands attempted	1) Before execution of an untagged command was completed, the same INIT issued a new command to the same LUN. 2) Before execution of a tagged command was completed, the same INIT issued a command to the same LUN with the same tag. Or, an untagged command was issued when not in the sense hold state.	B
55	04	Insufficient Registration Resource	PERSISTENT RESERVATION OUT command is issued from insufficient device server resource.	5
5D	nn	SMART predictive failure	SMART related sense data • 12: The read error rate attribute has reached the failure threshold. • 14: The frequency of grown defect allocation attribute has reached the failure threshold. • 43: The seek error rate attribute has reached the failure threshold. • 56: The spin up time attribute has reached the failure threshold. • 64: The remaining alternate sector count attribute has reached the failure threshold. • FF: The drive is in test mode.	0, 1, 6
C4	nn	Drive Failure	A serious error was detected in the drive's control system. ('nn' is a Fujitsu unique code) • 00: Abnormal Rotation of Spindle Motor • 01: Any error at Spindle Motor Start • 30: On track failure	4

* C: Additional Sense Code, Q: Additional Sense Code Qualifier

5.1.3 Sense data additional information

Bytes 18 to 47 of sense data are defined as a Fujitsu unique field, and indicate the additional information which is explained below.

(1) PORT/LINKRATE

PORT: Connected PORT is shown.

0: PORT-A

1: PORT-B

LINK RATE: LINK RATE working at present is indicated.

111	It is working with 1.0625GHz.
110	It is working with 2.1250GHz.
Others	Reserved

(2) CDB operation code

This field indicates the operation code (the value in the first byte of the CDB) of the command where the error occurred. When sense data are generated without relation to the INIT issuing a command, this field shows zero.

(3) Detailed information

The information displayed in bytes 20 to 47 of sense data is information defined by Fujitsu for the specific product for the purpose of analyzing trouble, and the contents of this information are not made public. However, the user should present this information to the persons in charge at Fujitsu as troubleshooting and repair information collected in error logging (shown in Section 5.3.3) of all the bytes in sense data, including this field.

5.2 INIT Error Recovery Methods (Recommended)

When a single command or a series of linked commands are not terminated with a status reported, the INIT should execute error recovery processing corresponding to the state in which the command was terminated. Here, the procedure for analyzing the command execution termination state and recommended procedures for error recovery processing executed by the INIT in accordance with the results are explained.

5.2.1 Termination status analysis and error recovery methods

Figure 5.1 shows a model of the INIT's general processing flow from issuing of the command until reception of the termination status.

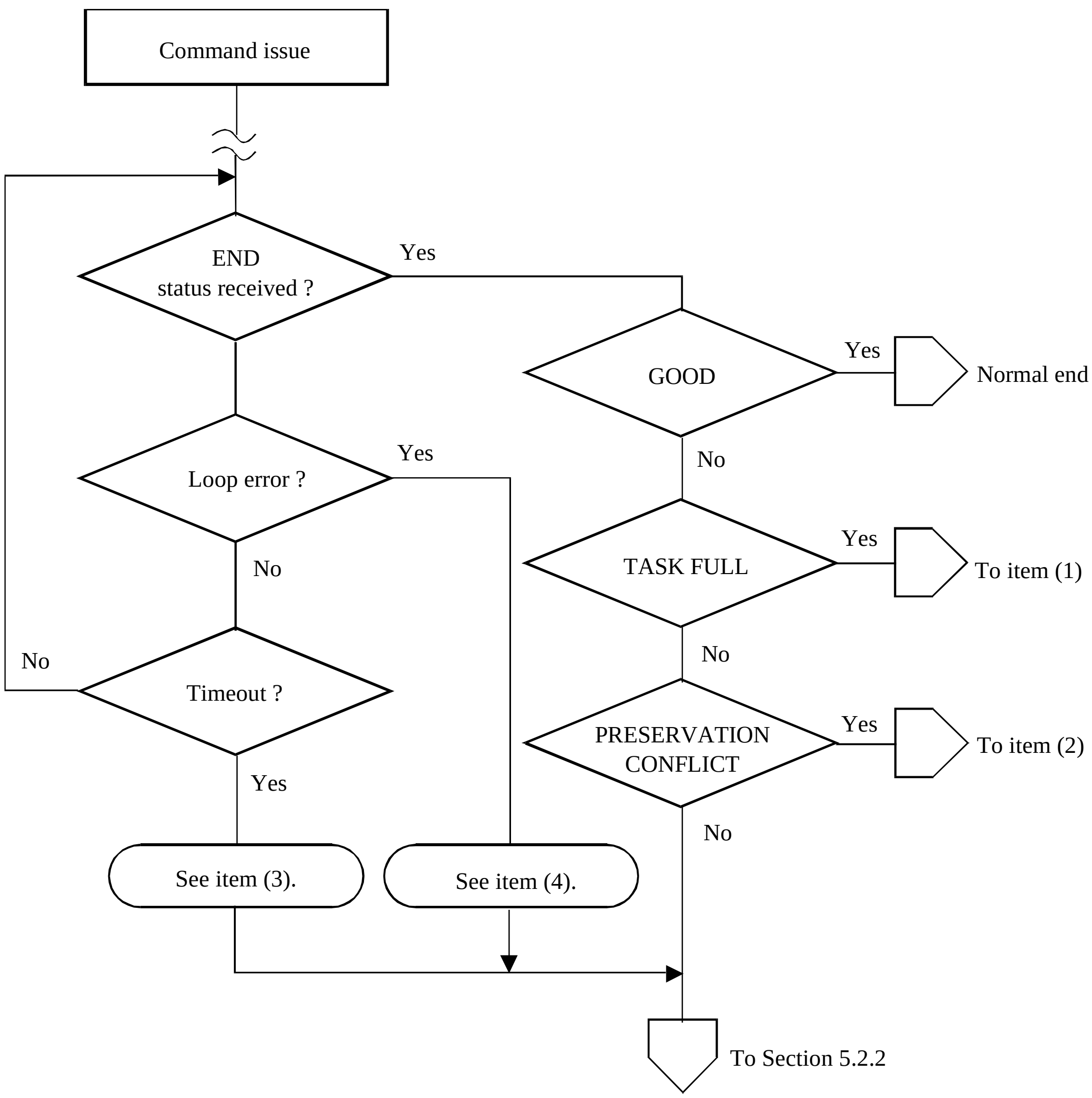

Figure 5.1 Analysis of the termination status

(1) TASK FULL status

This status indicates that the IDD is currently executing processing of another command and that a new command cannot be received. The INIT that receives this status can reissue the original command.

Under a multi-initiator environment, when an INIT receives this status, the time until the IDD can receive the next command depends on the operating state with other INITs, so ordinarily, it cannot be predicted. In such a case, it is necessary for the INIT that issued the command for which this status was received to repeatedly issue the command until it is accepted.

(2) RESERVATION CONFLICT status

This status shows, under a multi-initiator environment, that the IDD is currently reserved by another INIT, and cannot be used until that reserved status is released.

The period over which the reserved status continues should be managed by the system, but normally, an INIT that receives this status reissues the original command after waiting an appropriate length of time. The wait time until a command is reissued is generally an inherent value of the system and it is necessary that consideration be given to the operating states of the other INITs in the system when deciding it.

Of the INIT which reserved the IDD falls into a state which it cannot recover from for any reason before the reserved state is released, it will be impossible for other INITs to access the IDD because that reserved state will continue. In such a case, it is necessary for the INIT to take one of the following measures to forcibly release the reserved state and recover the access right.

- TARGET RESET
- Lip (y, x)

(3) Command completion wait time-out

This error is a state where the completed status for a command is not reported within the time expected by the INIT that issued the command.

One cause of this error occurring, besides a malfunction of the IDD, is that the command was cleared by some method which the INIT that issued the command cannot clearly detect, such as a TARGET RESET, or the command was cleared when an unrecoverable error was detected in arbitration processing executed by the IDD, etc. When this error occurs, then judge which recovery method to use based on the contents of the sense data (see Section 5.2.2).

Not only does command execution time differ widely depending on the type and specified contents of the command, but since it has an influence on the following factors, it is necessary to give adequate consideration to these points when setting the monitoring time value at the INIT.

- Since the command stack feature exists (see Section 1.4), even if the IDD accepts a command normally, if a command issued by another INIT is being executed, or if there are other commands in the stack, execution of the command is caused to wait until all the other commands have been processed. The execution wait time is dependent upon the type of command issued by the other INITs and the contents of its specifications.

- If the IDD has executed error recovery processing (retried) for an error that occurred on the FC bus or in the disk drive, command completion time will be longer than normal.

(4) Loop error

This error occurs in the case that the FC Loop enters the initialization at a time when the INIT is not expecting it, during execution of a command on the FC Loop. Even in cases where a Lip is generated by another FC device on the bus, the same state occurs, but the occurrence of an unexpected Loop initialize should be processed as an abnormal state of the system.

The cause of this error is the occurrence of an unrecoverable error on the FC Loop, the occurrence of a serious protocol error, etc. When this error is detected, the INIT should issue the REQUEST SENSE command and gather sense data then judge the error recovery method according to the contents of the sense data or system information.

5.2.2 Sense data analysis and error recovery methods

The INIT can judge the procedure for error recovery by analyzing the contents of the sense data. Table 5.5 the classifications of error information displayed in the sense data are shown and in Table 5.6, the procedures for error recovery recommended for the INIT to execute are shown. The error recovery procedure which can be executed by the INIT will differ depending on the system's condition, so the optimum processing procedure should be selected for the user system with reference to the following descriptions.

Table 5.5 Sense data error classification (1/3)

K*	C*	Q*	Outline of Error	L*	Recovery Method (See Table 5.6.)
0	x	x	No sense data showing the error contents are held.	None	4
1	13	00	Sync byte not found for data field	Need	8
	15	xx	Positioning error		
	17	xx	Recovered data without ECC		
	18	xx	Recovered data with error correction applied.		
			These errors are errors detected during accessing of the disk media, but they are recovered from through the IDD's retry processing. However, when "1" is specified in the DTE flag in the MODE SELECT parameters, the command may not necessarily be executed until it is completed.		
1	37	00	Rounded parameter	None	9
			The IDD's rounding processing was applied to the MODE SELECT parameters specified by the INIT.		
2	04	01	Logical unit not ready	Need**	10**
			The logical unit specified by the command is in a state where it cannot be accessed.		
		02	Logical unit not ready		
2	04	04	Logical unit not ready, format in progress	None	11
			The logical unit specified by the command is currently being formatted, so access is impossible.		
3	03	xx	Peripheral device write fault	Need	7
	0C	03	Write error recommend reassignament		
			Unrecoverred write error		
3	11	xx	Unrecovered read error	Need	12
	13	00	Sync byte not found for data field		
	14	01	No record found		
			These errors were detected during accessing of the disk media, but they were errors which could not be recovered from through the IDD's retry processing.		
	15	xx	Positioning error		
			This is an error of the disk drive’s seek system		
3	19	xx	SA information error	Need	7
	1C	xx	SA information error not found		
			The information recorded in (SA) on the disk media cannot be read correctly.		

* K: Sense Key C: Additional Sense Code
Q: Additional Sense Code Qualifier L: Logging Necessary? (shown in Section 5.2.3)

** Except within the time required for the disk drive to reach the ready state (approx. 20 seconds) after the power has been switched on, or after a start instruction has been executed by the START/STOP UNIT command.

Table 5.5 Sense data error classification (2/3)

K*	C*	Q*	Outline of Error	L*	Recovery Method (See Table 5.6.)
3	31	00	Medium form at corrupted	Need	18
	31	01	FORMAT command failed The data format on the disk media is not correct.		
			The data format on the disk media is not correct.		
4	03	xx	Peripheral device write fault	Need	7
			This is an error of the disk drive's write system.		
	32	01	Defect list update failure		
			These are errors detected in the operation of the disk drive.		
4	32	00	No defect spare location available	None	19
			No usable alternate blocks exist on the disk drive.		
4	40	nn	Diagnostic failure on component 'nn'	Need	13
			An error was detected in the IDD's self-diagnosis.		
4	44	nn	Internal target failure	Need	20
			An internal hardware error or a microcode detection error was detected in the IDD.		
4	4C	xx	Calibration failed	Need	10
	C4	xx	Drive failure		
			The initial seek was terminated abnormally. Or, a serious error was detected in the drive's control system.		
5	20	00	Invalid command operation code	None	2
	21	00	Logical block address out of range		
	24	00	Invalid field in CDB		
	25	00	Logical unit not supported		
	26	00	Invalid field in parameter list		
			There is an error in the command specification contents.		
5	3D	00	Invalid bits in IDENTIFY message	None	3
	90	00	Initiator's SCSI ID not identified		
			An error was detected in the SCSI protocol in the command execution sequence.		

* K: Sense Key C: Additional Sense Code
Q: Additional Sense Code Qualifier L: Logging Necessary? (shown in Section 5.2.3)

Table 5.5 Sense data error classification (3/3)

K*	C*	Q*	Outline of Error	L*	Recovery Method (See Table 5.6.)
6	29	xx	Power on, reset, or BUS DEVICE RESET occurred The IDD was initialized by a Power on, RESET condition or BUS DEVICE RESET message.	None	14
6	2A	01	Mode parameters changed The MODE SELECT parameters were changed by another INIT.	None	21
6	2F	00	Commands cleared by another INIT Commands were cleared by another INIT.	None	25
6	3F	01	Microcode has been changed	None	27
		02	Changed operation definition		
7	27	00	Write protected Access to a read protected or write protected.	None	15
B	03	xx	Peripheral device write fault	Need	12
	11	xx	Unrecovered read error		
	13	xx	Sync byte not found for data field		
	14	xx	Record not found		
	15	xx	Mechanical positioning error		
B	1B	00	Synchronous data transfer error offset		
	43	00	Message error	Need	6
	44	9D	SPC detected Sync offset error interrupt.		
	45	80	Select/Reselect failure		
	47	00	SCSI parity error		
	48	00	INITIATOR DETECTED ERROR message received		
	49	00	Invalid message error An unrecoverable SCSI related error occurred in the command execution sequence.		
B	4E	00	Overlapped commands attempted Before execution of a command was completed, a new command was issued by the same INIT.	None	2
	4D	nn	Tagged overlapped commands		
E	1D	00	Miscompare during verify operation Data failed to match in the Byte check mode of the Verify command.	None	24

* K: Sense Key C: Additional Sense Code
Q: Additional Sense Code Qualifier L: Logging Necessary? (shown in Section 5.2.3)

Table 5.6 Error recovery processing procedures (1/4)

Recovery Method	Recovery Processing Procedure
0	It is not necessary to perform the error recovery processing. Continue processing.
1	Error recovery processing is impossible. Terminate processing.
2	This is a programming error and error recovery processing is impossible. Terminate processing and correct the error in the system (INIT) programming.
3	This is an error in the FC protocol and error recovery processing is impossible. Terminate processing and check the system's FC Loop operation.
4	1) Reissue the original command (Retry). 2) If the command is terminated with the same error when retried, perform recovery method 3 or 1. 3) If the command is terminated with a different error when retried, execute the recovery processing procedure for that error.
5	1) After waiting about 1 second, reissue the original command (Retry). 2) If it doesn't recover after 10 retries, perform recovery method 1.
6	1) Reissue the original command (Retry). 2) If it doesn't recover after 10 retries, perform recovery method 3.
7	1) Reissue the original command (Retry). 2) If it doesn't recover after 10 retries, perform recovery method 1.
8	1) If the DTE flag in the MODE SELECT parameter is "0," perform recovery method 0. 2) If the DTE flag in the MODE SELECT parameter is "1," execute one of the following according to the content indicated by the sense data. – If the "Valid" bit is "1," and if the address of the final data block in the data block group in the area specified in the command is indicated in the information field, perform recovery method 0. – If the "Valid" bit is "0," or even if the "Valid" bit is "1," but the address of a data block which is not that of the final data group in the area specified in the command is indicated in the information field, reissue the original command. 3) If this error (Other than a positioning error [15-xx]) occurs repeatedly in the same data block, implement alternate block allocation processing (shown in Section 6.4).

Table 5.6 Error recovery processing procedures (2/4)

Recovery Method	Recovery Processing Procedure
9	1) Issue the MODE SENSE command and when a RECOVERED ERROR is reported, read the "Current" value in the changed MODE SELECT or MODE SELECT EXTENDED parameter. 2) If the value actually set in that parameter page is within the INIT's permissible range, perform recovery method 0. 3) If the value actually set in that parameter page is not within the INIT's permissible range, adjust the value specified in the parameter and issue the MODE SELECT or MODE SELECT EXTENDED command again.
10	1) Issue the START instruction using the START/STOP UNIT command ("Immed" = 0). 2) When the START/STOP UNIT command is terminated abnormally, perform recovery method 1. 3) When the START/STOP UNIT command is terminated normally, reissue the original command (Retry).
11	1) Wait for formatting (FORMAT UNIT command) to be completed. 2) Reissue the original command (Retry).
12	1) Set the "Number of Retries" value in the MODE SELECT parameters at the "Default" value. 2) Reissue the original command (Retry). (Note) 3) If the error is not recovered from after the first retry, issue the REZERO UNIT command. 4) Reissue the original command (Retry). (Note) 5) If the error is not recovered from, perform one of the following. – When the sense key is "HARDWARE ERROR [=4]," perform recovery method 1. – When the sense key is "MEDIUM ERROR [=3]," implement alternate block allocation processing (shown in Section 6.4). Note When the original command is the REASSIGN BLOCKS command, it may be necessary to reconfigure the defect list. For details, see the description of the REASSIGN BLOCKS command (Section 4.3.2).

Table 5.6 Error recovery processing procedures (3/4)

Recovery Method	Recovery Processing Procedure
13	1) Issue a TARGET RESET or Lip (y, x). 2) After waiting 2 seconds or longer, reissue the original command (Retry), and if the spindle motor's start mode is set on "Start by Command," issue the START instruction by the START/STOP UNIT command ("Immed" = 0) before retrying. 3) If the retry procedure 2) does not terminate normally, perform recovery method 1.
14	1) The parameter is initialized at the "Save" value (if the "Save" value does not exist, the "Default" value), so when it is necessary to set the inherent parameter, issued the MODE SELECT command. 2) Reissue the original command (Retry).
16	1) Issue the LOG SENSE command and read the "Current" values in the LOG SELECT parameters. 2) If the parameters' values are appropriate, reissue the original command. Note This error could also be caused by a UNIT ATTENTION condition being generated, caused by a programming error of another INIT, so when the value in the parameter read in (is illegal, recovery method 2 should be performed, or the operations of the other INITs should be confirmed.)
17	If the PRIORITY RESERVE command issued by another INIT is proper in the system, perform the necessary recovery processing in the system. If not, perform recovery method 2.
18	1) Issue the MODE SENSE or MODE SENSE EXTENDED command and confirm the values of the disk media data format related parameters (Block descriptor, Page 3: Format parameters, Page 4: Drive parameters). 2) If the parameter values are correct, issue the FORMAT UNIT command and initialize the entire disk media surface. (Note) 3) If the parameter values are not correct, issue a MODE SELECT or MODE SELECT EXTENDED command and reset the necessary parameters, then reinitialize the entire disk media surface by the FORMAT UNIT command. (Note) Note In a system where multiple INITs are connected together, an error may have been reported due to a MODE SELECT or MODE SELECT EXTENDED command, or a FORMAT UNIT command issued by another INIT, so before executing this recovery method, it is necessary to confirm the operations of the other INITs.

Table 5.6 Error recovery processing procedures (4/4)

Recovery Method	Recovery Processing Procedure
19	Initialize the entire disk media surface. It is desirable at this time to increase the number of spare sectors as much as possible. If this error occurs repeatedly, it is necessary to perform alternate block allocation processing through the system (shown in Chapter 5) or reconfirm the use conditions of the disk drive, such as the installation environment.
20	1) Reissue the original command (Retry). 2) If it doesn't recover after 10 retries, perform recovery method 13.
21	1) Issue the MODE SENSE or MODE SENSE EXTENDED command and read the "Current" values in the MODE SELECT parameters. 2) If the parameters' values are appropriate, reissue the original command. Note This error could also be caused by a UNIT ATTENTION condition being generated, caused by a programming error of another INIT, so when the values in the parameters read in (are illegal, recovery method 2 should be performed, or the operations of the other INITs should be confirmed.)
24	1) Issue the READ or READ EXTENDED command and read the data for the block where the error occurred. 2) Investigate the cause of the data not matching and perform data recovery processing from the INIT.
25	Reissue the original command (Retry). It is desirable at this time to confirm the operations of the other INITs.
26	1) Issue the LOG SENSE command and read the "Current" values of the LOG SELECT parameters. 2) Search for any parameter values which exceed the threshold value or have reached the maximum value, then issue the LOG SELECT command from the INIT and perform resetting. 3) Reissue the original command.
27	1) Issue the INQUIRY command and read the operation mode information. 2) If the parameter values are appropriate, reissue the original command. Note: This error could also be caused by a UNIT ATTENTION condition being generated, caused by a programming error of another INIT, so when the values in the parameters read in (are illegal, recovery method 2 should be performed, or the operations of the other INITs should be confirmed.)

5.2.3 Error logging

In order to collect information that is effective in maintenance, it is desirable for the INIT to accumulate (log) error information related to the FC interface which it has detected itself (Loop error, command completion wait time-out, etc.) and error information reported by the IDD.

By specifying "1" in the PER bit in the "Read/Write Error Recovery parameter (Page 1) and the "Verify Error Recovery parameter (Page 7) of the MODE SELECT or MODE SELECT EXTENDED command, the INIT can know of the occurrence of errors which were recovered from successfully by the IDD's internal error recovery processing and their contents. By logging that error information, the INIT can obtain data for more detailed analysis of the disk drive's operating condition.

Concerning the contents of the error log, it is recommended that the data have a time stamp affixed so that they can be edited in a time series of the times the errors were detected, and that they include the following information.

- The source which issued the command and the ID of the device which was the target of the command.
- The CDB which was issued.
- The receiving status, or, when the status was that the command could not be received, the code showing the type of error detected by the INIT and its content.
- All bytes reported by the IDD.

5.3 Disk Drive Error Recovery Processing

This section explains concerning error recovery processing methods and procedures executed by the IDD for each type of disk drive related error. The INIT can control the error recovery processing methods executed by the IDD using the MODE SELECT parameters.

5.3.1 Error states and retry processing procedures

(1) Seek error

Mechanical malfunctions of the disk drive during a seek operation and failure of serial addresses detected during verification of the ID area to match are included in this error.

When a seek error occurs, the IDD first executes rezero seek, then tries repositioning at the target cylinder and restarts the original processing. If the error is not recovered from, retry processing (rezero seek and repositioning) is performed up to the number of times specified in "Number of Retries during Seek Error" in the MODE SELECT parameters.

If the error cannot be recovered from even when retry processing is executed the specified number of times, the IDD terminates the command which is currently being executed with a CHECK CONDITION status. The sense key in the sense data at this time is "HARDWARE ERROR [=4]" and the sense code indicates "Mechanical positioning error [=15-01]" or "Positioning error detected by read of medium [=15-02]."

(2) Read error in uncorrectable data

This error is a failure to detect the Sync Byte pattern during reading of data or an ECC error for which correction processing is impossible. If this error is detected, the IDD, after waiting one revolution of the disk media, tries reading again. When the error is not recovered from, reading is retried repeatedly the number of times specified in the MODE SELECT parameter ("Number of Retries during Read" or "Number of Retries during Write").

In cases where correction is possible during execution of retry processing, the processing procedure is according to "Correctable Data Read Error" in item (3). If errors cannot be recovered from even after retry is executed the specified number of times, the IDD terminates the command that is currently being executed with a CHECK CONDITION status. The sense key in the sense data at this time is "MEDIUM ERROR [=3]" and the sense code indicates "Sync byte not found for data field [=13-00]" or "Unrecovered read error [=11-01]."

In this error retry processing, rereading accompanied by head offset processing is performed.

(3) Correctable data read error

This error is a correctable ECC error when data are being read. Processing methods when this error is detected differ depending on the values specified in the EER flag and DCR flag in the MODE SELECT parameters.

If immediate correction of errors is permitted (DCR = 0, EER = 1), the IDD immediately makes error corrections in the data buffer and sends the corrected data to the INIT. Also, in the case of Verify processing, at the point when it judges that correction is possible, it regards verification as being successful and continues processing of subsequent data blocks.

If error correction is permitted but immediate correction is not permitted (DCR = 0, EER = 0), reading of data as in item (2) is retried up to the number of times specified in the other MODE SELECT parameters ("Number of Retries during Read" or "Number of Retries during Write").

If error correction is prohibited (DCR = 1, EER = 0), reading of data as in item (2) is retried up to the number of times specified in "Number of Retries during Read" or "Number of Retries during Write."

If the error cannot be recovered from even when this retry processing is executed, the IDD terminates the command that is currently being executed with a CHECK CONDITION status. The sense key in the sense data at this time is "MEDIUM ERROR [=3]" and the sense code indicates "Unrecovered read error [=11-00]."

(4) Other internal IDD errors

If an irrecoverable error other than those in items (1) to (3) above is detected internally in the IDD, the IDD terminates the command that is currently being executed with a CHECK CONDITION status. The sense key in the sense data at this time is "HARDWARE ERROR [=4]."

5.3.2 Auto alternate block allocation processing

The IDD is equipped with a function which automatically executes alternate block allocation processing for defective data blocks detected during execution of the READ and READ EXTENDED commands.

(1) Auto alternate block allocation processing during a read operation

This function is enabled by specifying "1" in the ARRE flag in the MODE SELECT parameters. Furthermore, this function is applicable to the following commands only.

- READ command
- READ EXTENDED command

When this function is permitted, if, during read processing to the data area, an error which is an object of retry processing is detected, and which it is impossible to recover from even when reading is retried (see Section 5.3.1 (2)) the number of times specified in the "Number of Retries during Read" field in the MODE SELECT parameters, the IDD allocates an alternate block for that data block and executes copying of the alternate block to the data area. Alternate block allocation processing is the same as processing with the REASSIGN BLOCKS command. Furthermore, recovered data copied to the alternate block are data which are read out, skipping the ID area, if there is an ID area, or they are data which have been corrected through the ECC.

This function is applied once only during execution of one command. Alternate block allocation processing and copying are executed for the first defective data block to be detected during execution of a command, but if a second defective data block is detected, the command that is being executed at that point is terminated with an error. However, by the INIT's reissuing the same command, auto alternate block allocation is applied sequentially and error recovery can be attempted.

Remark:

1. When this function is specified (ARRE = "1"), the EER flag's specification in the MODE SELECT parameter is made invalid and Read retry processing is performed up to the number of times specified in the "Number of Retries during Read" parameter. If "0" is specified in the DCR flag, correction processing of the data is performed afterward (see Section 5.3.1 (3)). When "1" is specified in the DCR flag, ECC correction processing is prohibited, so even if "1" is specified in the ARRE flag, auto alternate block allocation processing will not be executed for errors in the data area.

2. When errors in the data area are recovered from by ECC correction processing, before implementing alternate block allocation processing, rewriting of the recovered data and a verify check (rereading) are performed. If data are recovered by rewriting, alternate block allocation of that data block is not performed.

(2) Auto alternate block allocation processing during a write operation 1

This function is enabled by specifying "1" in the AWRE flag in the MODE SELECT parameters. Furthermore, this function is applicable to the following commands only.

- WRITE command
- WRITE EXTENDED command
- WRITE AND VERIFY command

The function handles the unrecoverable media error (MEDIUM ERROR [= 3]/Read Retries Exhausted [= 11 - 01]) detected when the number of read retries for an error reaches the specified value in the "Number of retries during READ" field of the MODE SELECT parameter (refer to Section 5.3.1 (3)). In such cases, if this function is enabled, the IDD registers the data block as the target block of AWRE processing. If the WRITE, WRITE EXTENDED, or WRITE AND VERIFY command is executed for the same data block, an alternate block is allocated to the data block. The data field of the alternate block is verified, and the required write data is written in the data field. This alternate block allocation is applied with the same processing as that of the REASSIGN BLOCKS command.

If multiple data blocks are the target blocks of AWRE processing when a single command is executed, this function applies to all of these data blocks. If an unrecoverable media error (MEDIUM ERROR [= 3]/Read Retries Exhausted [= 11 - 01]) is then detected during the read operation for a data block, INIT should issue the WRITE, WRITE EXTENDED, or WRITE AND VERIFY command to the data block. Thus, auto alternate block allocation is applied, and error recovery is possible.

Remark 1: When this function has been set (AWRE = "1"), up to eight unrecoverable media errors (MEDIUM ERROR [= 3]/Read Retries Exhausted [= 11 - 01]) detected during the read operation of the READ or READ EXTENDED command can be recorded. This recorded information is cleared when power is turned off or microcode is downloaded with the WRITE BUFFER command (regardless of whether save is specified).

Remark 2: Before data for a data block is allocated to an alternate block in AWRE processing, the data is written again to the data block and verified (re-read).

If error recovery is completed by rewriting the data to the data block, alternate block allocation is not performed for this data block. The data block is removed as the target of AWRE processing.

(3) Auto alternate block allocation processing during a write operation 2 (servo auto alternate)

This function is enabled by specifying "1" in the AWRE flag in the MODE SELECT parameters. Furthermore, this function is applicable to the following commands only.

- WRITE command
- WRITE EXTENDED command
- WRITE AND VERIFY

When this function is permitted, if, during WRITE/WRITE EXTENDED command detects any Servo error (e.g. Write offtrack error) and cannot be recovered within pre-determined retry number (specified in Mode Parameter). For the sectors around defective Servo, alternate blocks are allocated and the data of this WRITE commands are re-written.

Sectors to be made AWRE shall be following:

- the sector where the error occurs and the latter sectors and,
- the sectors whose data are logically continual and stored in Cache,
- the sectors which will be processed in this Write command and,
- the sectors which locate between erroneous Servo -1 and +1 (including Split sector)

This function is also applied for the sector which has already been re-assigned.

5.3.3 Error recovery processing control

The INIT can, by specifying the MODE SELECT parameters, can control the error recovery processing (retries) of the IDD with respect to each type of error related to the disk drive.

Table 5.7 shows the types of error and the method of specifying the number of retries for those errors. for those items where the INIT can specify the number of retries, normally, it is recommended that the default value or a greater number of times be specified. If a value smaller than the default value is specified, and commands are terminated abnormally without error recovery processing succeeding, the INIT should reset the corresponding MODE SELECT parameters at the default value, then reexecute the original commands.

The MODE SELECT parameters related to disk drive error recovery processing which the INIT can specify are shown below. See the description of the MODE SELECT command (Section 4.1.4) concerning details of the functions of each parameter. The INIT can issue the MODE SELECT or MODE SELECT EXTENDED command as necessary and select the error recovery flags and the number of retries.

a. Read/Write Error Recovery Parameters (Page Code = 1)

- AWRE (automatic write reallocation enabled)
- ARRE (automatic read reallocation enabled)
- TB (transfer block)
- EER (enable early recovery)
- PER (post error)
- DTE (disable transfer on error)
- DCR (disable correction)
- Number of retries during read (See Table 5.7)
- Number of retries during write (See Table 5.7)

b. Verify Error Recovery Parameters (Page Code = 7)

- EER (enable early recovery)
- PER (post error)
- DTE (disable transfer on error)
- DCR (disable correction)
- Number of retries during verify (See Table 5.7)

c. Additional Error Recovery Parameters (Page Code = 21)

- Number of retries during seek error (See Table 5.7)

Table 5.7 Disk drive errors and number of retries

Item	Type of Error	Number of Tries Specification [Default value]	
1	Seek Error	Number of Retries during a Seek Error	[15]
2	Data field Read Error of Data field	Number of Retries during Read or Number of Retries during Verify	[63]
3	Data field Write Error	Number of Retries during Write	[63]

Remark:

The number of retries is calculated single logical sector processing units, except in the following cases.

- The number of retries is calculated as individual retries.
- In processing of data blocks for which alternate sector processing is completed, the number of retries on the defective sectors is calculated separately from the number of retries on the alternate sectors.

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CHAPTER 6 Disk Media Management

In this chapter, disk media defect management methods, treatment methods for media defects which occur during operation, reinitialization procedures and other disk media management methods are discussed. Furthermore, see Chapter 3, "Data Format" in the "Product Manual" concerning details of the data recording format on the disk media.

6.1 Defect Management

(1) Defect lists

Information on the positions of defects in the disk media are managed by the types of defect list shown below. See the description of the FORMAT UNIT command (Section 4.3.1) concerning methods for using the defect lists.

- P List Defect position information at the point when the disk drive was shipped from the factory is recorded in this list. The defective portions included in this list are permanent defects, and when the disk media is initialized, it is necessary that this list be used and alternate block processing be executed.
- D List This list includes defect position information specified by the INIT in the FORMAT UNIT command when initializing the disk media.
- C List This list contains information on the positions of defective blocks detected during the data block Verify operation (Certification) after initialization by the FORMAT UNIT command. This information is generated internally by the IDD when the FORMAT UNIT command is executed.
- G List This list is composed from the defective logical data block position information specified by the INIT in the REASSIGN BLOCKS command, defective logical data block position information from alternate blocks which have been allocated by the IDD's auto alternate block allocation processing, information specified as the D List and information generated as the C List.

The P List and G List are recorded in the system space on the disk media. The INIT can read the contents of these lists by the READ DEFECT DATA command.

(2) Alternate block allocation

Alternate data blocks are allocated in defective sector units for defective data blocks (= sectors) on the disk media by the IDD's internal defect management methods.

a. Spare sector area

Spare sectors for allocation as alternate blocks are secured in one or both of the following areas. When the INIT initializes the disk media, it can specify the spare sector area to be prepared on the disk drive and the size of that area.

– Spare sectors within a cell

Spare sectors are secured in the final track of each cell. They are used as alternate blocks for defective sectors within the same cell.

– Alternate cells

This is an exclusive cells for allocation of alternate blocks. Alternate cells are secured only in the specified quantity in order from the topmost cells. Spare sectors in an alternate cell are used only in the case that the spare sectors within each cell are used up and alternate block allocation is not possible within the same cell.

b. Alternate block allocation methods

Alternate block allocation processing is performed using one of the following methods.

– Sector slip processing

This is a method of skipping defective sectors and writing the logical data blocks corresponding to those sectors in order in physically consecutive sectors. Sector slip processing is performed only within the same cell as the defective sectors and until all the spare sectors within that cell are used up.

– Alternate sector processing

This is a method of allocating logical data blocks corresponding to defective sectors to unused spare sectors within the same cylinder or to unused spare sectors in an alternate cell.

c. Alternate block allocation processing

Alternate block allocation processing is implemented by the FORMAT UNIT command, REASSIGN BLOCKS command or "Auto Alternate Block Allocation Processing." In sector slip processing, the defective sectors re excluded and logical data blocks are located in physically consecutive sectors, but when alternate block processing is performed, the affected logical data blocks are located in spare sectors which are not physically consecutive with the previous and following logical data blocks which are physically located on the disk.

– Alternate block allocation processing during FORMAT UNIT command execution

With the FORMAT UNIT command, alternate block allocation is done by sector slip processing until all the spare sectors within the same cell have been used up for defective sectors included in the type of defect list (P, G or D) specified in the command. When all the spare sectors in the same cell have been used up, subsequent defective sectors in that cell are treated by allocating spare sectors in an alternate cell by alternate sector processing.

After implementing this alternate block allocation and initializing the disk media, at times when a data block Verify (Certification) operation is not prohibited, the IDD, reads all the initialized data blocks and verifies their normalcy. If a defective data block is detected during this processing, the IDD generates the C List as defect position information and allocates alternate blocks by alternate sector processing for those defective data blocks. In this case, alternate blocks are allocated in spare sectors in an alternate cell.

– Alternate block allocation processing by the REASSIGN BLOCKS command

With the REASSIGN BLOCKS command, alternate block allocation is performed by alternate sector processing for defective logical data blocks specified by the INIT. In this case, alternate blocks are allocated in spare sectors in an alternate cell.

– Auto alternate block allocation processing

If auto alternate block allocation processing is permitted by the AWRE flag or the ARRE flag of the MODE SELECT parameters, the IDD executes alternate clock allocation automatically by alternate sector processing for defective data blocks detected during execution of the WRITE, WRITE EXTENDED, WRITE AND VERIFY, READ and READ EXTENDED commands. The alternate block allocation method in this case is the same as in the case of the REASSIGN BLOCKS command. See the description in Section 5.3.2 concerning "Auto Alternate Block Allocation Processing".

6.2 Disk Media Initialization

6.2.1 Initialization during installation

The disk drive is initialized for the inherent (default) data format for each respective model name (model class) when it is shipped from the factory, so ordinarily, it is not necessary to initialized (format) the disk media when it is installed in a system. However, in cases where data attributes which differ from the default format are necessary, initialization (formatting) of the entire disk media by the following procedures is necessary. At this time, the INIT can change the following data format attributes.

- The logical data block length.
- The number of logical data blocks or the number of cylinders in the User Space.
- The size of the spare area for alternate blocks.

(1) Issuing the MODE SELECT command

The MODE SELECT or MODE SELECT EXTENDED command is issued and the format attributes on the disk media are specified. The necessary parameters at this time are as follows.

a. Block descriptor

The logical data block size (byte length) is specified in the "Data block length" field. Also, when desiring to clearly specify the logical data block count, specify that value in the "Data block count" field. If not, zero may be specified in the "Data block count" field. In that case, the number of logical data blocks after initialization will be determined by the values specified in the Format parameters (Page 3) and the Drive parameters (Page 4).

b. Format parameters (Page 3)

Specify the number of spare sectors secured in each cylinder in the "Alternate sector count/zone" field. It is desirable not to specify a value that is lower than the IDD's default value in this field.

c. Drive parameters (Page 4)

The number of cylinders in the "User Space," cannot be changed. The number of cylinders necessary to secure the number of logical data blocks specified in the "Data block count" field in the block descriptor will be allocated to the user space.

(2) Issuing the FORMAT UNIT command

Issue the FORMAT UNIT command and initialize the entire disk media surface.

In this FORMAT UNIT command, the entire disk media surface is initialized using the P List, then after initialization, the data blocks are verified. If any defective blocks are detected in the Verify operation, alternate blocks are allocated for those data blocks. Also, the defect position information for only the defective data blocks detected in the Verify operation is recorded in the G List.

The contents which need to be specified at this time are as follows.

a. CDB specification

Specify "0" in the "FmtData" bit and the "CmpLst" and "000" in the "Defect List Format" field in the CDB.

b. FORMAT parameters

If the items values in the previous item are specified in the CDB, the Format parameter is not necessary.

6.2.2 Re-initialization

The INIT can reinitialize the disk drive after it has been operated using the FORMAT UNIT command.

IMPORTANT

If it is necessary after reinitialization to restore the data that were stored on the disk media, it is necessary to save the data before executing reinitialization, then execute data restore using system software after reinitialization.

The INIT can change the size of the spare sector area and its location as well as the number of logical data blocks before reinitialization. The recommended procedure for reinitialization is shown below. However, in cases where the logical data block length is changed, the initialization procedure described in Section 6.2.1 must be followed during installation.

(1) MODE SELECT command

If the logical data block count (size of the User Space) or the size of the spare sector area and its location are changed, issue the MODE SELECT EXTENDED command and specify the disk media format attributes. The parameter specification method is the same as in the case of initialization processing during installation, described in Section 6.2.1. If the same format attributes as at present will continue to be used, it is not necessary to issue the MODE SELECT EXTENDED command.

(2) FORMAT UNIT command

Issue the FORMAT UNIT command in either of the following two formats and initialize the entire disk media surface.

a) Specify "1" in the "FmtData" bit, "0" in the "CmpLst" bit and "000" in the "Defect List Format" field. Also, prepare only a 4-byte header, specify "0" in the "FOV," "DPRY," "DCRT" and "STPF" bits and zero in the "Defect List Length" field.

   – In this FORMAT UNIT command, the entire disk media surface is initialized using the P List and the previously existing G List, then after initialization, the data blocks are verified. If any defective blocks are detected in the Verify operation, alternate blocks are allocated for those data blocks. Also, the previously existing G List is saved, and the defect position information for the defective data blocks detected in the Verify operation is added to the G List. During initialization, alternate blocks for which sector slip processing was applied for previously known defects are reallocated, so optimization of the logical data block locations on the disk media can be expected.

b) Specify "0" in the "FmtData" bit and in the "CmpLst" bit and "000" in the "Defect List Format" field. In this case, specification of the format parameters is not necessary.

   – In this FORMAT UNIT command, the disk media is initialized using only the P List, then after initialization, the data blocks are verified. If any defective blocks are detected in the Verify operation, alternate blocks are allocated for those data blocks. Also, the previously existing G List is erased and defect position information for the defective data blocks detected in the Verify operation is recorded in a new G List.

6.3 Data Block Verification Methods (Recommended)

The recommended procedure for verifying from the INIT the normalcy of logical data blocks located on the disk media is as shown below. It is desirable for the INIT to verify the data blocks after initialization of the disk media is completed or when executing alternate block allocation processing by the REASSIGN BLOCKS command.

IMPORTANT

The INIT must not recognize the defective data blocks included in the P List as normal data blocks in the verification operation.

After the INIT has written a specific data pattern for logical data blocks which is the object of verification using the procedure described below, it next reads those data or verifies the data blocks by executing Verify.

(1) Setting parameters by the MODE SELECT command

Issue the MODE SELECT or the MODE SELECT EXTENDED command and prohibit retry processing, data correction and operation of the Read-Ahead Cache feature. The necessary parameter settings are as shown below.

a. Read/Write Error Recovery Parameters (Page 1)

- AWRE = 0, ARRE = 0
- TB = 0 or 1
- EER = 0, PER = 1, DTE = 1, and DCR = 1
- Number of Retries during Read = Zero
- Number of Retries during Write = Zero

b. Verify Error Recovery Parameters (Page 1)

- EER = 0, PER = 1, DTE = 1, and DCR = 1
- Number of Retries during Verify = Zero

c. Caching Parameters (Page 8)

- RCD = 1

(2) Writing a data pattern

Write a data pattern for verification in the data block which is the object. The recommended data pattern at this time is X '0123456789ABCDEF' repeated. The WRITE, WRITE EXTENDED or WRITE SAME command can be used to write data.

(3) Reading and verification of data

Issue the READ, READ EXTENDED or VERIFY command and verify that the data written to the disk media in item (2) were read correctly.

To verify reading of data, it is recommended that reading of the same data block be done at lease 2 times, but the number of times verification is performed is determined by the conditions on the system. If reading of all data is completed normally, it can be recognized that use of that data block can be used normally.

(4) Error verification

When an error related to the disk media (Sense Key = 3: MEDIUM ERROR) occurs during writing of the data pattern (see item (2)) or verification of data reading (see item (3)), reexecute the rewriting and reading verification combination (two times) at least 8 times.

When the same type of error occurs even once during reexecution, it is recommended that the INIT treat that data block as a defective block. If the reexecution of verification is completed normally every time, it should be regarded that that data block can be used normally.

6.4 Alternate Block Allocation Processing

If errors on the disk media which cannot be recovered from are detected, or if a recoverable error occurs repeatedly in the same data block, it is necessary for the INIT to allocate an alternate block for the data block where the error occurred using the REASSIGN BLOCKS command. The procedure for alternate block processing is shown below.

IMPORTANT

An attempt will be made to copy the contents of the data area of the logical data block specified in the "Defect Data" list to the alternate block allocated by this command, but in some cases, the data cannot be copied. Confirmation of the contents of data in the allocated alternate block, saving of data before issuing this command and restoring of data after executing this command are the responsibility of the INIT.

1) Verify data blocks in accordance with the procedure in Section 6.3 for data blocks where error occur. When such a data block is judged to be normal, alternate block allocation need not be implemented. In this case, rewrite the original data to that data block if necessary. When the data block is judged to be defective, implement the processing in item 2) and after.

2) Specify a logical block address for a data block which is judged to be defective and issue the REASSIGN BLOCKS command.

3) If the REASSIGN BLOCKS command is terminated normally, verify that logical data block according to the procedure in Section 6.3. If that data block is judged to be correct, allocate an alternate block and terminate processing. When the data block is judged to be defective, return to 2) and issue the REASSIGN BLOCKS command again, then try reallocating another alternate block for that logical data block.

The alternate block allocation history (defect position information) is registered as an addition to the defect list (G List). Therefore, when reinitializing the hard disk with the FORMAT UNIT command (see Section 6.2.2), if use of the G List is specified, defect processing can be performed which reflects the operation results up to that time. Also, since "Alternate sector processing" is applied in alternate block allocation in the REASSIGN BLOCKS command, the physical connectivity of the logical data block positions on the disk media is destroyed, but by reinitializing the disk, as long as the number of defective sectors in the cylinder does not exceed the number of spare sectors per cylinder, the logical data blocks are relocated by sector slip processing so that their physical connectivity is maintained.

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Glossary

CDB

Command Descriptor Block
A series of data which describes commands related to input/output operations, sent from the initiator to the target.

Command

This is a command to a target to perform an input/output operation, and it is described as the CDB.

Common Command Set (CCS)

SCSI standard logical specifications established by a working group of the American National Standard Institute (ANSI). Requirements and features for supported direct-access devices (e.g., hard disk devices) are stipulated with the CCS.

FC Device

The general name given to a device which is connected to the FC bus (input/output device, I/O controller, host adapter, etc.).

Initiator (INIT)

This is a FC device which initiates input and output operations on the FC bus. In this manual, initiator has been abbreviated to "INIT."

Sense Code

This is a 1-byte code displayed in the sense data and is information which specifies the type of error that was detected.

Sense Data

When several items of error information are included in a command's completion status, this is information generated by the target for reporting detailed information on that status.

Sense Key

This is a 4-bit code displayed in the sense data. It contains information for classifying the type of error that was detected.

Small Computer System Interface (SCSI)

Input/output interface standardized by the American National Standard Institute (ANSI)
[Specification Number: ANSI X3.131-1986]

Status

This is 1 byte of information reported to the initiator by the target device when execution of each command is completed, which displays the command's completion state.

Target (TARG)

This is the FC device that executes the input/output operations initiated by the initiator (INIT). In this manual, target is abbreviated "TARG."

Acronyms and 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
DevOfi	Device Offine
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

FC	Fibre Channel
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

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 sector
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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C

D

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