

Universal Serial Bus Mass Storage Class

UFI Command Specification

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USB Mass Storage Class UFI Command Specification
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Please send comments via electronic mail to techsup@usb.org

Additional contributions made by:

Shing F. Lin	Adaptec	Jim Quigley	Iomega Corporation
Mark McCoy	Anchor Chips Inc.	Glen Slick	Microsoft Corporation
Mike Leibow	eTEK Labs	Mark Williams	Microsoft Corporation
David G. Lawrence	Smart Technology Enablers, Inc.	Takashi Matsui	Nanao
Hiromichi Oribe	Hagiwara Sys-Com Co., Ltd.	Ryota Okazaki	NEC Corporation
Yuji Oishi	Hagiwara Sys-Com Co., Ltd.	Curtis E. Stevens	Phoenix Technologies Ltd
Steve Bayless	Hewlett-Packard	Al Richey	Phoenix Technologies Ltd.
Dave Gilbert	In-System Design, Inc.	Trenton Henry	Standard Microsystems Corporation
David Luke	In-System Design, Inc.	Mike Nguyen	TEAC America, Inc.
Darrell Redford	Iomega Corporation	Tsuyoshi Osawa	TEAC Corporation
David Jolley	Iomega Corporation	Toyoko Shimizu	Y-E Data, Inc.
Mike Poulsen	Iomega Corporation		

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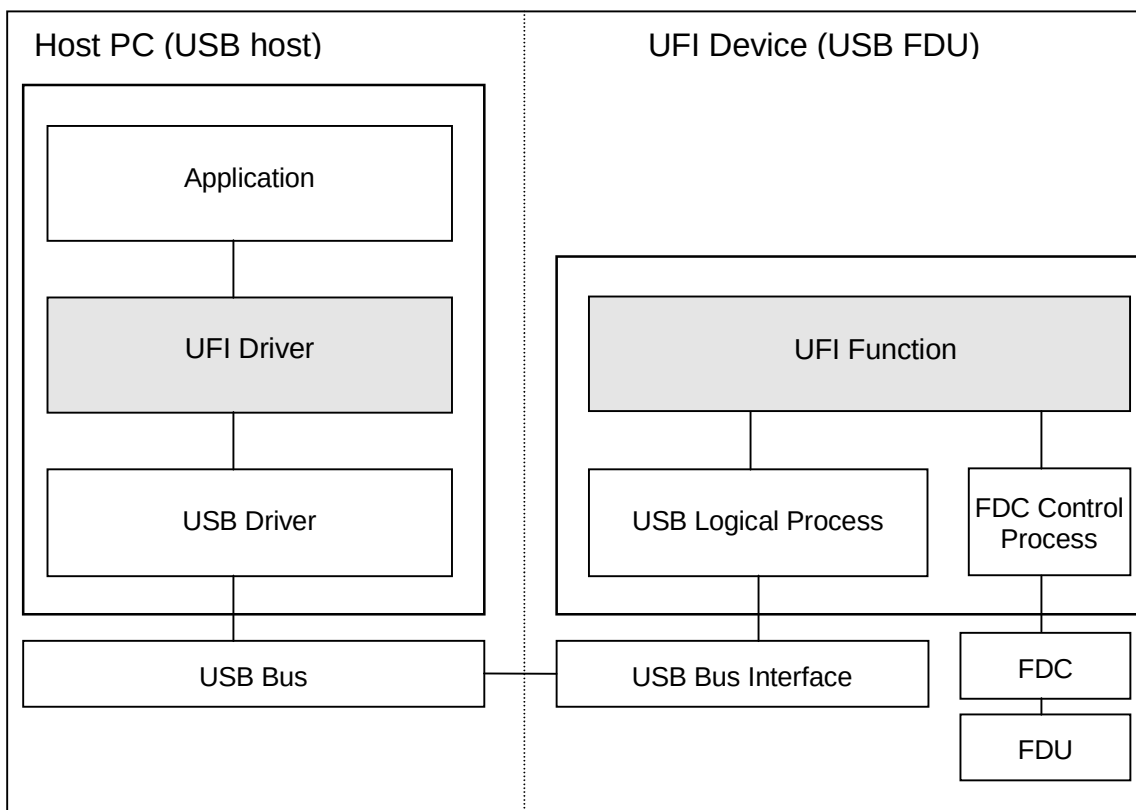
1. Introduction

A UFI Device is a removable-media mass storage subsystem, which connects to a Host computer via its Universal Serial Bus (USB) port. The Host and UFI Device communicate by exchanging Command Blocks, data, and status information as defined by this specification. The method used to transport this information over the USB is defined by the Bulk-Only or CBI transport specifications.

A conceptual view of the Host and UFI Device is shown in Figure 1. The UFI device is represented by a USB Floppy Disk Unit (USB FDU). The UFI device driver software running on the Host controls the UFI device by sending it UFI command blocks defined by this specification. The UFI Function in the device processes these command blocks as specified herein.

All exchanges of command block, data, and status information are carried out by the transfer of packets over the USB. This exchange is managed by the USB Driver on the Host, and the USB Logical Device process in the USB-FDU.

Figure 1 - Host/UFI Device Conceptual View



Note:  indicates software handling UFI commands

1.1 Scope

A familiarity with the USB 1.0 and 1.1 specifications, and the Bulk-Only or CBI Transport specification is assumed.

This specification defines the UFI Command Set, which was designed to interface Floppy Disk Drives to the USB. The “USB Floppy Interface” (UFI) Command Set is based on the SCSI-2 and SFF-8070i command sets.

The exchange across the USB of command blocks, data, and status information as defined herein is specified by the Bulk-Only or CBI Transport Specifications.

1.2 Terms and Abbreviations

CPU data	Data read from or written to the floppy media. This data is “consumed” by the Host’s CPU, as compared to audio data read from a CD-ROM, which is “consumed” by a sound card.
FDC	Floppy Disk Controller. An integrated circuit which controls, writes data to, and reads data from a floppy disk drive. The USB-FDU contains one internal FDC which controls the USB-FDU floppy disk drive unit. This FDC is in turn controlled by the micro-controller, which transfers data and commands between the USB-FDU driver on the Host and the FDC.
FDC Control Process	A process in the USB-FDU device that manages the FDC. This process is called by the UFI Function to read, write, or format the FDD media.
FDD	Floppy Disk Drive.
UFI Function	The main control process in the USB-FDU device that processes UFI commands.
Host	The user’s Computer, which contains the USB host controller.
Universal Serial Bus	A collection of Universal Serial Bus devices and the software and hardware that allow them to connect the capabilities provided by functions to the Host.
USB	Universal Serial Bus.
USB FDU	Floppy Disk Drive Unit with USB

2. USB Usage

The UFI device and host shall support USB requests and use the USB for the transport of command blocks, data, and status information as defined by the Bulk-Only or CBI Transport specifications, including the following restrictions.

2.1 CBI: Interrupt Endpoint Required

A UFI device which uses the CBI Transport shall implement an interrupt endpoint and use the interrupt endpoint for command completion interrupts, as defined by the CBI specification. The UFI device shall set the *bInterfaceProtocol* field of the CBI Data Interface Descriptor to the appropriate value indicating “CBI with command block completion interrupt.” See the *USB Mass Storage Class Specification Overview*.

The UFI Device shall return interrupt data blocks as specified in the *CBI Transport Specification*, section 3.4.3.1.3. “Interrupt Data Block for bInterfaceSubClass = 04h”

2.2 CBI: Accept Device-Specific Command Request

When using CBI Transport, the host shall use an Accept Device-Specific Command (ADSC) class-specific request to send a command block to a UFI device, as defined by the CBI specification.

The host shall transport command blocks of exactly 12 bytes, and shall set the *wLength* field of the ADSC request to 0Ch. The UFI device may fail the ADSC request if the value of the *wLength* field is invalid.

The host shall pad any short command blocks by appending zeros to the end of the command block.

2.3 Zero-Length Data UFI Command Blocks

It is possible for the host to issue a command block in which the transfer length or parameter list length is set to zero. For example, a READ command block with a transfer length of zero blocks.

Such command blocks shall be interpreted by this specification to mean that no data shall be transferred. While the *USB specification* allows the transfer of a block of zero length (USB header with no attached data), the UFI device shall not use this facility. Instead, the UFI device shall skip the data transfer and proceed with status transport. For example, see *CBI Transport Specification*, section 2.3 “Non-Data Command Protocol.”

3. UFI Commands

UFI commands are packets or command data blocks issued by the host to the UFI device. Each command block is 12-bytes in length. The format of each command block is based on *SFF-8070i* and *SCSI-2*.

Some command blocks require extra parameters or CPU data. These are sent to the UFI device on the host bulk out endpoint, as defined by the transport specification.

Some command blocks request data be sent from the UFI device to the host. This data is sent on the host bulk in endpoint, as defined by the transport specification.

Table 1 - Required UFI Commands

Command	Description	OP Code
Format Unit	Format unformatted media.	04h
Inquiry	Get device information.	12h
Start / Stop	Request a removable-media device to load or unload its media.	1Bh
Mode Select	Allow the host to set parameters in a peripheral. Mode Sense should be issued prior to a Mode Select .	55h
Mode Sense	Report parameters to the host. Backward compatibility of floppy drives requires support for the Mode Sense command, Flexible Disk page.	5Ah
Prevent/ Allow Medium Removal	Prevent or allow the removal of media from a removable media device.	1Eh
Read (10)	Transfer binary data from the media to the host.	28h
Read (12)	Transfer binary data from the media to the host.	A8h
Read Capacity	Report current media capacity.	25h
Read Format Capacity	Report current media capacity and formattable capacities supported by media.	23h
Request Sense	Transfer status sense data to the host.	03h
Rezero Unit	Position a head of the drive to zero track .	01h
Seek (10)	Seek the device to a specified address.	2Bh
Send Diagnostic	Perform a hard reset and execute diagnostics.	1Dh
Test Unit Ready	Request the device to report if it is ready.	00h
Verify	Verify data on the media.	2Fh
Write (10)	Transfer binary data from the host to the media.	2Ah
Write (12)	Transfer binary data from the host to the media.	AAh
Write and Verify	Transfer binary data from the host to the media and verify data.	2Eh

3.1 Command Block Implementation Requirements

The UFI device shall implement all required commands.

3.1.1 Reserved

Reserved bits, fields, bytes, and code values are set aside for future standardization. Their use and interpretation may be specified by future extensions to this or other standards. A reserved bit, field or byte shall be set to zero, or in accordance with a future extension to this standard. The recipient shall not check reserved fields.

3.2 UFI Command Block Description

For all commands, if there is an invalid parameter in the command block, the UFI device shall abort the command block without altering the medium.

Table 2 - Typical Command Block for Most Commands

Byte	Bit	7	6	5	4	3	2	1	0
0		Operation Code							
1		Logical Unit Number			Reserved				
2	(MSB)	Logical Block Address (if required)							
3									
4									
5									
6		Reserved							
7	(MSB)	Transfer or Parameter List or Allocation Length (if required)							
8									
9		Reserved							
10		Reserved							
11		Reserved							

Table 3 - Typical Command Block for Some Extended Commands

Byte	Bit	7	6	5	4	3	2	1	0
0		Operation Code							
1		Logical Unit Number			Reserved				
2	(MSB)	Logical Block Address (if required)							
3									
4									
5									
6	(MSB)	Transfer or Parameter List or Allocation Length (if required)							
7									
8									
9									
10		Reserved							
11		Reserved							

3.2.1 Operation Code

The first byte of all command blocks shall contain an Operation Code. The Operation Code of the command block indicates the operation to be performed. There are 256 possible operation codes. Operation codes are defined in the subsequent sections.

3.2.2 Logical Unit Number

The Logical Unit Number field specifies the Logical Unit that shall process the command block.

Even though *SFF-8070i* states that the Logical Unit Number (LUN) at the block (packet) level will be made obsolete in a future standard, block level LUNs are used by UFI command blocks because a control level LUN does not exist. (The control level LUN is set in the ATAPI Block Device Select Register, which does not exist on the UFI device.)

If the UFI device supports only one logical unit, its Logical Unit Number shall be zero. For other than the INQUIRY command, if the UFI device detects a unsupported Logical Unit Number, the device shall abort the command, setting the sense key shall be set to ILLEGAL REQUEST and the additional sense code to LOGICAL UNIT NOT SUPPORTED.

3.2.3 Logical Block Address

The Logical Block Address must begin with block zero and be contiguous through the last logical block.

For the USB-FDU, the logical block is the logical sector, which occupies one physical sector on the floppy diskette medium. Logical block 0 is the first sector on the diskette, namely, track 0, head 0, sector 1. The Logical Block Address can be calculated from the track-head-sector numbers using the following formula.

$$LBA = (((Track \times HeadTrk) + Head) \times SecTrk) + (Sector - 1)$$

where:

LBA	Logical Block Address (zero-based)
Track	Track Number (zero-based)
HeadTrk	Number of heads per track
Head	Head Number (zero-based)
SecTrk	Number of sectors per track
Sector	Sector Number (one-based)

The number of heads per track and the number of sectors per track depends on the format of the floppy medium.

Given a logical block address, the track, head, and sector numbers can be calculated as follows:

$$Sector = (LBA \bmod SecTrk) + 1$$

$$Head = (LBA \div SecTrk) \bmod HeadTrk$$

$$Track = (LBA \div SecTrk) \div HeadTrk$$

where **mod** is the modulo or remainder function.

3.2.4 Transfer Length

The Transfer Length Field specifies the amount of data to be transferred, usually the number of blocks. For several command blocks the Transfer Length indicates the requested number of bytes to be sent as defined in the command block description. For these command blocks, the Transfer Length Field may be identified by a different name. See the following descriptions and the individual command block descriptions for further information.

In command blocks that use multiple bytes for the Transfer Length, a Transfer Length of zero indicates that no data transfer will take place. A value of one or greater indicates the number of blocks that will be transferred.

3.2.5 Parameter List Length

The Parameter List Length is used to specify the number of bytes to be sent to the UFI device. This field is typically used in command blocks for parameters that are sent to a drive (e.g. mode parameters, diagnostic parameters, etc.). A Parameter List Length of zero indicates that no data shall be transferred. This condition shall not be considered as an error.

3.2.6 Allocation Length

The Allocation Length Field specifies the maximum number of bytes that the host has allocated for returned data. An Allocation Length of zero indicates that no data shall be transferred. This condition shall not be considered as an error.

If the Allocation Length Field is non-zero, the UFI device shall terminate the data transfer when allocation length bytes have been transferred or when all available data have been transferred to the host, whichever is less. The Allocation Length is used to limit the maximum amount of data (e.g. sense data, mode data, etc.) returned to the host.

3.3 Status

The UFI device indicates the status of a command block, In-Progress, Passed, and Failed, using the status transport as defined by the transport specification.

When a command block completes, the UFI device shall record the command completion result internally as sense key information. If using the CBI Transport, the UFI device shall also queue a command completion interrupt.

The host may retrieve the sense key information with the REQUEST SENSE command block.

3.4 Immediate Command Processing Considerations

SFF-8070i defines Immediate Commands as those commands that return “preliminary” completion status to the host before they are finished executing the command.. *FORMAT UNIT* is one such example.

The USB-FDU does not support immediate commands.

3.5 UFI Command Process Flow

The UFI device processes one UFI command block at a time, in the order they are received. While one command block is being processed, the UFI device may receive or may delay the receipt of the next UFI command block. But this next UFI command block will not be processed until the previous one finishes. The exception is the *SEND DIAGNOSTICS* command block and the *CBI Command Block Reset Protocol*. See section 4.14.

After the UFI device fails a command, it shall enter the Persistent Command Block Failure state. In this state, the UFI device shall reject all command blocks, except *INQUIRY*, *REQUEST SENSE*, and *SEND DIAGNOSTIC*.

The UFI device continues in this state until the host supplies a *REQUEST SENSE* or *SEND DIAGNOSTICS* command block or performs a USB Suspend.

3.6 Aborting an UFI Command

The Host may attempt to abort an In-Progress command block using one of the following methods.

- Send a *SEND DIAGNOSTICS* command block;
- Reset the UFI device using the Reset Protocol defined by the transport specification.

4. UFI Command Descriptions

UFI command block descriptions are arranged in alphabetical order in the table below.

Table 4 - UFI Commands Supported By UFI Devices

Command Description	Code	USB Data Flow Pattern	Reference
Format Unit	04h	output	section 4.1 on page 16
Inquiry	12h	input	section 4.2 on page 19
Mode Select	55h	output	section 4.3 on page 21
Mode Sense	5Ah	input	section 4.4 on page 22
Prevent-Allow Medium Removal	1Eh	-----	section 4.6 on page 29
Read(10)	28h	input	section 4.7 on page 30
Read(12)	A8h	input	section 4.8 on page 31
Read Capacity	25h	input	section 4.9 on page 32
Read Format Capacities	23h	input	section 4.10 on page 33
Request Sense	03h	input	section 4.11 on page 37
Rezero	01h	-----	section 4.12 on page 39
Seek(10)	2Bh	-----	section 4.13 on page 40
Send Diagnostic	1Dh	-----	section 4.14 on page 41
Start-Stop Unit	1Bh	-----	section 4.15 on page 42
Test Unit Ready	00h	-----	section 4.16 on page 44
Verify	2Fh	-----	section 4.17 on page 45
Write(10)	2Ah	output	section 4.18 on page 46
Write(12)	AAh	output	section 4.19 on page 47
Write and Verify	2Eh	output	section 4.20 on page 48

4.1 FORMAT UNIT Command: 04h

The Host sends the FORMAT UNIT command to physically format one track of a diskette according to the selected options.

This is an extended command as specified by *SFF-8070i* for system floppy drives. *SFF-8070i* added a Track Number in Byte 2 of the Command Packet, and Single Track and Side bits to Byte 1 of the Defect List Header.

Table 5 - FORMAT UNIT Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (04h)							
1	Logical Unit Number			FmtData (1)	CmpList (0)	Defect List Format (7)		
2	Track Number							
3	Interleave (MSB) Interleave (LSB)							
4								
5	Reserved							
6	Reserved							
7	Parameter List Length (MSB)							
8	Parameter List Length (LSB)							
9	Reserved							
10	Reserved							
11	Reserved							

The FmtData bit shall be set to 1, the CmpList bit shall be set to 0, and the Defect List Format shall be set to 7. All other values in these fields shall cause an error with the Sense Key set to ILLEGAL REQUEST and the Sense Code set to INVALID FIELD IN COMMAND PACKET.

Track Number: This specifies which track is to be formatted. This field is valid for HD and DD single-track formats.

Interleave: This specifies the interleave that shall be used for formatting.

- 0: use the default interleave. For USB-FDU this is 1:1.
- 1: use an interleave of 1:1.

An interleave of 1 means consecutive logical blocks will be placed in contiguous ascending order.

Parameter List Length: the number of bytes in the parameter list. The host shall send the parameter list to the UFI device on the Bulk Out endpoint, after the FORMAT UNIT command has been sent. A length of zero is not an error for FORMAT UNIT commands. The parameter list length is typically 4 + 8 bytes.

4.1.1 Format Parameter List

After sending the command packet, the host shall then transfer a Format Parameter List on the Bulk Out endpoint. The Format Parameter List may consist of:

- Defect List Header + Format Descriptor

Table 6 - FORMAT UNIT (04h) Parameter List

Bit	7	6	5	4	3	2	1	0
Byte								
0-3	Defect List Header							
4-11	Format Descriptor							

Table 7 - Defect List Header

Bit	7	6	5	4	3	2	1	0
Byte								
0	Reserved							
1	FOV	Extend	DCRT	Single Track	Reserved	Immediate	Side	
2	Defect List Length (MSB) [0]							
3	Defect List Length (LSB) [8]							

The **FOV (Format Options Valid)** bit is set to one, when **DCRT** bit is set to one or **Immediate** bit is set to one.

The **Extended** bit is set to 0 .

If the **DCRT (Disable Certification)** bit is set to one, the UFI device *shall not* certify this disk (or track, if the Single Track bit is set). The UFI device does not implement certification, so this bit should always be set to one.

The **Single Track** bit, when set to one, specifies that only the track specified in the Track Number field (see Table 5) shall be formatted. This bit is only required when formatting a compatible HD or DD floppy diskette.

The **Immediate** bit specifies that this command shall return status immediately when set to one. Immediate mode is not supported by the UFI device. If this bit is set, the UFI device shall fail the command with a Check Condition, with the Sense Key set to ILLEGAL REQUEST and the Sense Code set to ILLEGAL FIELD IN PARAMETER LIST.

The **Side** bit specifies which side is to be formatted on a Single Track format. If the Side bit is set, the top side will be formatted. If the side bit is reset, the bottom side will be formatted. This bit is only required when formatting a compatible HD or DD floppy disk. (The bottom side has the smaller LBA.)

The **Defect List Length** shall be set to 8, that is, the number of bytes in the Format Descriptor. Any other value in this field shall return a Check Condition with the Sense Key set to ILLEGAL REQUEST and the Sense Code set to ILLEGAL FIELD IN PARAMETER LIST.

The **Format Descriptor** shall exactly match one of the Formattable Descriptors (see Table 35) from the Read Format Capacities command. If these numbers do not match a returned block from the Read Format Capacities command, or they specify an invalid format for the installed media, the UFI device shall return a Check Condition with the Sense Key set to ILLEGAL REQUEST and the Sense Code set to ILLEGAL FIELD IN PARAMETER LIST.

Table 8 - Format Descriptor

Byte	Bit	7	6	5	4	3	2	1	0
0		(MSB) Number of Blocks (LSB)							
1									
2									
3									
4		Reserved							
5		(MSB) Block Length (LSB)							
6									
7									

The Number of Blocks and Block Length fields specify a unique format for the installed media. These numbers shall match a returned block from the Read Format Capacities command. If these numbers do not match a returned block from the Read Format Capacities command, or they specify an invalid format for the installed media, the UFI device shall return a Check Condition with the Sense Key set to ILLEGAL REQUEST and the Sense Code set to ILLEGAL FIELD IN PARAMETER LIST.

Note: When the UFI device receives a FORMAT UNIT command with a Format Descriptor, the UFI device resets the Flexible Disk pages to reflect the received Format Descriptor.

4.1.2 Result Values

If there was no error, the FORMAT UNIT command sets the sense data to NO SENSE. Otherwise it sets the sense data to one of the values listed in section 5.

If an error occurs because of a MEDIUM ERROR, sense key of 03, the UFI device may indicate the location of the error. In this case, the Valid bit of the REQUEST SENSE DATA field may be set to one, and the Information Field set to the Logical Block Address at which the error occurred.

4.2 INQUIRY Command: 12h

The INQUIRY command requests that information regarding parameters of the UFI device itself be sent to the host. It is used by a driver on the host to ask the configuration of the UFI device, typically after power-on or hardware reset.

Table 9 - INQUIRY Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (12h)							
1	Logical Unit Number			Reserved				EVPD (0)
2	Page Code							
3	Reserved							
4	Allocation Length							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Reserved							
10	Reserved							
11	Reserved							

The EVPD (**Enable Vital Product Data**) is set to zero.

The **Logical Unit Number** field specifies the logical unit (0~7) for which Inquiry data should be returned.

The **Page Code** field specifies which page of vital product data information the UFI device shall return to the Host Computer. The UFI device supports only Page Code zero (00h), Standard Inquiry Data.

Allocation Length specifies the maximum number of bytes of inquiry data to be returned. A value of zero will not cause an error.

The UFI device shall always return the Inquiry Data, up to the number of bytes requested. The UFI device does not use the INQUIRY command to report the media status, such as media change or drive not ready. The Inquiry command shall not effect the drive unit condition or media status.

4.2.1 Standard INQUIRY Data

The UFI device shall return a standard INQUIRY data, containing 36 required bytes, on the Bulk In endpoint.

Table 10 - INQUIRY Data Format

Bit	7	6	5	4	3	2	1	0
Byte								
0	Reserved			Peripheral Device Type				
1	RMB	Reserved						
2	ISO Version		ECMA Version			ANSI Version (00h)		
3	Reserved				Response Data Format			
4	Additional Length (31)							
5	Reserved							
7								
8								
15	Vendor Information							
16	Product Identification							
31								
32								
35	Product Revision Level n.nn							

Peripheral Device Type: identifies the device currently connected to the requested logical unit.

00h Direct-access device (floppy)

1Fh none (no FDD connected to the requested logical unit)

RMB: Removable Media Bit: this shall be set to one to indicate removable media.

ISO/ECMA: These fields shall be zero for the UFI device.

ANSI Version: must contain a zero to comply with this version of the Specification.

Response Data Format: a value of 01h shall be used for UFI device

The **Additional Length** field shall specify the length in bytes of the parameters. If the Allocation Length of the Command Packet is too small to transfer all of the parameters, the Additional Length **shall not** be adjusted to reflect the truncation. The UFI device shall set this field to 1Fh.

The **Vendor Identification** field contains 8 bytes of ASCII data identifying the vendor of the product. The data shall be left aligned within this field.

The **Product Identification** field contains 16 bytes of ASCII data as defined by the vendor. The data shall be left-aligned within this field.

The **Product Revision Level** field contains 4 bytes of ASCII data as defined by the vendor. The data shall be left-aligned within this field. For a UFI device, this field indicates the firmware revision number.

4.3 MODE SELECT Command: 55h

The MODE SELECT command allows the host to specify medium or device parameters to the UFI device. The host shall issue a MODE SENSE command before each MODE SELECT, to determine the supported page, page lengths, and other parameters.

Table 11 - MODE SELECT Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (55h)							
1	Logical Unit Number			PF	Reserved			SP
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Parameter List Length (MSB)							
8	Parameter List Length (LSB)							
9	Reserved							
10	Reserved							
11	Reserved							

PF: the UFI device supports only a Page Format bit of one.

SP: Save Pages: USB-FDU does not support saving pages to non-volatile memory. If the SP bit is set to one, the command shall be terminated with an error; the sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN COMMAND PACKET.

Parameter List Length: the number of bytes in the parameter list. The Host will send the parameter list data to the UFI device on the Bulk Output endpoint, after the MODE SELECT command has been sent. A length of zero is not an error, but has no meaning for the UFI device, since it does not support Save Pages.

The parameter list format is listed in section 4.5.

Error handling shall be as specified in *SFF-8070i*.

4.4 MODE SENSE Command: 5Ah

The MODE SENSE command allows the UFI device to report medium or device parameters to the host. It is the complement of the MODE SELECT command.

Table 12 - MODE SENSE Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (5Ah)							
1	Logical Unit Number			Reserved	DBD	Reserved		
2	PC		Page Code					
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Parameter List Length (MSB)							
8	Parameter List Length (LSB)							
9	Reserved							
10	Reserved							
11	Reserved							

DBD: The **Disable Block Descriptor** is set to zero.

PC: the Page Control field specifies the type of mode parameters to return.

Table 13 - Page Control Field

Code	Type of Parameter	Reference
00b	Current values	4.4.1
01b	Changeable values	4.4.2
10b	Default values	4.4.3
11b	Saved values	4.4.4

Page Code: specifies which mode page(s) to return. Specifying 3Fh requests all mode pages. In this case, mode pages shall be returned in ascending Page Code order except for mode page 00h. See the appropriate section for a description of the mode pages.

If an unsupported page code is specified, the UFI device returns an error: CHECK CONDITION status; the sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to INVALID FIELD IN COMMAND PACKET.

Parameter List Length: the number of bytes in the buffer the host has allocated to hold the returned mode parameter list.

4.4.1 Current Values

A PC field value of 00b requests that the UFI device return the current values of the mode parameters. The current values returned are:

1. the current values of the mode parameters established by last successful MODE SELECT command;
2. the default values of the mode parameters.

4.4.2 Changeable Values

A PC field value of 01b requests that the UFI device return a mask denoting those mode parameters that are changeable. In the mask, the fields of the mode parameters that are changeable shall be set to all one bits and the fields of the mode parameters that are non-changeable (i.e. defined by the UFI device) shall be set to all zero bits.

An attempt to change a non-changeable mode parameter (via MODE SELECT) shall result in an error condition.

The host shall issue a MODE SENSE command with the PC field set to 1h and the Page Code field set to 3Fh to determine which mode pages are supported, which mode parameters within the mode pages are changeable, and the supported length of each mode page prior to issuing any MODE SELECT commands.

4.4.3 Default Values

A PC field of 10b requests that the UFI device return the default values of the mode parameters. Parameters not supported by the UFI device shall be set to zero. Default values are accessible even if the UFI device is not ready.

4.4.4 Saved Values

A PC field of 11b requests that the UFI device return the saved values of the mode parameters. Because the UFI device does not support Saved Values, the UFI device shall return an error: the command shall be terminated with CHECK CONDITION status; the sense key shall be set to ILLEGAL REQUEST and the additional sense code shall be set to SAVING PARAMETERS NOT SUPPORTED.

4.4.5 Initial Responses

After a power-up condition or hard reset condition, the UFI device shall respond in the following manner:

1. If default values are requested, the UFI device shall return the default values.
2. If saved values are requested, the UFI device shall return the valid restored mode parameters, or restore the mode parameters and report them. If the saved values of the mode parameters are not able to be accessed from the non-volatile vendor-specific location, the UFI device shall terminate the command with CHECK CONDITION status and set the sense key to NOT READY. If saved parameters are not implemented, the UFI device shall respond as defined in 4.4.4.
3. If current values are requested and the current values of the mode parameters have not been sent by the host (via a MODE SELECT command), the UFI device shall return the default values. If current values have been sent, the current values shall be reported.

4.5 Mode Select / Sense Parameters

This section explains the mode pages used with the MODE SELECT and MODE SENSE commands. The commands transfer parameter data between the host and UFI device with a parameter list. The parameter list is sent on the Bulk In or Bulk Out endpoint, depending on the MODE command.

The mode parameter pages supported by the UFI device are show below.

Table 14 - UFI Device Mode Pages

Page	Description	Number of Bytes
Header	Media Type and Write Protect	8
01h	Read-Write Error Recovery Page	12
05h	Flexible Disk Page	32
1Bh	Removable Block Access Capacities Page	12
1Ch	Timer and Protect Page	8
3Fh	Return all pages (valid only for the MODE SENSE command)	72

4.5.1 MODE Parameter List

The MODE Parameter List consists of a header, and zero or more pages. The number of bytes in the parameter list is set in the Parameter List Length field of each MODE command, as shown in Table 11 or Table 12.

The Mode Parameter List contains a header, followed by zero or more variable-length Pages.

Table 15 - Mode Parameter List

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

4.5.2 MODE Parameter Header

Table 16 - Mode Parameter Header

Bit	7	6	5	4	3	2	1	0
Byte								
0	(MSB) Mode Data Length (LSB)							
1								
2	Medium Type Code							
3	WP	Reserved		DPOFUA	Reserved			
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							

Mode Data Length: For the MODE SELECT command, the Mode Data Length field should be set to zero, otherwise an error will be reported, with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN PARAMETER LIST.

For the MODE SENSE command, the Mode Data Length field specifies the length in bytes of the following data that is available to be transferred (not including itself).

Medium Type Code: The Medium Type Code field specifies the inserted medium type. The values in this field are vendor specific, and are shown in the table below.

WP: This bit is ignored for the MODE SELECT command.

For the MODE SENSE command, a Write Protected bit of zero indicates the medium is write enabled. A Write Protect bit of one indicates the medium is write disabled.

DPOFUA: This bit should be set to zero.

4.5.3 Medium Type Codes

The UFI device supports the follow medium types.

Table 17 - Medium Type Codes

Code	Medium Type Definition					
00h	Default medium type (current mounted medium type)					
1Eh	720 KB formatted	Double-sided: DD	3.5-inch	135 tpi	1 MB unformatted	7,958 bits/radian
*93h	1.25 MB formatted	Double-sided: HD	3.5-inch	135 tpi	1.6 MB unformatted	12,362 bits/radian
*94h	1.44 MB formatted	Double-sided: HD	3.5-inch	135 tpi	2 MB unformatted	15,916 bits/radian

* these codes are UFI-specific medium types

00h: This medium type is used by the MODE SELECT command to indicate the current medium type, that is, to not change the medium type. However, the medium type will change if a different type is specified by a Flexible Disk Page 5 descriptor, or by a FORMAT UNIT command.

1Eh, 93h, 94h: A MODE SELECT command will set the specified medium type, and update the Flexible Disk Page. Detailed settings can be made by including a Flexible Disk Page descriptor with the MODE SELECT command. Flexible Disk Page settings have priority over the medium type setting.

A MODE SENSE command will return one of these values to the Host, indicating the medium type of the currently mounted diskette.

4.5.4 Read-Write Error Recovery Page (01h)

This page specifies the error recovery parameters the UFI device uses during any command that performs a read/write operation.

Table 18 - Read-Write Error Recovery Page (01h)

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

PS: Parameters Savable is not supported by USB-FDU. This bit shall always zero.

AWRE: Automatic Write Reallocation Enable is not supported by USB-FDU. This bit must be zero for MODE SELECT. This bit is returned as zero by MODE SENSE. A value of zero indicates that USB-FDU does not automatically reallocate defective bad blocks.

RC: Read Continuous is not supported by USB-FDU. This bit is always zero.

PER: Post Error: A Post Error bit of one indicates the device returns an error status at the completion of any command, when an error which has a RECOVERED ERROR sense key has occurred. A Post Error bit of zero indicates a GOOD status is returned for recovered errors (the sense key is set to NO SENSE).

Implementation note: The USB-FDU uses a retry algorithm to recover from read and write errors. Unrecovered errors cause an error status. If the error was recovered, the USB-FDU will first complete processing of the command, i.e. return all requested data read from the diskette, or write all sent data to the diskette. Then, if PER is one, the USB-FDU sets the sense key to RECOVERED ERROR to report the error, otherwise it sets the sense key to NO SENSE to ignore the error.

DCR: Disable Correction: USB-FDU does not implement error correction codes internally, so this bit is always zero.

Read Retry Count: The Read Retry Count field specifies the number of times that the Drive attempts its recovery during read operation. The maximum value of this field is set to 255.

Write Retry Count: The Write Retry Count field specifies the number of times that the Drive attempts its retry during write and verify operation for a sector.

4.5.5 Flexible Disk Page (05h)

The Flexible Disk Page specifies parameters relating to the currently installed medium type.

Table 19 - Flexible Disk Page (05h)

Byte	Bit	7	6	5	4	3	2	1	0
0		PS	Reserved	Page Code (05h)					
1		Page Length (1Eh)							
2		Transfer Rate (MSB)							
3		Transfer Rate (LSB)							
4		Number of Heads							
5		Sectors per Track							
6		Data Bytes per Sector (MSB)							
7		Data Bytes per Sector (LSB)							
8		Number of Cylinders (MSB)							
9		Number of Cylinders (LSB)							
10		Reserved							
18									
19		Motor On Delay							
20		Motor Off Delay							
21		Reserved							
27									
28		Medium Rotation Rate (MSB)							
29		Medium Rotation Rate (LSB)							
30		Reserved							
31		Reserved							

PS: Parameters Savable is not supported by USB-FDU. This bit shall always zero.

The **Transfer Rate** field shall indicate, in kilobits per second, the data rate between the Removable Direct Access Device and the installed medium type. For zoned media, this number may be an average.

Table 20 - Examples of transfer rates

Value	Transfer rate
00FAh	250 kbit/s transfer rate
012Ch	300 kbit/s transfer rate
01F4h	500 kbit/s transfer rate
03E8h	1 mbit/s transfer rate
07D0h	2 mbit/s transfer rate
1388h	5 mbit/s transfer rate

The **Number of Heads** field specifies the number of heads. USB-FDU supports only double-sided media, so this value shall always be 2.

The **Sectors per Track** field specifies the number of sectors per revolution per head. Range is 1 – 63.

The **Number of Cylinders** field specifies the number of cylinders (tracks) used for data storage.

The **Motor On Delay** field specifies, in tenths of a second, the time that the Removable Direct Access device shall wait after turning on the motor, before accessing the disk. Range is 1 – 255. On the USB-FDU, this value is fixed at 5 (0.5 seconds).

The **Motor Off Delay** field specifies, in tenths of a second, the time that the Removable Direct Access device shall wait after going idle before turning off the spindle motor. A value of FFh indicates that the motor **shall not** turn off. In this case, the motor will be turned off in response to a START STOP command. On the USB-FDU, this value is fixed at 30 (3 seconds).

The **Medium Rotation Rate** field indicates the speed at which the medium rotates. The unit of measure is rotations per minute (rpm). The USB-FDU supports rates of 300 and 360.

4.5.6 Removable Block Access Capabilities Page (1Bh)

This page defines the capabilities of devices covered by this specification.

Table 21 - Removable Block Access Capabilities Page (1Bh)

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

PS: Parameters Savable is not supported by USB-FDU. This bit shall always zero.

SFLP: System Floppy Type device. If this bit is one, it indicates the device can be used as a system floppy device.

SRFP: Supports Reporting Format Progress via the REQUEST SENSE command. This feature is not supported by USB-FDU, so this bit is always zero.

NCD: Non-CD optical device: This bit is always zero for USB-FDU.

SML: Single/Multiple LUN supported: USB-FDU is not a phase change dual device, so this bit is always zero.

TLUN: The total number of logical units supported by this device. USB-FDU reports one.

4.5.7 Timer and Protect Page (1Ch)

This page defines the capabilities of devices covered by this specification.

Table 22 - Timer and Protect Page (1Bh)

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

PS: Parameters Savable is not supported by USB-FDU. This bit shall always be zero.

Inactivity Time Multiplier: specifies the length of time the device remains in the current state after the completion of a seek, read, or write operation.

DISP: Disable Media Access until Power cycle: reserved; not supported by the USB-FDU.

SWPP: Software Write Protect until Power cycle: reserved; not supported by the USB-FDU.

Table 23 - Inactivity Time Multiplier Values

Inactivity Timer Multiplier	Minimum Time in Current State	Inactivity Timer Multiplier	Minimum Time in Current State
0h	Infinite	8h	16 s
1h	125 ms	9h	32 s
2h	250 ms	Ah	1 min
3h	500 ms	Bh	2 min
4h	1 s	Ch	4 min
5h	2 s	Dh	8 min
6h	4 s	Eh	16 min
7h	8 s	Fh	32 min

For the USB-FDU, the Inactivity Time Multiplier is fixed at 5h, and cannot be changed.

4.6 PREVENT-ALLOW MEDIUM REMOVAL Command: 1Eh

This command tells the UFI device to enable or disable the removal of the medium in the logical unit.

Table 24 - PREVENT-ALLOW MEDIUM REMOVAL Command

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

Prevent: prevent media removal flag

- 0 enable (allow) the removal of the medium
- 1 disable (prevent) removal of the medium

If the UFI device supports no locking mechanism, the medium is always unlocked. In this case, an ALLOW (Prevent = 0) command will complete successfully with a sense key of NO SENSE. However, a PREVENT (Prevent = 1) command will result in an error status, with a sense key of ILLEGAL REQUEST and an additional sense code set to INVALID FIELD IN COMMAND PACKET.

4.7 READ(10) Command: 28h

The READ(10) command requests that the UFI device transfer data to the host. The most recent data value written in the addressed logical block shall be returned.

See section 4.8 “READ(12) Command: A8h” on page 31 for a definition of the operation of this command.

Table 25 - READ(10) Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (28h)							
1	Logical Unit Number			DPO	FUA	Reserved		RelAdr
2	(MSB) Logical Block Address <							

DPO: This bit should be set to zero.

FUA: This bit should be set zero.

RelAdr: This bit should be set to zero.

4.8 READ(12) Command: A8h

The READ(12) command requests that the UFI device transfer data to the host. The most recent data value written in the addressed logical block on the medium shall be returned. The data is returned on the Bulk In endpoint.

Compared to the READ(10) command, the Transfer Length has been expanded into a 32-bit value.

Table 26 - READ(12) Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (A8h)							
1	Logical Unit Number			DPO	FUA	Reserved		RelAdr
2	(MSB) Logical Block Address 							

DPO: This bit should be set zero.

FUA: This bit should be set to zero.

RelAdr: This bit should be set to zero.

The **Logical Block Address** field specifies the logical block at which the read operation shall begin.

The **Transfer Length** field specifies the number of contiguous logical blocks of data that shall be transferred. A Transfer Length of zero indicates that no logical blocks shall be transferred. This condition **shall not** be considered an error. Any other value indicates the number of logical blocks that shall be transferred.

Description

Upon acceptance for this command, the UFI device attempts to read the data from the diskette at the specified address. The UFI device shall perform motor drive control automatically as necessary (start and stop). The drive heads will also be moved automatically if necessary (implied seek).

Should an error occur, the UFI device will retry and attempt to recover the data as appropriate. Retry and recovery options can be specified via MODE SELECT, Read-Write Error Recovery Page (01).

Outputs

The UFI device returns the read data to the host on the Bulk In endpoint, if there was no hard error. Otherwise only a partial amount of data or nothing may be returned.

Result Status

Upon successful completion, the UFI device shall set the sense data to NO SENSE.

If the command block fails, the device shall set the sense data to an appropriate value as listed in section 5. The UFI device may fail the command block even though all requested data is sent to the host.

4.9 READ CAPACITY Command: 25h

The READ CAPACITY command allows the host to request capacities of the currently installed medium.

Table 27 - READ CAPACITY Command

Byte	Bit	7	6	5	4	3	2	1	0
0		Operation Code (25h)							
1		Logical Unit Number			Reserved				RelAdr
2		(MSB) Logical Block Address (LSB)							
3									
4									
5									
6									
6		Reserved							
7		Reserved							
8		Reserved							PMI
9		Reserved							
10		Reserved							
11		Reserved							

RelAdr: This bit should be set to zero.

Logical Block Address should be set to zero.

PMI: This bit should be set to zero.

If the UFI device recognizes the formatted medium, the UFI device returns a **READ CAPACITY Data** to the host on the Bulk In endpoint. The UFI device sets the sense key to NO SENSE. if the command block Passed.

If the medium is unformatted, unknown, or not presented, the UFI device fails the command block and sets the sense key to an appropriate value as listed in section 5.

Table 28 - READ CAPACITY Data

Byte	Bit	7	6	5	4	3	2	1	0
0		(MSB) Last Logical Block Address (LSB)							
1									
2									
3									
4		(MSB) Block Length In Bytes (LSB)							
5									
6									
7									

The **Last Logical Block Address** field holds the last valid LBA for use with media access commands.

The **Block Length In Bytes** field specifies the length in bytes of each logical block for the given capacity descriptor.

4.10 READ FORMAT CAPACITIES Command: 23h

The READ FORMAT CAPACITIES command allows the host to request a list of the possible capacities that can be formatted on the currently installed medium. If no medium is currently installed, the UFI device shall return the maximum capacity that can be formatted by the device.

Table 29 - READ FORMAT CAPACITIES Command

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

Allocation Length: specifies the maximum number of bytes of format data the Host can receive. If this is less than the size of capacity data, the UFI device returns only the number of bytes requested. However, the UFI device **shall not** adjust the Capacity List Length in the format data to reflect truncation.

4.10.1 Capacity List

Upon receipt of this command block, the UFI device returns a Capacity List to the host on the Bulk In endpoint.

- No media in FDU: Capacity List Header + Maximum Capacity Header
- Media in FDU: Capacity List Header + Current Capacity Header + Formattable Capacity Descriptors

Table 30 - Capacity List

Bit	7	6	5	4	3	2	1	0
Byte								
	Capacity List Header							
	Current/Maximum Capacity Header							
	Formattable Capacity Descriptor(s) (if any)							
0	Formattable Capacity Descriptor 0							
7								
0	Formattable Capacity Descriptor x							
7								

The Capacity List Header gives the length of the descriptor data to follow.

Table 31 - Capacity List Header

Bit	7	6	5	4	3	2	1	0
Byte								
0	Reserved							
1	Reserved							
2	Reserved							
3	Capacity List Length							

The **Capacity List Length** field specifies the length in bytes of the Capacity Descriptors that follow. Each Capacity Descriptor is eight bytes in length, making the Capacity List Length equal to eight times the number of descriptors.

The Current/Maximum Capacity Descriptor describes the current medium capacity if media is mounted in the UFI device and the format is known, else the maximum capacity that can be formatted by the UFI device if no media is mounted, or if the mounted media is unformatted, or if the format of the mounted media is unknown.

Table 32 - Current/Maximum Capacity Descriptor

Bit	7	6	5	4	3	2	1	0
Byte								
0	(MSB) Number of Blocks 							

The **Number of Blocks** field indicates the total number of addressable blocks for the descriptor's media type.

The **Descriptor Code** field specifies the type of descriptor returned to the Host.

Table 33 - Descriptor Code definition

Descriptor Code	Descriptor Type
01b	Unformatted Media - Maximum formattable capacity for this cartridge
10b	Formatted Media - Current media capacity
11b	No Cartridge in Drive - Maximum formattable capacity for any cartridge

Table 34 - Formattable Capacity Descriptor

Bit	7	6	5	4	3	2	1	0
Byte								
0	(MSB) Number of Blocks (LSB)							
1								
2								
3								
4	Reserved							
5	(MSB) Block Length (LSB)							
6								
7								

The **Number of Blocks** field indicates the maximum (or fixed) number of addressable blocks for the given capacity descriptor.

The **Block Length** specifies the length in bytes of each logical block for the given capacity descriptor.

4.10.2 Formattable Capacity Descriptors

The UFI device supports the following capacity descriptors.

Table 35 - Capacity Descriptors Supported by USB-FDU

Medium	Medium Type Code	Formatted Capacity	Tracks	Heads	Sectors/Track	Total Blocks		Block Length	
DD	1Eh	720 KB	80	2	9	1440	05A0h	512	0200h
HD	93h	1.25 MB	77	2	8	1232	04D0h	1024	0400h
	94h	1.44 MB	80	2	18	2880	0B40h	512	0200h

If there is no medium in the FDU, the UFI device returns only the Capacity List Header and a Maximum Capacity Descriptor denoting the 1.44 MB format.

Table 36 - Maximum Capacity Descriptor Example (No Medium)

Byte	0	1	2	3	4	5	6	7	8	9	10	11
Field	Capacity List Header				Maximum Capacity Descriptor							
				Length	Number of Blocks				Desc Type	Block Length		
Value	00h	00h	00h	08h	00h	00h	0Bh	40h	03h	00h	02h	00h

The device **shall not** return Formattable Capacity Descriptors for formats that it is capable of reading, but not formatting.

Table 37 - Format Capacity Descriptors Returned by USB-FDU

Medium	Condition	Medium Type	Returned Data	Descriptor Type	Returned FCDs
None	None		CLH + MCD	11b	
DD	unformatted		CLH + MCD	01b	
	current	1Eh	CLH + MCD + FCD(2)	10b	720 KB
HD	unformatted		CLH + MCD	01b	
	current	93h	CLH + MCD + FCD(3)	10b	1.25 MB
		94h			1.44 MB

Note: if the current medium is formatted but the UFI device cannot read it, the UFI device will report that the medium is unformatted. If the medium is readable with a valid BPB, the UFI device will report Formatted Media, with a block count and length based on the BPB information.

4.11 REQUEST SENSE Command: 03h

The REQUEST SENSE command instructs the UFI device to transfer sense data to the host for the specified logical unit. The sense data for the previous UFI command block is returned via the Bulk In endpoint.

The host should issue a REQUEST SENSE command after every UFI command block to receive the resulting sense data, in order to determine if an error occurred or not. If the Host issues another UFI command block instead, the sense data for the previous UFI command will be lost (overwritten).

Table 38 - REQUEST SENSE Command

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

Allocation Length: specifies the maximum number of bytes of sense data the host can receive. If this is less than the size of sense data, the UFI device shall return only the number of bytes requested. However, UFI device **shall not** adjust the Additional Sense Length in the sense data to reflect truncation if the Allocation Length is less than the sense data available.

Description

After the processing of each command block, the UFI device sets the sense data to indicate the execution result. The sense data is output to the host in a Request Sense Standard Data Block by the UFI device in response to a REQUEST SENSE command block.

The UFI device shall preserve the sense data until it is overwritten by the execution result of the next command block. The UFI device **shall not** change the sense data upon completion of the REQUEST SENSE command block.

Persistent Command Block Failure and UNIT ATTENTION conditions, such as media change or power on reset, shall be cleared by the UFI device when retrieved by a REQUEST SENSE command block.

If the UFI device receives a REQUEST SENSE command while an command block is still executing, the UFI device shall first finish execution of the current command block, then process the REQUEST SENSE command.

Outputs

The UFI device returns 18 bytes of sense data in response to a REQUEST SENSE command.

Table 39 - Request Sense Standard Data

Byte	Bit	7	6	5	4	3	2	1	0
0		Valid	Error Code (70h)						
1		Reserved							
2		Reserved				Sense Key			
3		(MSB) Information (LSB)							
4									
5									
6									
7		Additional Sense Length (10)							
8		Reserved							
9									
10									
11									
12		Additional Sense Code (Mandatory)							
13		Additional Sense Code Qualifier (Mandatory)							
14		Reserved							
15		Reserved							
16									
17									

Error Code: this field shall contain a value of 70h to indicate current errors.

Valid: A Valid bit of zero indicates that the Information field is not as defined in this Specification. A Valid bit of one indicates that the Information field contains valid information as defined in this Specification.

Sense Key, Additional Sense Code, and Additional Sense Code Qualifier provide a hierarchy of error or command result information. The values returned in these fields by the UFI device are those set by the previous UFI command block. A summary of these values is given in section 5

Information: This field is command-specific; it is typically used by some commands to return a logical block address denoting where an error occurred. If this field has a value, the Valid bit shall be set to one.

Additional Sense Length: the UFI device sets the value of this field to ten, to indicate that ten more bytes of sense data follow this field.

Result Values

None.

4.12 REZERO UNIT Command: 01h

The REZERO UNIT command positions the head of the drive to the cylinder 0 .

Table 40 - REQUEST SENSE Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (01h)							
1	Logical Unit Number			Reserved				
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Reserved							
10	Reserved							
11	Reserved							

Description

When the UFI device processes this REZERO UNIT command block, the UFI device moves the head of its drive to cylinder 0.

This command exists for command compatibility, therefore the UFI device may return Passed status without attempting any action.

4.13 SEEK Command: 2Bh

The SEEK command requests that the UFI device seek to the specified Logical Block Address. The content of the sector at the specified LBA **shall not** affect the seek operation nor cause an error to be generated.

Table 41 - SEEK Command

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

Description

The UFI device moves its drive heads to the specified logical address. The UFI device automatically starts and stops the drive motor as needed.

The UFI device shall implement implied seeks for other disk access command blocks (READ, WRITE, FORMAT UNIT, etc.), to automatically move the disk heads to the specified logical block address. Therefore, use of the SEEK command by the host is not mandatory on the UFI device.

Result Values

If the SEEK command block completes successfully, the UFI device shall set the sense data to NO SENSE. Otherwise the device shall set the sense data to an appropriate value as listed in section 5.

4.14 SEND DIAGNOSTIC Command: 1Dh

The SEND DIAGNOSTIC command requests the UFI device to do a reset or perform a self-test.

Table 42 - SEND DIAGNOSTIC Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (1Dh)							
1	Logical Unit Number			PF	Reserved	SelfTest	DefOfI	UnitOfI
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Reserved							
8	Reserved							
9	Reserved							
10	Reserved							
11	Reserved							

SelfTest: 0 = perform special diagnostic test; 1 = perform default self-test;
Support for and the contents of any special diagnostic test is vendor-specific.

The UFI device requires the Logical Unit Number to indicate a supported logical unit.

A UFI device may interpret a SEND DIAGNOSTICS command block of the following format as a CBI Command Block Reset:

1Dh 04h 00h 00h 00h 00h ...

4.15 START-STOP UNIT Command: 1Bh

The START-STOP UNIT command instructs the UFI device to enable or disable media access operations.

Table 43 - START-STOP UNIT Command

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

IMMED: The Immediate bit: ignored by the USB-FDU.

Start: A Start bit of one instructs the UFI device to enable media access operations. A Start bit of zero instructs the UFI device to disable media access operations.

LoEj: A Load Eject (LoEj) bit of zero requests that no eject action be performed. A LoEj bit of one, with the Start bit cleared to zero, instructs the UFI device to eject the media.

Description

This command can be used by the host to update the media type and the write protect status.

The START/STOP commands are not interpreted by the USB-FDU as a master disk access enable/disable. The USB-FDU allows access to the disk, even if no START command is received. Similarly, the USB-FDU does not forbid access to the disk, even if a STOP command is received.

The Start and LoEj bits combine to specify the operation to be performed, as summarized in Table 44 below.

Table 44 - Start-Stop and Eject Operations

LoEj	Start	Operation to be Performed	USB-FDU
0	0	Stop the media	motor off
0	1	Start the media and acquire the format type	motor on; determine medium type
1	0	Eject the media if possible	ILLEGAL REQUEST
1	1	Reserved	ILLEGAL REQUEST

Stop: The USB-FDU turns off the drive motor, if it is currently on, without waiting for the motor off delay timer to time out. If the drive motor is already off, then the USB-FDU does nothing.

Start: The USB-FDU turns on the drive motor, and attempts to determine the media type, if it has not already been determined. If the media type has changed, the FLEXIBLE DISK PAGE (05) is updated according to the new media type. The write protect state is also updated.

If the motor off delay timer times out, the USB-FDU shall turn off the drive motor, whether a stop command is pending or not.

Eject: The USB-FDU does not support Eject capability. The USB-FDU shall flag the command as an error, by setting the sense key to ILLEGAL REQUEST and the additional sense code to ILLEGAL FIELD IN COMMAND PACKET. However, no endpoint shall be stalled.

4.15.1 Motor On/Off

Being an intelligent device, the UFI device controls the drive motor automatically by itself. For example, before doing a read, the UFI device will turn on the drive motor, seek to the required logical block, perform the read, and finally turn off the drive motor after a certain delay.

The UFI device will turn on the drive motor in response to a Start command, and turn off the drive motor in response to a Stop command. However, the UFI device shall also turn off the drive motor when the motor off delay time has lapsed, even if the drive motor was turned on in response to a Start command.

4.16 TEST UNIT READY Command: 00h

The TEST UNIT READY command provides a means to check if the UFI device is ready. This is not a request for a self-test. If the UFI device would accept an appropriate medium-access command without returning CHECK CONDITION status, this command shall return a GOOD status. If the UFI device cannot become operational or is in a state such that a host action is required to make the UFI device ready, the UFI device shall return CHECK CONDITION status with a sense key of NOT READY.

Table 45 - TEST UNIT READY Command

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

The UFI device may fail a TEST UNIT READY command with a sense key of NOT READY and an Additional Sense Code of LOGICAL DRIVE NOT READY – INITIALIZATION REQUIRED. After clearing the error, the host should try issuing a START command block.

4.17 VERIFY Command: 2Fh

The VERIFY command requests that the UFI device verify the data on the medium.

Table 46 - VERIFY Command

Byte	Bit	7	6	5	4	3	2	1	0
0		Operation Code (2Fh)							
1		Logical Unit Number			DPO	Reserved	Reserved	ByteChk	RelAdr
2		(MSB) Logical Block Address (LSB)							
3									
4									
5									
6		Reserved							
7		(MSB) Verification Length (LSB)							
8									
9									
10									
11		Reserved							

DPO: This bit should be set to zero.

ByteChk: This bit should set to zero. The USB-FDU only checks the CRC data on the medium, with no data comparison.

RelAdr: This bit should be set to zero

Logical Block Address: This field specifies the logical block at which the verification operation shall begin.

Verification Length: The Verification Length field specifies the number of contiguous logical blocks of data to be verified. A Verification Length of zero indicates that no logical blocks will be verified. This condition will not be considered an error and no data will be verified. Any other value indicates the number of logical blocks that will be verified.

Result Values

If the VERIFY command completes successfully, the UFI device shall set the sense data to NO SENSE. Otherwise the device shall set the sense data to an appropriate value as listed in section 5.

If the VERIFY command is aborted because of a USB bit stuffing error or CRC error, the UFI device shall set the sense data to USB TO HOST SYSTEM INTERFACE FAILURE.

4.18 WRITE(10) Command: 2Ah

The WRITE(10) command requests that the UFI device write the data transferred by the host to the medium.

See section 4.19 “WRITE(12) Command: AAh” on page 47 for a definition of the operation of this command.

Table 47 - WRITE(10) Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (2Ah)							
1	Logical Unit Number			DPO	FUA	Reserved		RelAdr
2	(MSB) Logical Block Address 							

DPO: This bit should be set to zero.

FUA: This bit should be set to zero.

RelAdr: This bit should be set to zero.

4.19 WRITE(12) Command: AAh

The WRITE(12) command requests that the UFI device write the data transferred by the host to the medium.

Table 48 - WRITE (12) Command

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (AAh)							
1	Logical Unit Number			DPO	FUA	Reserved		RelAdr
2	(MSB) Logical Block Address							
3								
4								
5								
6	(LSB)							
7	(MSB) Transfer Length							
8								
9								
10								
11	(LSB)							
10	Reserved							
11	Reserved							

DPO: This bit should be set to zero.

FUA: This bit should be set to zero.

RelAdr: This bit should be set to zero.

Logical Block Address: This field specifies the logical block at which the write operation shall begin.

Transfer Length: The Transfer Length field specifies the number of contiguous logical blocks of data that shall be transferred. A Transfer Length of zero indicates that no logical blocks shall be transferred. This condition **shall not** be considered an error and no data shall be written. Any other value indicates the number of logical blocks that shall be transferred.

The host sends the data to be written to the UFI device on the Bulk Output endpoint. The number of bytes transferred shall be the Transfer Length times the Logical Block Size.

If the WRITE command completes successfully, the UFI device shall set the sense data to NO SENSE. Otherwise the device shall set the sense data to an appropriate value as listed in section 5.

If the WRITE command is aborted because of a USB bit stuffing error or CRC error, the UFI device shall set the sense data to USB TO HOST SYSTEM INTERFACE FAILURE.

Note: the medium may have been altered, even if a write error occurs. This is especially true for command blocks which span more than one physical track of the diskette.

4.20 WRITE AND VERIFY Command: 2Eh

The WRITE AND VERIFY command requests that the UFI device write the data transferred by the host to the medium, then verify the data on the medium .

Table 49 - WRITE AND VERIFY Command

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

DPO: This bit should be set to zero.

ByteChk: This bit should set to zero.

RelAdr: This bit should be set to zero

Logical Block Address: This field specifies the logical block at which the write operation shall begin.

Transfer Length: The Transfer Length field specifies the number of contiguous logical blocks of data that shall be transferred. A Transfer Length of zero indicates that no logical blocks shall be transferred. This condition **shall not** be considered an error and no data shall be written and verified . Any other value indicates the number of logical blocks that shall be transferred.

The host sends the data to be written to the UFI device on the Bulk Out endpoint. The number of bytes transferred shall be the Transfer Length times the Logical Block Size.

If the WRITE AND VERIFY command completes successfully, the UFI device shall set the sense data to NO SENSE. Otherwise the device shall set the sense data to an appropriate value as listed in section 5.

If the WRITE AND VERIFY command is aborted because of a USB bit stuffing error or CRC error, the UFI device shall set the sense data to USB TO HOST SYSTEM INTERFACE FAILURE.

Note: the medium may have been altered, even if a write error occurs. This is especially true for commands which span more than one physical track of the diskette.

5. Sense Data

The UFI device stores the execution result status of every command block as Sense Data. Sense Data is returned to the host by the REQUEST SENSE command.

Sense Data consists of three levels of error codes of increasing detail. The intention is to provide a top-down approach for a host to determine information relating to the error and exception conditions. The Sense Key provides generic categories in which error and exception conditions can be reported. Hosts would typically use sense keys for high-level error recovery procedures. Additional Sense Codes provide further detail describing the sense key. Additional Sense Code Qualifiers add further detail to the additional sense code. The Additional Sense Code and Additional Sense Code Qualifier can be used by hosts where sophisticated error recovery procedures require detailed information describing the error and exception conditions.

Table 50 - Sense Key Descriptions

Sense Key	Description
0h	NO SENSE. Indicates that there is no specific sense key information to be reported. This would be the case for a successful command.
1h	RECOVERED ERROR. Indicates that the last command completed successfully with some recovery action performed by the UFI device. Details may be determinable by examining the additional sense bytes and the Information field. When multiple recovered errors occur during one command, the choice of which error to report is device specific.
2h	NOT READY. Indicates that the UFI device cannot be accessed. Operator intervention may be required to correct this condition.
3h	MEDIUM ERROR. Indicates that the command terminated with a non-recovered error condition that was probably caused by a flaw in the medium or an error in the recorded data. This sense key may also be returned if the UFI device is unable to distinguish between a flaw in the medium and a specific hardware failure (sense key 4h).
4h	HARDWARE ERROR. Indicates that the UFI device detected a non-recoverable hardware failure while performing the command or during a self test.
5h	ILLEGAL REQUEST. Indicates that there was an illegal parameter in the Command Packet or in the additional parameters supplied as data for some commands. If the UFI device detects an invalid parameter in the Command Packet, then it shall terminate the command without altering the medium. If the UFI device detects an invalid parameter in the additional parameters supplied as data, then the UFI device may have already altered the medium.
6h	UNIT ATTENTION. Indicates that the removable medium may have been changed or the UFI device has been reset.
7h	DATA PROTECT. Indicates that a command that writes the medium was attempted on a block that is protected from this operation. The write operation was not performed.
8h	BLANK CHECK. Indicates that a write-once device or a sequential-access device encountered blank medium or format-defined end-of-data indication while reading or a write-once device encountered a non-blank medium while writing.
9h	Vendor Specific. This sense key is available for reporting vendor specific conditions.
Ah	Reserved
Bh	ABORTED COMMAND. Indicates that the UFI device has aborted the command. The host may be able to recover by trying the command again.

Sense Key	Description
Ch	Reserved
Dh	VOLUME OVERFLOW. Indicates that a buffered peripheral device has reached the end-of-partition and data may remain in the buffer that has not been written to the medium.
Eh	MISCOMPARE. Indicates that the source data did not match the data read from the medium.
Fh	Reserved

The Additional Sense Code (ASC) field indicates further information related to the error or exception condition reported in the Sense Key field. Support of the Additional Sense Codes not explicitly required by this Specification is optional. See the appropriate section for a list of Additional Sense. If the UFI device does not have further information related to the error or exception condition, the Additional Sense Code is set to NO ADDITIONAL SENSE INFORMATION.

The Additional Sense Code Qualifier (ASCQ) indicates detailed information related to the Additional Sense Code. The ASCQ is optional. If the error or exception condition is reportable by the UFI device, the value returned shall be as specified in the appropriate section. If the UFI device does not have detailed information related to the error or exception condition, the ASCQ shall be set to zero.

The Additional Sense Bytes field may contain command specific data, peripheral device specific data, or vendor specific data that further defines the nature of the CHECK CONDITION status.

The following table includes all suggested Sense Key, ASC, and ASCQ for all commands.

Table 51 - Sense Keys, ASC/ASCQ Listing for All Commands (sorted by Key)

Sense Key	ASC	ASCQ	Description of Error
00	00	00	NO SENSE
01	17	01	RECOVERED DATA WITH RETRIES
01	18	00	RECOVERED DATA WITH ECC
02	04	01	LOGICAL DRIVE NOT READY - BECOMING READY
02	04	02	LOGICAL DRIVE NOT READY - INITIALIZATION REQUIRED
02	04	04	LOGICAL UNIT NOT READY - FORMAT IN PROGRESS
02	04	FF	LOGICAL DRIVE NOT READY - DEVICE IS BUSY
02	06	00	NO REFERENCE POSITION FOUND
02	08	00	LOGICAL UNIT COMMUNICATION FAILURE
02	08	01	LOGICAL UNIT COMMUNICATION TIME-OUT
02	08	80	LOGICAL UNIT COMMUNICATION OVERRUN
02	3A	00	MEDIUM NOT PRESENT
02	54	00	USB TO HOST SYSTEM INTERFACE FAILURE
02	80	00	INSUFFICIENT RESOURCES
02	FF	FF	UNKNOWN ERROR
03	02	00	NO SEEK COMPLETE
03	03	00	WRITE FAULT
03	10	00	ID CRC ERROR
03	11	00	UNRECOVERED READ ERROR
03	12	00	ADDRESS MARK NOT FOUND FOR ID FIELD
03	13	00	ADDRESS MARK NOT FOUND FOR DATA FIELD
03	14	00	RECORDED ENTITY NOT FOUND
03	30	01	CANNOT READ MEDIUM - UNKNOWN FORMAT
03	31	01	FORMAT COMMAND FAILED
04	40	NN	DIAGNOSTIC FAILURE ON COMPONENT NN (80H-FFH)
05	1A	00	PARAMETER LIST LENGTH ERROR
05	20	00	INVALID COMMAND OPERATION CODE
05	21	00	LOGICAL BLOCK ADDRESS OUT OF RANGE
05	24	00	INVALID FIELD IN COMMAND PACKET
05	25	00	LOGICAL UNIT NOT SUPPORTED
05	26	00	INVALID FIELD IN PARAMETER LIST
05	26	01	PARAMETER NOT SUPPORTED
05	26	02	PARAMETER VALUE INVALID
05	39	00	SAVING PARAMETERS NOT SUPPORT
06	28	00	NOT READY TO READY TRANSITION - MEDIA CHANGED
06	29	00	POWER ON RESET OR BUS DEVICE RESET OCCURRED
06	2F	00	COMMANDS CLEARED BY ANOTHER INITIATOR
07	27	00	WRITE PROTECTED MEDIA
0B	4E	00	OVERLAPPED COMMAND ATTEMPTED

Table 52 - Sense Keys, ASC/ASCQ Listing for All Commands (sorted by ASC)

Sense Key	ASC	ASCQ	Description of Error
00	00	00	NO SENSE
03	02	00	NO SEEK COMPLETE
03	03	00	WRITE FAULT
02	04	01	LOGICAL DRIVE NOT READY - BECOMING READY
02	04	02	LOGICAL DRIVE NOT READY - INITIALIZATION REQUIRED
02	04	04	LOGICAL DRIVE NOT READY - FORMAT IN PROGRESS
02	04	FF	LOGICAL DRIVE NOT READY - DEVICE IS BUSY
02	06	00	NO REFERENCE POSITION FOUND
02	08	00	LOGICAL UNIT COMMUNICATION FAILURE
02	08	01	LOGICAL UNIT COMMUNICATION TIME-OUT
02	08	80	LOGICAL UNIT COMMUNICATION OVERRUN
03	10	00	ID CRC ERROR
03	11	00	UNRECOVERED READ ERROR
03	12	00	ADDRESS MARK NOT FOUND FOR ID FIELD
03	13	00	ADDRESS MARK NOT FOUND FOR DATA FIELD
03	14	00	RECORDED ENTITY NOT FOUND
01	17	01	RECOVERED DATA WITH RETRIES
01	18	00	RECOVERED DATA WITH ECC
05	1A	00	PARAMETER LIST LENGTH ERROR
05	20	00	INVALID COMMAND OPERATION CODE
05	21	00	LOGICAL BLOCK ADDRESS OUT OF RANGE
05	24	00	INVALID FIELD IN COMMAND PACKET
05	25	00	LOGICAL UNIT NOT SUPPORTED
05	26	00	INVALID FIELD IN PARAMETER LIST
05	26	01	PARAMETER NOT SUPPORTED
05	26	02	PARAMETER VALUE INVALID
07	27	00	WRITE PROTECTED MEDIA
06	28	00	NOT READY TO READY TRANSITION - MEDIA CHANGED
06	29	00	POWER ON RESET OR BUS DEVICE RESET OCCURRED
06	2F	00	COMMANDS CLEARED BY ANOTHER INITIATOR
03	30	01	CANNOT READ MEDIUM - UNKNOWN FORMAT
03	31	01	FORMAT COMMAND FAILED
05	39	00	SAVING PARAMETERS NOT SUPPORT
02	3A	00	MEDIUM NOT PRESENT
04	40	NN	DIAGNOSTIC FAILURE ON COMPONENT NN (80H-FFH)
0B	4E	00	OVERLAPPED COMMAND ATTEMPTED
02	54	00	USB TO HOST SYSTEM INTERFACE FAILURE
02	80	00	INSUFFICIENT RESOURCES
02	FF	FF	UNKNOWN ERROR

Table 53 - Sense Keys, ASC/ASCQ Listing for All Commands (sorted by Description)

Sense Key	ASC	ASCQ	Description of Error
03	13	00	ADDRESS MARK NOT FOUND FOR DATA FIELD
03	12	00	ADDRESS MARK NOT FOUND FOR ID FIELD
03	30	01	CANNOT READ MEDIUM - UNKNOWN FORMAT
06	2F	00	COMMANDS CLEARED BY ANOTHER INITIATOR
04	40	NN	DIAGNOSTIC FAILURE ON COMPONENT NN (80H-FFH)
03	31	01	FORMAT COMMAND FAILED
03	10	00	ID CRC ERROR
02	80	00	INSUFFICIENT RESOURCES
05	20	00	INVALID COMMAND OPERATION CODE
05	24	00	INVALID FIELD IN COMMAND PACKET
05	26	00	INVALID FIELD IN PARAMETER LIST
05	21	00	LOGICAL BLOCK ADDRESS OUT OF RANGE
02	04	01	LOGICAL DRIVE NOT READY - BECOMING READY
02	04	FF	LOGICAL DRIVE NOT READY - DEVICE IS BUSY
02	04	04	LOGICAL UNIT NOT READY - FORMAT IN PROGRESS
02	04	02	LOGICAL DRIVE NOT READY - INITIALIZATION REQUIRED
02	08	00	LOGICAL UNIT COMMUNICATION FAILURE
02	08	80	LOGICAL UNIT COMMUNICATION OVERRUN
02	08	01	LOGICAL UNIT COMMUNICATION TIME-OUT
05	25	00	LOGICAL UNIT NOT SUPPORTED
02	3A	00	MEDIUM NOT PRESENT
02	06	00	NO REFERENCE POSITION FOUND
03	02	00	NO SEEK COMPLETE
00	00	00	NO SENSE
06	28	00	NOT READY TO READY TRANSITION - MEDIA CHANGED
0B	4E	00	OVERLAPPED COMMAND ATTEMPTED
05	1A	00	PARAMETER LIST LENGTH ERROR
05	26	01	PARAMETER NOT SUPPORTED
05	26	02	PARAMETER VALUE INVALID
06	29	00	POWER ON RESET OR BUS DEVICE RESET OCCURRED
03	14	00	RECORDED ENTITY NOT FOUND
01	18	00	RECOVERED DATA WITH ECC
01	17	01	RECOVERED DATA WITH RETRIES
05	39	00	SAVING PARAMETERS NOT SUPPORT
02	FF	FF	UNKNOWN ERROR
03	11	00	UNRECOVERED READ ERROR
02	54	00	USB TO HOST SYSTEM INTERFACE FAILURE
03	03	00	WRITE FAULT
07	27	00	WRITE PROTECTED MEDIA