SFF specifications are available at http://www.snia.org/sff/specifications
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**This specification was developed by the SFF Committee prior to it becoming the SFF TA (Technology Affiliate) TWG (Technical Working Group) of SNIA (Storage Networking Industry Association).**


The information below should be used instead of the equivalent herein.

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                              Email: SFF-Chair@snia.org


If you are interested in participating in the activities of the SFF TWG, the membership application can be found at:
                    http://www.snia.org/sff/join

The complete list of SFF Specifications which have been completed or are currently being worked on can be found at:
                    http://www.snia.org/sff/specifications/SFF-8000.TXT

The operations which complement the SNIA's TWG Policies & Procedures to guide the SFF TWG can be found at:
                    http://www.snia.org/sff/specifications/SFF-8032.PDF


Suggestions for improvement of this specification will be welcome, they should be submitted to:
                    http://www.snia.org/feedback

**SFF Committee**

SFF-8070i Specification for

**ATAPI Removable Rewritable Media Devices**

Rev 1.3        July 5, 2001

Secretariat:  SFF Committee

Abstract:  This specification describes the ATAPI (AT Attachment Packet Interface) for Removable, Rewritable Media. Any questions should be addressed to the Technical Editors.

Information Specifications are not developed or endorsed by the SFF Committee but were submitted for distribution on the basis that they are of interest to the storage industry. If the members agree, then the document is distributed by the SFF. The copyright on the contents remains with the contributor.

Contributors are not required to abide by the SFF patent policy. Readers are advised of the possibility that there may be patent issues associated with an implementation which relies upon the contents of an 'i' specification.

SFF accepts no responsibility for the validity of the contents.

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**EXPRESSION OF SUPPORT BY MANUFACTURERS**


The following member companies of the SFF Committee voted in favor of
this industry specification.

            Amphenol
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            DDK Fujikura
            ENDL
            IBM
            Intel
            Matsushita
            Pioneer NewMedia
            Ricoh
            Toshiba America
            Volex
            Yamagata Fujitsu


The following member companies of the SFF Committee voted against
this industry specification.

            Adaptec
            Quantum


The following member companies of the SFF Committee voted to abstain on
this industry specification.

            FCI/Berg
            Foxconn Int'l
            Honda Connector
            I/O Interconnect
            Molex
            Seagate
            Tyco AMP

If you are not a member of the SFF Committee, but you are interested in participating, the following principles have been reprinted here for your information.

<u>**PRINCIPLES OF THE SFF COMMITTEE**</u>

The SFF Committee is an ad hoc group formed to address storage industry needs in a prompt manner. When formed in 1990, the original goals were limited to defining de facto mechanical envelopes within which disk drives can be developed to fit compact computer and other small products.

Adopting a common industry size simplifies the integration of small drives (2 1/2" or less) into such systems. Board-board connectors carrying power and signals, and their position relative to the envelope are critical parameters in a product that has no cables to provide packaging leeway for the integrator.

In November 1992, the SFF Committee objectives were broadened to encompass other areas which needed similar attention, such as pinouts for interface applications, and form factor issues on larger disk drives. SFF is a forum for resolving industry issues that are either not addressed by the standards process or need an immediate solution.

Documents created by the SFF Committee are expected to be submitted to bodies such as EIA (Electronic Industries Association) or an ASC (Accredited Standards Committee). They may be accepted for separate standards, or incorporated into other standards activities.

The principles of operation for the SFF Committee are not unlike those of an accredited standards committee. There are 3 levels of participation:

 - Attending the meetings is open to all, but taking part in discussions is limited to member companies, or those invited by member companies
 - The minutes and copies of material which are discussed during meetings are distributed only to those who sign up to receive documentation.
 - The individuals who represent member companies of the SFF Committee receive documentation and vote on issues that arise. Votes are not taken during meetings, only guidance on directions. All voting is by letter ballot, which ensures all members an equal opportunity to be heard.

Material presented at SFF Committee meetings becomes public domain. There are no restrictions on the open mailing of material presented at committee meetings. In order to reduce disagreements and misunderstandings, copies must be provided for all agenda items that are discussed. Copies of the material presented, or revisions if completed in time, are included in the documentation mailings.

The sites for SFF Committee meetings rotate based on which member companies volunteer to host the meetings. Meetings have typically been held during the ASC T10 weeks.

The funds received from the annual membership fees are placed in escrow, and are used to reimburse ENDL for the services to manage the SFF Committee.

If you are not receiving the documentation of SFF Committee activities or are interested in becoming a member, the following signup information is reprinted here for your information.

```
        Annual SFF Committee Membership Fee          $ 1,800.00
        Annual SFF Committee Paper Documentation Fee  $   300.00
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        Annual Surcharge for Electronic Documentation $   360.00
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**Please register me as a Member of the SFF Committee for one year.**
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        Paper documentation          $ 1,800
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        Saratoga  CA 95070           250-1752@mcimail.com
```

**Foreword**

When 2 1/2" diameter disk drives were introduced, there was no commonality on external dimensions e.g. physical size, mounting locations, connector type, connector location, between vendors.

The first use of these disk drives was in specific applications such as laptop portable computers in which space was at a premium and time to market with the latest machine was an important factor. System integrators worked individually with vendors to develop the packaging. The result was wide diversity, and with space being such a major consideration in packaging, it was not possible to replace one vendor's drive with a competitive product.

The desire to reduce disk drive sizes to even smaller dimensions such as 1.8" and 1.3" made it likely that devices would become even more constrained in dimensions because of a possibility that such small devices could be inserted into a socket, not unlike the method of retaining semiconductor devices.

The problems faced by integrators, device suppliers, and component suppliers led to the formation of an industry ad hoc group to address the marketing and engineering considerations of the emerging new technology in disk drives. After two informal gatherings on the subject in the summer of 1990, the SFF Committee held its first meeting in August.

During the development of the form factor definitions, other activities were suggested because participants in the SFF Committee faced problems other than the physical form factors of disk drives. In November 1992, the members approved an expansion in charter to address any issues of general interest and concern to the storage industry. The SFF Committee became a forum for resolving industry issues that are either not addressed by the standards process or need an immediate solution.

At the same time, the principle was adopted of restricting the scope of an SFF project to a narrow area, so that the majority of documents would be small and the projects could be completed in a rapid timeframe. If proposals are made by a number of contributors, the participating members select the best concepts and uses them to develop specifications which address specific issues in emerging storage markets.

Those companies which have agreed to support a documented specification are identified in the first pages of each SFF Specification. Industry consensus is not an essential requirement to publish an SFF Specification because it is recognized that in an emerging product area, there is room for more than one approach. By making the documentation on competing proposals available, an integrator can examine the alternatives available and select the product that is felt to be most suitable.

Suggestions for improvement of this document will be welcome. They should be sent to the SFF Committee, 14426 Black Walnut Ct, Saratoga,  CA 95070.

The development work on this specification was done by the SFF Committee, an industry group. The membership of the committee since its formation in 1990 has included a mix of companies which are leaders across the industry.

**SFF Specifications**

There are several projects active within the SFF Committee. At the date of printing document numbers had been assigned to the following projects. The status of Specifications is dependent on committee activities.

```
 F = Forwarded    The document has been approved by the members for
                  forwarding to a formal standards body.
 P = Published    The document has been balloted by members and is
                  available as a published SFF Specification.
 A = Approved     The document has been approved by ballot of the members
                  and is in preparation as an SFF Specification.
 C = Canceled     The project was canceled, and no Specification was
                  Published.
 D = Development  The document is under development at SFF.
 E = Expired      The document has been published as an SFF
                  Specification, and the members voted against re-
                  publishing it when it came up for annual review.
 e = electronic   Used as a suffix to indicate an SFF Specification which
                  has Expired but is still available in electronic form
                  from SFF e.g. a specification has been incorporated
                  into a draft or published standard which is only
                  available in hard copy.
 i = Information  The document has no SFF project activity in progress,
                  but it defines features in developing industry
                  standards. The document was provided by a company,
                  editor of an accredited standard in development, or an
                  individual. It is provided for broad review (comments
                  to the author are encouraged).
 s = submitted    The document is a proposal to the members for
                  consideration to become an SFF Specification.
```

```
 Spec #    Rev  List of Specifications as of July 26, 2001
 --------  ---  ------------------------------------------
 SFF-8000       SFF Committee Information
 INF-8001i  E   44-pin ATA (AT Attachment) Pinouts for SFF Drives
 INF-8002i  E   68-pin ATA (AT Attachment) for SFF Drives
 SFF-8003   E   SCSI Pinouts for SFF Drives
 SFF-8004   E   Small Form Factor 2.5" Drives
 SFF-8005   E   Small Form Factor 1.8" Drives
 SFF-8006   E   Small Form Factor 1.3" Drives
 SFF-8007   E   2mm Connector Alternatives
 SFF-8008   E   68-pin Embedded Interface for SFF Drives
 SFF-8009  4.1  Unitized Connector for Cabled Drives

 SFF-8010   E   Small Form Factor 15mm 1.8" Drives
 INF-8011i  E   ATA Timing Extensions for Local Bus
 SFF-8012  3.0  4-Pin Power Connector Dimensions
 SFF-8013   E   ATA Download Microcode Command
 SFF-8014   C   Unitized Connector for Rack Mounted Drives
 SFF-8015   E   SCA Connector for Rack Mounted SFF SCSI Drives
 SFF-8016   C   Small Form Factor 10mm 2.5" Drives
 SFF-8017   E   SCSI Wiring Rules for Mixed Cable Plants
 SFF-8018   E   ATA Low Power Modes
 SFF-8019   E   Identify Drive Data for ATA Disks up to 8 GB
```

```
INF-8020i  E    ATA Packet Interface for CD-ROMs
INF-8028i  E    - Errata to SFF-8020 Rev 2.5
SFF-8029   E    - Errata to SFF-8020 Rev 1.2


SFF-8030  1.8   SFF Committee Charter
SFF-8031        Named Representatives of SFF Committee Members
SFF-8032  1.4   SFF Committee Principles of Operation
INF-8033i  E    Improved ATA Timing Extensions to 16.6 MBs
INF-8034i  E    High Speed Local Bus ATA Line Termination Issues
INF-8035i  E    Self-Monitoring, Analysis and Reporting Technolog
INF-8036i  E    ATA Signal Integrity Issues
INF-8037i  E    Intel Small PCI SIG
INF-8038i  E    Intel Bus Master IDE ATA Specification
INF-8039i  E    Phoenix EDD (Enhanced Disk Drive) Specification


SFF-8040  1.2   25-pin Asynchronous SCSI Pinout
SFF-8041   C    SCA-2 Connector Backend Configurations
SFF-8042   C    VHDCI Connector Backend Configurations
SFF-8043   E    40-pin MicroSCSI Pinout
SFF-8045  4.5   40-pin SCA-2 Connector w/Parallel Selection
SFF-8046   E    80-pin SCA-2 Connector for SCSI Disk Drives
SFF-8047   C    40-pin SCA-2 Connector w/Serial Selection
SFF-8048   C    80-pin SCA-2 Connector w/Parallel ESI
SFF-8049   E    80-conductor ATA Cable Assembly


INF-8050i 1.0   Bootable CD-ROM
INF-8051i  E    Small Form Factor 3" Drives
INF-8052i  E    ATA Interface for 3" Removable Devices
SFF-8053  5.5   GBIC (Gigabit Interface Converter)
INF-8055i  E    SMART Application Guide for ATA Interface
SFF-8056   C    50-pin 2mm Connector
SFF-8057   E    Unitized ATA 2-plus Connector
SFF-8058   E    Unitized ATA 3-in-1 Connector
SFF-8059   E    40-pin ATA Connector


SFF-8060  1.1   SFF Committee Patent Policy
SFF-8061  1.1   Emailing drawings over the SFF Reflector
SFF-8062        Rolling Calendar of SSWGs and Plenaries
SFF-8065   C    40-pin SCA-2 Connector w/High Voltage
SFF-8066   C    80-pin SCA-2 Connector w/High Voltage
SFF-8067  2.9   40-pin SCA-2 Connector w/Bidirectional ESI
INF-8068i 1.0   Guidelines to Import Drawings into SFF Specs
SFF-8069   E    Fax-Access Instructions


INF-8070i 1.2   ATAPI for Rewritable Removable Media


SFF-8072  1.2   80-pin SCA-2 for Fibre Channel Tape Applications
SFF-8073   -    20-pin SCA-2 for GBIC Applications
INF-8074i 1.0   SFP (Small Formfactor Pluggable) Transceiver
SFF-8075  1.0   PCI Card Version of SFP Cage
SFF-8080   E    ATAPI for CD-Recordable Media
INF-8090i 5.3   ATAPI for DVD (Digital Video Data)


SFF-8101        3 Gbs and 4 Gbs Signal Characteristics
SFF-8110   C    5V Parallel 1.8" drive form factor
SFF-8111  1.2   1.8" drive form factor (60x70mm)
```

```
SFF-8120  2.4  1.8" drive form factor (78x54mm)

SFF-8200e 1.1  2 1/2" drive form factors (all of 82xx family)
SFF-8201e 1.3  2 1/2" drive form factor dimensions
SFF-8212e 1.2  2 1/2" drive w/SFF-8001 44-pin ATA Connector

SFF-8300e 1.1  3 1/2" drive form factors (all of 83xx family)
SFF-8301e 1.2  3 1/2" drive form factor dimensions
SFF-8302e 1.1  3 1/2" Cabled Connector locations
SFF-8332e 1.2  3 1/2" drive w/80-pin SFF-8015 SCA Connector
SFF-8337e 1.2  3 1/2" drive w/SCA-2 Connector
SFF-8342e 1.3  3 1/2" drive w/Serial Unitized Connector
INF-8350i 6.1  3 1/2" Packaged Drives

SFF-8400   C   VHDCI (Very High Density Cable Interconnect)
SFF-8410 16.1  High Speed Serial Testing for Copper Links
SFF-8411       High Speed Serial Testing for Backplanes
SFF-8412  3.1  HSS Requirements for Duplex Optical Links
SFF-8415  1.1  HPEI (High Performance Electrical Interconnect)
SFF-8416       HSS Bulk Cable Performance Requirements
SFF-8420 11.1  HSSDC-1 Shielded Connections
SFF-8421  1.1  HSSDC-2 Shielded Connections
SFF-8422   C   FCI Shielded Connections
SFF-8423   C   Molex Shielded Connections

SFF-8430  4.1  MT-RJ Duplex Optical Connections
SFF-8441 14.1  VHDCI Shielded Configurations
SFF-8451 10.1  SCA-2 Unshielded Connections
SFF-8452  3.1  Glitch Free Mating Connections for Multidrop Aps

SFF-8460  1.1  HSS Backplane Design Guidelines
SFF-8470  1.0  Multi Lane Copper Connector
SFF-8472  3.1  Diagnostic Monitoring Interface for Optical Xcvrs
SFF-8480  2.1  HSS (High Speed Serial) DB9 Connections

SFF-8500e 1.1  5 1/4" drive form factors (all of 85xx family)
SFF-8501e 1.1  5 1/4" drive form factor dimensions
SFF-8508e 1.1  5 1/4" ATAPI CD-ROM w/audio connectors
SFF-8551  3.2  5 1/4" CD Drives form factor
SFF-8572   -   5 1/4" Tape form factor
SFF-8610   C   SDX (Storage Device Architecture)
```

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## *1.0  Introduction*

The objective of this proposed draft standard is to provide the following enhancements to X3T13 1321D (ATA/ATAPI-5)  due to the additions of new device types, i.e. Non-CD Optical drives,120 MB floppy drives and Magneto Optical Device. These devices add enhancements such as rewritability and concepts of multiple logical unit numbers within one device.

### *1.1    Abstract*

This document defines a standard method for interfacing to a Rewritable Removable Media drive utilizing the existing ATA host computer hardware and cabling. This specification supplements the definitions of an ATA mass storage peripheral found in the ATA document. The Rewritable ATAPI interface described in this document is compatible with existing ATA hardware without any changes or additional pins.

### *1.2    Scope*

This document is intended to be used with the ATA document. Its purpose is to highlight those areas of implementation in which the Rewritable ATAPI interface and the ATA document differ. In addition, it indicates areas within the ATA document that are modified for operation in the Rewritable ATAPI environment. Both mandatory and optional specifications are presented.

### *1.3    Audience*

This document is intended for use by computer system, peripheral and chip set vendors.

### *1.4    Normative References*

The following standards contain provisions which, when referenced in the text of this standard, constitute provisions of this Specification. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Specification are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

American National Standard Institute X3T13/1321D (ATA/ATAPI-5)
American National Standard Institute X3T10/Project 1236-D Information technology – SCSI Primary Commands – 2 (SPC-2)
American National Standard Institute X3T10/Project 996-D Information technology – SCSI-3 Block Commands (SBC)
American National Standard Institute X3T10/1228D Information Technology - SCSI-3 Multimedia Commands – 2
Small Form Factor Committee Specification of ATA Packet Interface for CD-ROMs SFF-8020i Revision 2.6
ECMA - 240: Data Interchange on 120mm Optical Disk Cartridges using Phase Change PD Format - Capacity: 650MBytes per cartridge
Microsoft Corporation: Media Status Notification Support Specification, Version 1.03

### 1.5    Layout of the Document

*Table 1 - Layout of the Document*

| Section 1. "Introduction" | Description of Abstract, Scope, etc. |
|---|---|
| Section 2. "General" | Description of Overview, Feature Summary |
| Section 3. "Conventions" | Description of Conventions.<br>Refer to X3T13 1321D (ATA/ATAPI-5) in chapter 3 - Definitions, abbreviation, and conventions. |
| Section 4. "ATAPI Overview" | Description of ATAPI Overview.<br>Refer to X3T13 1321D (ATA/ATAPI-5) in chapter 6 - General operational requirements. |
| Section 5. "ATAPI Protocol" | Description of ATAPI Protocol.<br>Refer to X3T13 1321D (ATA/ATAPI-5) in chapter 9 – Protocol. |
| Section 6. "ATAPI Transport Mechanism" | Description of ATAPI Transport Mechanism.<br>Refer to X3T13 1321D (ATA/ATAPI-5) in chapter 7 – Interface register definitions and descriptions. |
| Section 7. "Removable Media Status Notification and Removable Media feature set" | Description of Removable Media Status Notification and Removable Media feature set.<br>Refer to X3T13 1321D (ATA/ATAPI-5) in chapter 6, clause 6.14 – Removable Media Status Notification and Removable Media feature set. |
| Section 8. "ATA Commands" | Description of ATA Commands.<br>Refer to X3T13 1321D (ATA/ATAPI-5) in chapter 8 – Command Descriptions. |
| Section 9. "Packet Commands for Block Device" | Description of Block Packet commands for Generic Rewritable Removable Media device. |
| Section 10. "Non-CD Optical Device Model" | Description of Non-CD Optical Device Model, e.g. PD drives. |
| Section 11. "Removable Direct Access Model" | Description of Removable Direct Access Device Model, e.g. 120 MB Floppy drives. |
| Section 12. "Magneto Optical Device Model" | Description of Magneto Optical Device Model. |

### 1.6    Patents

The developers of this specification have requested that holders of patents that may be required for the implementation of the specification disclose such patents to the publisher. However, neither the developers nor the publisher have under-taken a patent search in order to identify which, if any, patents apply to this specification.

No position is taken with respect to the validity of any claim or any patent rights that may have been disclosed. Details of submitted statements may be obtained from the publisher concerning any statement of patents and willingness to grant a license under these rights on reasonable and nondiscriminatory terms and conditions to applicants desiring to obtain such a license.

### 1.7    Unresolved Issues

This section identifies issues that are still unresolved.
Note at this time, there are no unresolved issues.

*1.8    Change History*

**Revision 1.0** was published in May 23, 1996.

**1.0 to 1.1 October 1996**
- Layout of document was adjusted to SFF-8020i Revision 2.6.
- All fonts of text were changed to Arial from Times Roman.
- Many small editorial and clarification changes.
- The description of "Packet LUN filed to be obsolete in this standard. Only ATA LUN field is to be used" was deleted.
- Last LUN Identifier (Word 126) and Media Status Notification, Device Write Protect (Word 127) in Identify Device Information were clarified.
- FOV bit was added to FORMAT UNIT command.
- SRFP bit in Removable Block Access Capabilities Page was clarified.
- 00b of Descriptor Code in READ FORMAT CAPACITIES command was deleted.
- ASC/ASCQ (04/04, 25/00, 30/00, 30/02, 4E/00, 53/02) were added.
- Table of  "Action for Eject/Load Disc" was added to START/STOP UNIT command.
- Sense Key Specific field was added to Request Sense Standard Data.

**1.1 to 1.2 November 1998**
- Reference to SFF-8020i R2.6 was deleted. Instead of SFF-8020i R2.6, refer to X3T13 1153D (ATA/ATAPI-4).
- READ (12) and WRITE (12) have been changed to option.
- TB bit in Read-Write Error Recovery Page was added.
- Caching Page was added.
- SFLP bit in Removable Block Access Capabilities Page was deleted.
- Timer & Protect Page has been changed to option.
- Added "Magneto Optical Device Model".

**1.2 to 1.3 November 1998**
- Reference to X3T13 1153D (ATA/ATAPI-4) was deleted. Instead of X3T13 1153D (ATA/ATAPI-4), refer to X3T13 1321D (ATA/ATAPI-5).
- All description of ATA commands were deleted.  Because SFF-8070i follows to X3T13 1321D (ATA/ATAPI-5) completely.
- Packet LUN has been changed to option and ATA LUN has been obsolete.

## 2.0  General

### 2.1    Overview

The primary objective of this standard is to add the rewritable feature for the Removable Rewritable Media Device (i.e. PD, SuperDisk (LS-120), MO) and support for multiple Logical Units numbers as option.

### 2.2    Feature Summary

This clause provides an abbreviated list of the perceived requirements upon which the development of this specification was based.

- Provide Generic Rewritable command set
- Support for Multiple LUN as option
- Support for Generic capacity format
- Support for Multiple Floppy Formats
- Support for Media Status Notification
- Support for multiple block size (i.e. 512,1024,2048 bytes)

## 3.0  Conventions

Please refer to X3T13 1321D (ATA/ATAPI-5) for further details in chapter 3 - Definitions, abbreviations, and conventions.

## 4.0  ATAPI Overview

Please refer to X3T13 1321D (ATA/ATAPI-5) for further details in chapter 6 - General operation requirements.

## 5.0  ATAPI Protocol

Please refer to X3T13 1321D (ATA/ATAPI-5) for further details in chapter 9 - Protocol.

### 5.1    ATAPI Transport Mechanism

Please refer to X3T13 1321D (ATA/ATAPI-5) for further details in chapter 7 Interface register definitions and descriptions.

## 6.0  ATAPI Transport Mechanism

Please refer to X3T13 1321D (ATA/ATAPI-5) for further details in chapter 7 – Interface register definitions and descriptions.

## 7.0  Removable Media Status Notification and Removable Media feature sets

Please refer to X3T13 1321D (ATA/ATAPI-5) for further details in Chapter 6, clause 6.17 - Removable Media Status Notification and Removable Media feature sets.

## 8.0  ATA Commands

### 8.1    ATA Command Implementation Requirements

Please refer to X3T13 1321D (ATA/ATAPI-5) for further details in chapter 8 - Command Descriptions.

### 9.0  ATAPI Command Packet Description

### 9.1    Packet Command Implementation Requirements

The first byte of all ATAPI Block Devices command packets *shall* contain an operation code as defined in this Specification. ATAPI Block Device *shall* implement all commands with mandatory operation codes.

### 9.1.1    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.

### 9.2    ATAPI Command Packet Description

An ATAPI command is communicated by sending a Command Packet to the ATAPI Block Device. For several commands, the Command Packet is accompanied by a list of parameters sent upon receiving an interrupt following the Command Packet being sent. See the specific commands for detailed information.

The Command Packet always has an operation code as its first byte.

For all commands, if there is an invalid parameter in the Command Packet, then ATAPI Block Device *shall* abort the command without altering the medium.

**Table 6 - Typical Command Packet for Most Commands**

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

**Table 7 - Typical Command Packet for Some Extended Commands**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Operation Code | | | | | | | |
| 1 | Logical Unit Number (Optional) | | | Reserved | | | | |
| 2 | (MSB) | | | | | | | |
| 3 | Logical Block Address (if required) | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | (LSB) |
| 6 | (MSB) | | | | | | | |

| 7 | Transfer or Parameter List or Allocation Length (if required) | |
|----|-----------------------------------------------------|---|
| 8 | | |
| 9 | | (LSB) |
| 10 | Reserved | |
| 11 | Reserved | |

### 9.2.1  Operation Code

The Operation Code of the Command Packet has a group code field and a command code field. The three-bit group code field provides for eight groups of command codes. The five-bit command code field provides for thirty-two command codes in each group. Thus, a total of 256 possible operation codes exist. Operation codes are defined in the subsequent sections.

***Table 8 - Operation Code***

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

NOTE: The Group/Command code fields have been kept for backward compatibility and are not used by ATAPI.

### 9.2.2  Logical Unit Number

The Logical Unit Number field specifies the Logical Unit that performs the command.

This field is optional.

### 9.2.3  Logical Block Address

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

### 9.2.4  Transfer Length

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

In commands 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.

### 9.2.5  Parameter List Length

The Parameter List Length is used to specify the number of bytes to be sent to ATAPI Block Device. This field is typically used in Command Packets 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 will be transferred. This condition will not be considered as an error.

### 9.2.6  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 will be transferred. This condition will not be considered as an error. ATAPI Block Device will 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.

### *9.3    Status*

A status byte *shall* be sent from ATAPI Block Device to the host computer at the completion of each command unless the command is terminated by one of the following events:

1.  A hard reset condition.
2.  An unexpected event.

Status is normally presented at the end of a command, but in some cases may occur prior to transferring the Command Packet.

### *9.4    Immediate Command Processing Considerations*

Immediate commands are a class of commands that return completion status to the host system before they are finished executing the command. The purpose of immediate commands is to allow the host to execute more than one command at a time on the same ATA cable. ATAPI Block Device accepts the command, and interrupts the host to return status. The host system is now free to issue additional commands to any other Device at the same ATA port address, including ATAPI Block Device executing the immediate command.

ATAPI Block Device uses the DSC bit to indicate the completion status of immediate commands. No INTRQ is issued by the Drive when the DSC bit is set, so it is the responsibility of the ATAPI driver to poll this bit to determine the completion status of the immediate command.

### *9.5    Command Processing Considerations and Exception Conditions*

### *9.5.1    Parameter Rounding*

Certain parameters sent to an ATAPI Block Device with various commands contain a range of values. ATAPI Block Device may choose to implement only selected values from this rang. When the ATAPI Block Device receives a value that it does not support it either rejects the command (CHECK CONDITION status with ILLEGAL REQUEST sense key) or it rounds the value received to a supported value. The ATAPI Block Device *shall* reject unsupported values unless rounding is permitted in the description of the parameter.

Rounding of parameter values, when permitted *shall* be performed as follows - An ATAPI Block Device that receives a parameter value that is not an exact supported value *shall* adjust the value to one that it supports and *shall* return CHECK CONDITION status with a sense key of RECOVERED ERROR. The additional sense code *shall* be set to ROUNDED PARAMETER. The host computer is responsible for issuing an appropriate command to learn what value the ATAPI Block Device has selected.

### *9.6    Unit Attention Condition*

The Drive will generate an unit attention condition on each valid Logical Unit whenever the Drive has been reset by a hard reset condition, or by a power-on reset. The Drive also will generate a unit attention condition on the affected Logical Unit whenever a removable medium may have been changed.

The unit attention condition will persist, until the host clears the condition as described in the following paragraphs.

If a INQUIRY command is received from the host with a pending unit attention condition, the Drive will perform a INQUIRY command and will not clear the unit attention condition. If a INQUIRY command is received after the Drive has generated the contingent allegiance condition for a pending unit attention condition, then the unit attention condition on the Logical Unit is cleared, and the Drive will perform a INQUIRY command.

If a REQUEST SENSE command is received from the host with a pending unit attention condition, then ATAPI Block Device will report the unit attention condition, may discard any pending sense data, and clear the unit attention condition. Command Descriptions

The command descriptions are in alphabetical order by command name.

### *9.7    Packet Command for Generic ATAPI Block Device*

The following table lists all commands supported a generic ATAPI Block Device.

*Table 9 - Packet Commands Supported by ATAPI Block Devices*

| Command Description | Code | Type | Reference |
|---|---|---|---|
| FORMAT UNIT | 04h | M | Section 9.7.1 on page 22 |
| INQUIRY | 12h | M | Section 9.7.2 on page 25 |
| MODE SELECT | 55h | M | Section 9.7.3 on page 28 |
| MODE SENSE | 5Ah | M | Section 9.7.4 on page 29 |
| PREVENT/ALLOW MEDIUM REMOVAL | 1Eh | M | Section 9.7.6 on page 39 |
| READ (10) | 28h | M | Section 9.7.7 on page 41 |
| READ (12) | A8h | O | Section 9.7.8 on page 42 |
| READ CAPACITY | 25h | M | Section 9.7.9 on page 43 |
| READ FORMAT CAPACITIES | 23h | M | Section 9.7.10 on page 44 |
| REQUEST SENSE | 03h | M | Section 9.7.11 on page 47 |
| SEEK | 2Bh | M | Section 9.7.12 on page 52 |
| START STOP UNIT | 1Bh | M | Section 9.7.13 on page 53 |
| TEST UNIT READY | 00h | M | Section 9.7.14 on page 55 |
| VERIFY | 2Fh | M | Section 9.7.15 on page 56 |
| WRITE (10) | 2Ah | M | Section 9.7.16 on page 57 |
| WRITE (12) | AAh | O | Section 9.7.17 on page 58 |
| WRITE AND VEIRIFY | 2Eh | M | Section 9.7.18 on page 59 |

### 9.7.1 FORMAT UNIT Command

The FORMAT UNIT Command formats the medium per the host computer defined options.

*Table 10 - FORMAT UNIT Command*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Operation Code (04h) | | | | | | | |
| 1 | Logical Unit Number | | | FmtData (1) | CmpList (0) | Defect List Format (7) | | |
| 2 | Vendor Specific | | | | | | | |
| 3 | (MSB) | Interleave | | | | | | |
| 4 | | | | | | | | (LSB) |
| 5 | Reserved | | | | | | | |
| 6 | Reserved | | | | | | | |
| 7 | Reserved | | | | | | | |
| 8 | Reserved | | | | | | | |
| 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* return a Check Condition with the Sense Key set to ILLEGAL REQUEST and the Sense Code set to INVALID FIELD IN COMMAND PACKET.

The Interleave field specifies the interleave that is used when performing the format operation. An Interleave of zero specifies that the ATAPI Block Device use its default interleave. An Interleave of one specifies that consecutive logical blocks be placed in contiguous ascending order. All other value is vender-specific.

After sending the command packet, the host then transfers the 12 bytes of the Format Descriptor.

*Table 11 - FORMAT UNIT Parameter List*

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

*Table 12 - Format List Header*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Reserved | | | | | | | |
| 1 | FOV | Reserved | DCRT | Reserved | | | Immed | Reserved |
| 2 | (MSB) | Defect List Length (8) | | | | | | |
| 3 | | | | | | | | (LSB) |

A format options valid (FOV) bit of zero indicates that the ATAPI Block Device *shall* use its default setting for the DCRT and Immed bits. The host *shall* set these bits to zero. If any of these bits are not zero, the ATAPI Block Device *shall* terminate the command with CHECK CONDITION status. The sense key *shall* be set to ILLEGAL REQUEST and the additional sense code *shall* be set to INVALID FIELD IN PARAMETER LIST.

A FOV bit of one indicates that the ATAPI Block Device *shall* examine the setting of the DCRT and Immed bits. When the FOV bit is one, the DCRT and Immed bits are defined as follows.

A disable certification (DCRT) bit of zero indicates that the ATAPI Block Device *shall* perform a vender-specific medium certification. A DCRT bit of one indicates that the ATAPI Block Device *shall not* any vender-specific medium certification process or format verification operation while executing the FORMAT UNIT command.

A Immediate (Immed) bit of zero indicates that status *shall* be returned after the format operation has completed. An Immed bit of one indicates that the ATAPI Block Device *shall* return status as soon as the command descriptor block has been validated. The command will then proceed, and set ATAPI Block Device Ready bit when the command has actually finished.

If A Supports Reporting progress of Format (SRFP) bit (See "9.7.5.3 Removable Block Access Capabilities Page (1Bh)" on page 37) is one, the ATAPI Block Device *shall* accept a FORMAT UNIT with the Immediate bit set in the format header. If this bit is zero, the ATAPI Block Device *shall* reject a FORMAT UNIT command with the Immediate bit set and return INVALID FIELD IN PARAMETERS error.

The Defect List Length *shall* be set to 8. Any other value in this field *shall* return CHECK CONDITION with the Sense Key set to ILLEGAL REQUEST and the Sense Code set to ILLEGAL FIELD IN PARAMETER LIST.

The Format Descriptor must exactly match one of the Formattable Descriptors from the Read Format Capacities command.

*Table 13 - Formattable Capacity Descriptor*

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

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 ATAPI Block Device *shall* return CHECK CONDITION with the Sense Key set to ILLEGAL REQUEST and the Sense Code set to ILLEGAL FIELD IN PARAMETER LIST.

*Table 14 - Recommended Sense key, ASC and ASCQ for FORMAT UNIT Command Errors*

| Sense Key | ASC | ASCQ | Description of Error |
|---|---|---|---|
| 05 | 20 | 00 | INVALID COMMAND OPERATION CODE |
| 05 | 25 | 00 | LOGICAL UNIT NOT SUPPORTED |
| 05 | 24 | 00 | INVALID FIELD IN COMMAND PACKET |
| 06 | 28 | 00 | NOT READY TO READY TRANSITION - MEDIA CHANGED |
| 06 | 29 | 00 | POWER ON RESET OR BUS DEVICE RESET OCCURRED |
| 05 | 26 | 00 | ILLEGAL FIELD IN PARAMETER LIST |
| 07 | 27 | 00 | WRITE PROTECTED MEDIA |
| 02 | 3A | 00 | MEDIUM NOT PRESENT |
| 03 | 03 | 00 | WRITE FAULT |
| 03 | 30 | 00 | INCOMPATIBLE MEDIUM INSTALLED |
| 03 | 30 | 02 | CANNOT READ MEDIUM - INCOMPATIBLE FORMAT |
| 03 | 31 | 01 | FORMAT COMMAND FAILED |
| 03 | 12 | 00 | ADDRESS MARK NOT FOUND FOR ID FIELD |
| 0B | 4E | 00 | OVERLAPPED COMMAND ATTEMPTED |

### *9.7.2 INQUIRY Command*

The INQUIRY command requests that information regarding parameters of the ATAPI Block Device be sent to the host computer. An option allows the host computer to request additional information about the ATAPI Block Device.

*Table 15 - INQUIRY Command*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Operation Code (12h) | | | | | | | |
| 1 | Logical Unit Number | | | Reserved | | | | |
| 2 | Reserved | | | | | | | |
| 3 | Reserved | | | | | | | |
| 4 | Allocation Length | | | | | | | |
| 5 | Reserved | | | | | | | |
| 6 | Reserved | | | | | | | |
| 7 | Reserved | | | | | | | |
| 8 | Reserved | | | | | | | |
| 9 | Reserved | | | | | | | |
| 10 | Reserved | | | | | | | |
| 11 | Reserved | | | | | | | |

The INQUIRY command *shall* return CHECK CONDITION status only when the ATAPI Block Device cannot return the requested INQUIRY data. The INQUIRY data should be returned even though the ATAPI Block Device may not be ready for other commands.

If an INQUIRY command is received with a pending unit attention condition (i.e. before the ATAPI Block Device reports CHECK CONDITION status), the ATAPI Block Device *shall* perform the INQUIRY command and *shall not* clear the unit attention condition.

### *9.7.2.1 Standard INQUIRY Data*

The standard INQUIRY data contains 36 required bytes, followed by a variable number of vendor-specific parameters. Bytes 56 through 95, if returned, are reserved for future standardization.

*Table 16 - INQUIRY Data Format*

| Bit Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Reserved | | | | Peripheral Device Type | | | |
| 1 | RMB | Reserved | | | | | | |
| 2 | ISO Version | | ECMA Version | | | ANSI Version (00h) | | |
| 3 | Reserved | | | | Response Data Format | | | |
| 4 | Additional Length (Number of bytes following this one) | | | | | | | |
| 5 | Reserved | | | | | | | |
| 7 | | | | | | | | |
| 8 | Vendor Information | | | | | | | |
| 15 | | | | | | | | |
| 16 | Product Identification | | | | | | | |
| 31 | | | | | | | | |
| 32 | Product Revision Level | | | | | | | |
| 35 | | | | | | | | |
| 36 | Vendor Specific | | | | | | | |
| 55 | | | | | | | | |
| 56 | Reserved | | | | | | | |
| 95 | | | | | | | | |
| | Vendor Specific Parameters | | | | | | | |
| 96 | | | | | | | | |
| n | | | | | | | | |

The Device Type field identifies the device. It is defined in "Table 17 - Peripheral Device Types" on page 26.

#### 9.7.2.2    Using the INQUIRY Command

The INQUIRY command may be used by a host computer to determine the configuration of the ATAPI Block Device. ATAPI Block Devices respond with information that includes their type and specification level and may include the vendor's identification, model number and other useful information.

*Table 17 - Peripheral Device Types*

| Code | Description |
|---|---|
| 00h | Direct-access device (e.g., UHD Floppy disk) |
| 01h | Sequential-access device (e.g., magnetic tape) |
| 02-03h | Reserved |
| 04h | Write-once device (e.g., WORM optical disk) |
| 05h | CD-ROM device |
| 06h | Reserved |
| 07h | Optical memory device (e.g., Non-CD optical disks) |
| 08h-1Eh | Reserved |
| 1Fh | Unknown or no device type |

A Removable Medium Bit (RMB) of zero indicates that the medium is not removable. A RMB bit of one indicates that the medium is removable. ATAPI Block Devices should always report "Removable".

The usage of non-zero code values in the ISO version and ECMA version fields is defined by the International Organization for Standardization and the European Computer Manufacturers Association, respectively.

The ANSI-approved version field must contain a zero to comply with this version of the Specification.

A Response Data Format value of 01h indicates that the data ***shall*** be in the format specified in this Specification. Response data format values greater than one are reserved.

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.

ASCII data fields ***shall*** contain only graphic codes (i.e. code values 20h through 7Eh). Left-aligned fields ***shall*** place any unused bytes at the end of the field (highest offset) and the unused bytes ***shall*** be filled with space characters (20h). Right-aligned fields ***shall*** place any unused bytes at the start of the field (lowest offset) and the unused bytes ***shall*** be filled with space characters (20h).

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.

*Table 18 - Recommended Sense Key, ASC and ASCQ for INQUIRY Command Errors*

| Sense Key | ASC | ASCQ | Description of Error |
|-----------|-----|------|----------------------|
| 05 | 20 | 00 | INVALID COMMAND OPERATION CODE |
| 05 | 25 | 00 | LOGICAL UNIT NOT SUPPORTED |
| 05 | 24 | 00 | INVALID FIELD IN COMMAND PACKET |
| 0B | 4E | 00 | OVERLAPPED COMMAND ATTEMPED |

### 9.7.3    MODE SELECT Command

The MODE SELECT command provides a means for the host computer to specify medium or ATAPI Block Device parameters to the ATAPI Block Device. Host computers **shall** issue MODE SENSE prior to each MODE SELECT to determine supported pages, page lengths, and other parameters.

*Table 19 - MODE SELECT Command*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Operation Code (55h) | | | | | | | |
| 1 | Logical Unit Number | | | 1 | 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 | | | | | | | |

A Save Pages (SP) bit of zero specifies that the ATAPI Block Device **shall** perform the specified MODE SELECT operation, and **shall not** save any pages. An SP bit of one specifies that the ATAPI Block Device **shall** perform the specified MODE SELECT operation, and **shall** save to a non-volatile vendor-specific location all the savable pages. If an ATAPI Block Device supports saved pages, it **shall** save only one copy of the page. The SP bit is optional, even when mode pages are supported by the ATAPI Block Device. Pages that are saved are identified by the Parameter Savable (PS) bit that is returned in the page header by the MODE SENSE command. If the PS bit is set in the MODE SENSE data then the page **shall** be savable by issuing a MODE SELECT command with the SP bit set. If the ATAPI Block Device does not implement saved pages and the SP bit is set to one, 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 INVALID FIELD IN PACKET.

The Parameter List Length field specifies the length in bytes of the mode parameter list that **shall** be transferred from the host computer to the ATAPI Block Device after the Command Packet is transferred. A Parameter List Length of zero indicates that no data **shall** be transferred, and this condition **shall not** be considered an error.

The ATAPI Block Device **shall** terminate the command with CHECK CONDITION status if the Parameter List Length results in the truncation of any mode parameter header, or mode page. The sense key **shall** be set to ILLEGAL REQUEST, and the additional sense code **shall** be set to PARAMETER LIST LENGTH ERROR.

The mode parameter list for the MODE SELECT and MODE SENSE commands is defined "9.7.2 Mode Select / Sense Parameters" on page 25.

The ATAPI Block Device **shall** terminate the MODE SELECT command with CHECK CONDITION status, set the sense key to ILLEGAL REQUEST, set the additional sense code to INVALID FIELD IN PARAMETER LIST, and **shall not** change any mode parameters for the following conditions:

1. If the host computer sets any field (except for reserved fields) that is reported as not changeable by the ATAPI Block Device to a value other than its current value.

2.  If the host computer sets any field in the mode parameter header to an unsupported value.

3.  If the host computer sends a mode page with a page length not equal to the page length returned by the MODE SENSE command for that page.

If the host computer sends an unsupported value for a mode parameter and rounding is not implemented for that mode parameter.

If the host computer sends a value for a mode parameter that is outside the range supported by the ATAPI Block Device and rounding is implemented for that mode parameter, the ATAPI Block Device may either:

1.  round the parameter to an acceptable value and terminate the command;

2.  terminate the command with CHECK CONDITION status, the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER LIST.

An ATAPI Block Device may alter any mode parameter in any mode page (even those not reported as changeable) as a result of changes to other mode parameters.

The ATAPI Block Device validates the non-changeable mode parameters against the current values that existed for those mode parameters prior to the MODE SELECT command.

Mode pages are maintained per Logical Unit. The pages are thus used for multiple media insertions / removals.

*Table 20 - Recommended Sense Key, ASC and ASCQ for MODE SELECT Command Errors*

| Sense Key | ASC | ASCQ | Description of Error |
|---|---|---|---|
| 05 | 20 | 00 | INVALID COMMAND OPERATION CODE |
| 05 | 25 | 00 | LOGICAL UNIT NOT SUPPORTED |
| 05 | 24 | 00 | INVALID FIELD IN COMMAND PACKET |
| 06 | 28 | 00 | NOT READY TO READY TRANSITION - MEDIA CHANGED |
| 06 | 29 | 00 | POWER ON RESET OR BUS DEVICE RESET OCCURRED |
| 05 | 26 | 00 | INVALID FIELD IN PARAMETER LIST |
| 0B | 4E | 00 | OVERLAPPED COMMAND ATTEMPTED |

### 9.7.4  MODE SENSE Command

The MODE SENSE command provides a means for an ATAPI Block Device to report parameters to the host computer. It is a complementary command to the MODE SELECT command.

***Table 21 - MODE SENSE Command***

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

The Page Control (PC) field defines the type of mode parameter values to be returned in the mode pages. See sections "9.7.4.1 Current Values" to "9.7.4.4 Saved Values" below.

***Table 22 - Page Control Field***

| Code | Type of Parameter | Reference |
|---|---|---|
| 00b | Current values | 9.7.4.1 on page 31 |
| 01b | Changeable values | 9.7.4.2 on page 31 |
| 10b | Default values | 9.7.4.3 on page 31 |
| 11b | Saved values | 9.7.4.4 on page 31 |

The Page Code specifies which mode page(s) to return. 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.

A host computer may request any one or all of the supported mode pages from an ATAPI Block Device. If a host computer issues a MODE SENSE command with a Page Code value not implemented by the ATAPI Block Device, the ATAPI Block Device ***shall*** return 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.

A Page Code of 3Fh indicates that all mode pages implemented by the ATAPI Block Device ***shall*** be returned to the host computer. If the mode parameter list exceeds 65536 bytes for a MODE SENSE command, the ATAPI Block Device ***shall*** return 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.

Mode page 00h, if implemented, ***shall*** be returned after all other mode pages.

### 9.7.4.1 Current Values

A PC field value of 00b requests that the ATAPI Block 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 saved value of the mode parameters if a MODE SELECT command has not successfully completed since the last power-on, hard RESET condition.

3.  the default values of the mode parameters, if saved values, are not available or not supported.

### 9.7.4.2 Changeable Values

A PC field value of 01b requests that the ATAPI Block 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 ATAPI Block 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 computer *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.

### 9.7.4.3 Default Values

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

### 9.7.4.4 Saved Values

A PC field of 11b requests that the ATAPI Block Device return the saved values of the mode parameters. Implementation of saved page parameters is optional. Mode parameters not supported by the ATAPI Block Device *shall* be set to zero. If saved values are not implemented, 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.

The method of saving parameters is vendor-specific. The parameters are preserved in such a manner that they are retained when the ATAPI Block Device is powered down. All savable pages can be considered saved when a MODE SELECT command issued with the SP bit set to one has returned a "good" status.

### 9.7.4.5 Initial Responses

After a power-up condition or hard reset condition, the ATAPI Block Device *shall* respond in the following manner:

1.  If default values are requested, the ATAPI Block Device *shall* return the default values.

2.  If saved values are requested, the ATAPI Block 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 ATAPI Block Device *shall* terminate the command with CHECK CONDITION status and set the sense key to NOT

READY. If saved parameters are not implemented, the ATAPI Block Device ***shall*** respond as defined in "9.7.4.4 Saved Values" on page 31.

If current values are requested and the current values of the mode parameters have not been sent by the host computer (via a MODE SELECT command), the ATAPI Block Device ***shall*** return the default values. If current values have been sent, the current values ***shall*** be reported.

***Table 23 - Recommended Sense key, ASC and ASCQ for MODE SENSE Command Errors***

| Sense Key | ASC | ASCQ | Description of Error |
|---|---|---|---|
| 05 | 20 | 00 | INVALID COMMAND OPERATION CODE |
| 05 | 25 | 00 | LOGICAL UNIT NOT SUPPORTED |
| 05 | 24 | 00 | INVALID FIELD IN COMMAND PACKET |
| 06 | 28 | 00 | NOT READY TO READY TRANSITION - MEDIA CHANGED |
| 06 | 29 | 00 | POWER ON RESET OR BUS DEVICE RESET OCCURRED |
| 0B | 4E | 00 | OVERLAPPED COMMAND ATTEMPED |

### 9.7.5 Mode Select / Sense Parameters

This section describes the pages used with MODE SELECT and MODE SENSE commands.

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

*Table 24 - Mode Parameter List*

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

Each mode page contains a page code, a page length and a set of mode parameters.

*Table 25 - Mode Page Codes for ATAPI Block Device*

| Page Code | Definition | Type | Reference |
|---|---|---|---|
| 01h | Read-Write Error Recovery Page | M | 9.7.5.1 on page 35 |
| 08h | Caching Page | M | 9.7.5.2 on page 36 |
| 1Bh | Removable Block Access Capacities Page | M | 9.7.5.3 on page 37 |
| 1Ch | Timer & Protect Page | O | 9.7.5.4 on page 38 |
| 3Fh | Return all pages (valid only for MODE SENSE command) | M | |

*Table 26 - Mode Page Format*

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

When using the MODE SENSE command, a Parameter Savable (PS) bit of one indicates that the ATAPI Block Device can save the mode page in a non-volatile, vendor-specific location. A PS bit of zero indicates that the supported parameters cannot be saved. When using the MODE SELECT command, the PS bit is reserved.

The Page Code field identifies the format and parameters defined for that mode page.

When using the MODE SENSE command, if Page Code 00h (vendor-specific) is implemented, the ATAPI Block Device **shall** return that page last in response to a request to return all pages (page code 3Fh). When using MODE SELECT command, this page **shall** be sent last.

The Page Length field specifies the length in bytes of the mode parameters that follow. If the host does not set this value to the value that is returned for the page by the MODE SENSE command, the ATAPI Block Device **shall** terminate this command with CHECK CONDITION status. The sense key **shall** be set to ILLEGAL REQUEST with the additional sense code set to INVALID FIELD IN PARAMETER LIST. The ATAPI Block Device is permitted to implement a mode page that is less than the full page length defined in this Specification, provided no field in truncated and the Page Length filed correctly specifies the actual length implementation.

The mode parameters for each page are defined here. Mode parameters not implemented by the ATAPI Block Device **shall** be set to zero.

*Table 27 - Mode Parameter Header*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | (MSB) | | | Mode Data Length | | | | |
| 1 | | | | | | | | (LSB) |
| 2 | | | | Medium Type Code | | | | |
| 3 | WP | | | Reserved | | | | |
| 4 | | | | Reserved | | | | |
| 5 | | | | Reserved | | | | |
| 6 | | | | Reserved | | | | |
| 7 | | | | Reserved | | | | |

When using the MODE SENSE command, the mode data length field specifies the length in bytes of the following data that is available to be transferred. The mode data length is the total byte count of all data following the mode data length field. When using the MODE SELECT command, this field is reserved.

When using the MODE SENSE command, the Medium Type Code field specifies the inserted medium type. The values in this field are vendor specific. When using the MODE SELECT command, this field is ignored.

*Table 28 - Medium Type Codes*

| Code | Medium Type Definition |
|---|---|
| 00h-FFh | Vendor Specific |

When using the MODE SENSE command, the Write Protect (WP) bit of zero indicates that the medium is write enable. The WP bit of one indicates that the medium is write protected. When using the MODE SELECT command, the WP bit is ignored.

### 9.7.5.1 Read-Write Error Recovery Page (01h)

The Read-Write Error Recovery Page specifies the error recovery parameters the ATAPI Block Device *shall* uses during any command that performs a data read/write operation from the media.

**Table 29 - Read-Write Error Recovery Page**

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

The Parameters Savable (PS) bit is only used with the MODE SENSE command. This bit is reserved with the MODE SELECT command. A PS bit of one indicates that the ATAPI Block Device is capable of saving the page in a non-volatile vendor-specific location. The PS bit is optional.

An Automatic Write Reallocation Enable (AWRE) bit of one indicates that the ATAPI Block Device *shall* enable automatic reallocation to be performed during write operation. An AWRE bit of zero indicates that the ATAPI Block Device *shall not* perform automatic reallocation of defective data blocks during write operations.

A Transfer Block (TB) bit of one indicates that a data block that is not recovered within the recovery limits specified *shall* be transferred to the Host Computer before CHECK CONDITION status is returned. A TB bit of zero indicates that such a data block *shall* not be transferred t the Host Computer. The TB bit does not affect the action taken for recovered data.

A Read Continuous (RC) bit of one indicates that the ATAPI Block Device *shall* transfer the entire requested length of data without adding delays to perform error recovery procedures. This implies that the ATAPI Block Device may send data that is erroneous or fabricated in order to maintain a continuous flow of data. A RC bit of zero indicates that error recovery operations that cause delays are acceptable during the data transfer.

A Post Error (PER) bit of one indicates that the ATAPI Block Device *shall* return CHECK CONDITION status at completion of this command when an error that has a RECOVERED ERROR sense key has occurred. A PER bit of zero indicates that the ATAPI Block Device *shall* return a GOOD status at completion of this command in spite of recoverable error occurred.

A Disable Correction (DCR) bit of one indicates that error correction codes (ECC) *shall not* used for data error recovery. A DCR bit of zero allows the use of error correction codes for data error recovery.

The Read Retry Count field specifies the number of times that the ATAPI Block Device *shall* attempts its recovery during read operation.

The Write Retry Count field specifies the number of times that the ATAPI Block Device *shall* attempts its retry during write and verify operation.

### 9.7.5.2 Caching Page

The Caching Page specifies parameters relating to the use of the cache on the ATAPI Block Device.

*Table 30 - Caching Page*

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

A Write Cache Enable (WCE) bit of zero specifies that the ATAPI Block Device *shall* return GOOD status for WRITE (10), (12) and WRITE AND VERIFY commands after successfully writing all of the data to the medium (Write Trough). A WCE bit of one specifies that the ATAPI Block Device *shall* return GOOD status for WRITE (10), (12) and WRITE AND VERIFY commands after successfully receiving the data and prior to having successfully written it to the medium (Write Back).

A Read Cache Disable (RCD) bit of zero specifies that the ATAPI Block Device *shall* return data requested by a READ command by accessing either the cache or medium. A RCD bit of one specifies that the ATAPI Block Device *shall* transfer all of data requested by a READ command form the medium.

### 9.7.5.3 Removable Block Access Capabilities Page (1Bh)

The Removable Block Access Capabilities page defines the capabilities of ATAPI Block Device covered in this specification.

*Table 31 - Removable Block Access Capabilities Page*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | PS (0) | Reserved | Page Code (1Bh) | | | | | |
| 1 | Page Length (0Ah) | | | | | | | |
| 2 | Reserved | SRFP | Reserved | | | | | |
| 3 | NCD | SML | Reserved | | | | TLUN | |
| 4 | Reserved | | | | | | | |
| 5 | Reserved | | | | | | | |
| 6 | Reserved | | | | | | | |
| 7 | Reserved | | | | | | | |
| 8 | Reserved | | | | | | | |
| 9 | Reserved | | | | | | | |
| 10 | Reserved | | | | | | | |
| 11 | Reserved | | | | | | | |

A Supports Reporting progress of Format (SRFP) bit of one indicates that the ATAPI Block Device **shall be** capable of receiving a FORMAT UNIT command with the Immediate bit set. When this bit is one, during the format operation, the REQUEST SENSE command **shall** report NOT READY, LOGICAL DRIVE NOT READY - FORMAT IN PROGRESS with the sense key specific set to the percentage of the operation that has completed. The Sense Key Specific field contains a value from 0 to FFFFh, where FFFFh is complete.

If this bit is one, the ATAPI Block Device **shall** accept a FORMAT UNIT with the Immediate bit set in the format header. If this bit is zero, the ATAPI Block Device **shall** reject a FORMAT UNIT command with the Immediate bit set and return INVALID FIELD IN PARAMETERS error.

A Non-CD Optical Device (NCD) bit of one indicates that this device is a Non-CD Optical Device as defined in "10.0 Non-CD Optical Device Model" on page 61.

A Single/Multiple LUN supported (SML) bit of one indicates that this device is a phase change dual device and supports a CD device and a Non-CD Optical Device using the same LUN. Devices reporting a one in this bit will change the device type and commands supported based on the type of media installed.

The Total LUN (TLUN) field specifies the total number of LUN supported by this Device. This is different from the Last LUN Identifier in Word 127 of Identify Device Information.

Note: The Removable Block Access Capabilities Page is provided as a means for future implementations to identify the devices covered in this specification. Current compatibility allows for the use of the flexible diskette mode page to identify system floppy devices, and the ATA identify data, "Floppy" medium.

### 9.7.5.4   Timer & Protect Page (1Ch)

The Timer & Protect Page specifies parameters that affect all ATAPI Block Device operation.

***Table 32 - Timer & Protect Page***

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

The Parameters Savable (PS) bit is only used with the MODE SENSE command. This bit is reserved with the MODE SELECT command. A PS bit of one indicates that the ATAPI Block Device is capable of saving the page in a non-volatile vendor-specific location. The PS bit is optional.

The Inactivity Time Multiplier field specifies the length of time that ATAPI Block Device ***shall*** remain in the current state after the completion of a seek or read or write operation.

***Table 33 - Inactivity Time Multiplier Values***

| Inactivity Timer<br>Multiplier | Minimum Time in<br>Current State | Inactivity Timer<br>Multiplier | Minimum Time in<br>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 |

The Disable until Power cycle (DISP) bit will make ATAPI Block Device unavailable to the host until power has been removed and then reapplied. The ATAPI Block Device ***shall*** report NOT READY for all media access after this bit has been changed with MODE SELECT. Set Feature, Enable and Disable ATA commands ***shall not*** affect the status of this DISP bit.

The Software Write Protect until Power-down (SWPP) bit ***shall*** allow host-controlled drives write protection. Once set through the MODE SELECT command, this bit remains set until the next drive power down.

### *9.7.6 PREVENT/ALLOW MEDIUM REMOVAL Command*

The PREVENT/ALLOW MEDIUM REMOVAL command instructs the ATAPI Block Device to enable or disable the removal of the medium in the logical unit. This command *shall* be ignored if MSN is enabled.

*Table 34 - PREVENT/ALLOW MEDIUM REMOVAL Command*

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

The prevention of medium removal *shall* begin when the host computer issues a PREVENT-ALLOW MEDIUM REMOVAL command with a Prevent bit of one. The prevention of medium removal *shall* terminate when:

1.  after the host computer has issued a PREVENT-ALLOW MEDIUM REMOVAL command with a Prevent bit of zero and the ATAPI Block Device has successfully performed a synchronize cache operation (if the cache is implemented); or

2.  upon a hard RESET condition.

While a prevention of medium removal condition is in effect the ATAPI Block Device *shall* inhibit mechanisms that normally allow removal of the medium by an operator.

The default state of the ATAPI Block Device at power on is unlocked, unless ATAPI Block Device supports a prevent-allow jumper and the jumper is in the prevent state.

This command will affect the actions of the START-STOP UNIT command (See "9.7.13 START/STOP UNIT Command" on page 53) and other mechanisms external to this specification (e.g., manual ejection).

*Table 35 - Actions for Lock / Unlock / Eject*

| Operation | Locked / Unlocked | If Drive Not Ready (No Media) | If Drive Ready (Media Present) |
|---|---|---|---|
| Unlock (Prevent = 0) | Unlocked | No Error | No Error |
| | Locked | No Error, Now media may be inserted | No Error, Now media may be removed |
| Lock (Prevent = 1) | Unlocked | No Error, Drive door locked and will not allow media to be inserted | No Error, Drive door locked and will not allow media to be removed |
| | Locked | No Error | No Error |
| Lock when ATAPI Block Device does not support a Locking Mechanism | Would always be Unlocked | Error: 05 ILLEGAL REQUEST, 24 INVALID FIELD IN COMMAND PACKET | Error: 05 ILLEGAL REQUEST, 24 INVALID FIELD IN COMMAND PACKET |
| Eject (START/STOP UNIT command with LoEj set) | Unlocked | No Error and Tray is opened | No Error: Media Ejects |
| | Locked | Error: 02 Not ready, 53 Media Removal Prevented | Error: 02 Not ready, 53 Media Removal Prevented |
| Manual Eject | Unlocked | Tray opens (If tray exists) | Media is Ejected |
| | Locked | No operation occurs | No operation, Media stays locked in drive |

*Table 36 - Recommended Sense Key, ASC and ASCQ for PREVENT/ALLOW Command Errors*

| Sense Key | ASC | ASCQ | Description of Error |
|---|---|---|---|
| 05 | 20 | 00 | INVALID COMMAND OPERATION CODE |
| 05 | 25 | 00 | LOGICAL UNIT NOT SUPPORTED |
| 06 | 28 | 00 | NOT READY TO READY TRANSITION - MEDIA CHANGED |
| 06 | 29 | 00 | POWER ON RESET OR BUS DEVICE RESET OCCURRED |
| 0B | 4E | 00 | OVERLAPPED COMMAND ATTEMPED |

### *9.7.7 READ (10) Command*

The READ (10) command requests that the ATAPI Block Device transfer data to the host computer. The most recent data value written in the addressed logical block *shall* be returned.

This command is considered obsolete and is only supported by legacy drives.

*Table 37 - READ (10) Command*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Operation Code (28h) | | | | | | | |
| 1 | Logical Unit Number | | | Reserved | | | | |
| 2 | (MSB) | | | | | | | |
| 3 | Logical Block Address | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | (LSB) |
| 6 | Reserved | | | | | | | |
| 7 | Transfer Length (MSB) | | | | | | | |
| 8 | Transfer Length (LSB) | | | | | | | |
| 9 | Reserved | | | | | | | |
| 10 | Reserved | | | | | | | |
| 11 | Reserved | | | | | | | |

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.

### 9.7.8    READ (12) Command

The READ (12) command requests that the ATAPI Block Device transfer data to the host computer. The most recent data value written in the addressed logical block ***shall*** be returned.

***Table 38 - READ (12) Command***

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Operation Code (A8h) | | | | | | | |
| 1 | Logical Unit Number | | | Reserved | | | | |
| 2 | (MSB) | | | | | | | |
| 3 | Logical Block Address | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | (LSB) |
| 6 | (MSB) | | | | | | | |
| 7 | Transfer Length | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | (LSB) |
| 10 | Reserved | | | | | | | |
| 11 | Reserved | | | | | | | |

See "9.7.7 READ (10) Command" on page 41 for a definition of the operation of this command.

***Table 39 - Recommended Sense Key, ASC and ASCQ for READ (10) (12) Command Errors***

| Sense<br>Key | ASC | ASCQ | Description of Error |
|---|---|---|---|
| 05 | 20 | 00 | INVALID COMMAND OPERATION CODE |
| 05 | 25 | 00 | LOGICAL UNIT NOT SUPPORTED |
| 06 | 28 | 00 | NOT READY TO READY TRANSITION - MEDIA CHANGED |
| 06 | 29 | 00 | POWER ON RESET OR BUS DEVICE RESET OCCURRED |
| 02 | 04 | 01 | LOGICAL DRIVE NOT READY - BECOMING READY |
| 02 | 06 | 00 | NO REFERENCE POSITION FOUND |
| 02 | 3A | 00 | MEDIUM NOT PRESENT |
| 03 | 02 | 00 | NO SEEK COMPLETE |
| 05 | 21 | 00 | LOGICAL BLOCK ADDRESS OUT OF RANGE |
| 03 | 11 | 00 | UNRECOVERED READ ERROR |
| 01 | 17 | 01 | RECOVERED DATA WITH RETRIES |
| 01 | 18 | 00 | RECOVERED DATA WITH ECC |
| 03 | 12 | 00 | ADDRESS MARK NOT FOUND FOR ID FIELD |
| 03 | 14 | 00 | RECORDED ENTITY NOT FOUND |
| 03 | 10 | 00 | ID CRC ERROR |
| 03 | 30 | 00 | INCOMPATIBLE MEDIUM INSTALLED |
| 03 | 30 | 02 | CANNOT READ MEDIUM - INCOMPATIBLE FORMAT |
| 0B | 4E | 00 | OVERLAPPED COMMAND ATTEMPTED |

### 9.7.9 READ CAPACITY Command

The READ CAPACITY command provides a means for the host computer to request information regarding the capacity of the installed medium of the ATAPI Block Device. This command is considered obsolete and is only supported by legacy drives.

*Table 40 - READ CAPACITY Command*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Operation Code (25h) | | | | | | | |
| 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 | | | | | | | |

Eight bytes of READ CAPACITY data *shall* be returned to the host computer.

*Table 41 - READ CAPACITY Data*

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

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

*Table 42 - Recommended Sense Key, ASC and ASCQ for READ CAPACITY command Errors*

| Sense<br>Key | ASC | ASCQ | Description of Error |
|---|---|---|---|
| 05 | 20 | 00 | INVALID COMMAND OPERATION CODE |
| 05 | 25 | 00 | LOGICAL UNIT NOT SUPPORTED |
| 06 | 28 | 00 | NOT READY TO READY TRANSITION - MEDIA CHANGED |
| 06 | 29 | 00 | POWER ON RESET OR BUS DEVICE RESET OCCURRED |
| 02 | 3A | 00 | MEDIUM NOT PRESENT |
| 03 | 30 | 01 | CANNOT READ MEDIUM |
| 0b | 4E | 00 | OVERLAPPED COMMAND ATTEMPTED |

### 9.7.10   READ FORMAT CAPACITIES Command

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, it **shall** return the maximum capacity that can be formatted by the ATAPI Block Device.

*Table 43 - READ FORMAT CAPACITIES Command*

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

*Table 44 - Read Format Capacities Data Format*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 - 3 | Capacity List Header | | | | | | | |
| 0 - 7 | 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 (See "Table 45 - Capacity List Header" on page 44) gives the length of the descriptor data to follow.

*Table 45 - Capacity List Header*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 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.

*Table 46 - Current/Maximum Capacity Descriptor*

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

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

The Descriptor Code field specifies the type of descriptor returned to the host (See "Table 47 - Descriptor Code definition" on page 45).

**Table 47 - 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 48 - Formattable Capacity Descriptor**

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

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. There is one format capacity descriptor for each physical format that the ATAPI Block Device can support.

The ATAPI Block Device *shall* only return Formattable Capacity Descriptors that apply to the installed media. If there is no media installed, the ATAPI Block Device *shall* return a single Formattable Capacity Descriptor, with the maximum capacity that the ATAPI Block Device is capable of formatting.

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

If the ATAPI Block Device is capable of placing more than one physical format on the installed media, the ATAPI Block Device *shall* return one Formattable Capacity Descriptor for each physical format the ATAPI Block Device can place on the installed media.

*Table 49 - Recommended Sense Key, ASC and ASCQ for READ FORMAT CAP Command Errors*

| Sense Key | ASC | ASCQ | Description of Error |
|-----------|-----|------|----------------------|
| 05 | 20 | 00 | INVALID COMMAND OPERATION CODE |
| 05 | 25 | 00 | LOGICAL UNIT NOT SUPPORTED |
| 06 | 28 | 00 | NOT READY TO READY TRANSITION - MEDIA CHANGED |
| 06 | 29 | 00 | POWER ON RESET OR BUS DEVICE RESET OCCURRED |
| 03 | 30 | 00 | INCOMPATIBLE MEDIUM INSTALLED |
| 03 | 30 | 02 | CANNOT READ MEDIUM - INCOMPATIBLE FORMAT |
| 0B | 4E | 00 | OVERLAPPED COMMAND ATTEMPTED |

### 9.7.11 REQUEST SENSE Command

The REQUEST SENSE command instructs the ATAPI Block Device to transfer sense data to the host computer.

*Table 50 - REQUEST SENSE Command*

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

The sense data:

1. *shall* be available if an error condition (CHECK CONDITION) had previously been reported to the host computer;

2. *shall* be available if other information (e.g. medium position) is available in any field.

If the ATAPI Block Device has no other sense data available to return, it *shall* return a sense key of NO SENSE and an additional sense code of NO ADDITIONAL SENSE INFORMATION.

The sense data *shall* be preserved by the ATAPI Block Device until retrieved by a REQUEST SENSE command or until the receipt of any other I/O Command.

The ATAPI Block Device *shall* return CHECK CONDITION status for a REQUEST SENSE command only to report exception conditions specific to the command itself. For example:

1. An ATAPI Block Device malfunction prevents return of the sense data.

If a recovered error occurs during the execution of the REQUEST SENSE command, the ATAPI Block Device *shall* return the sense data with GOOD status. If an ATAPI Block Device returns CHECK CONDITION status for a REQUEST SENSE command, the sense data may be invalid.

ATAPI Block Devices *shall* be capable of returning at least 18 bytes of data in response to a REQUEST SENSE command. If the Allocation Length is 18 or greater, and an ATAPI Block Device returns less than 18 bytes of data, the host computer should assume that the bytes not transferred are zeros. Host computers can determine how much sense data has been returned by examining the Allocation Length parameter in the Command Packet and the Additional Sense Length in the sense data. ATAPI Block Devices *shall not* adjust the Additional Sense Length to reflect truncation if the Allocation Length is less than the sense data available.

*Table 51 - Request Sense Standard Data*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Valid | Error Code (70h) | | | | | | |
| 1 | Reserved | | | | | | | |
| 2 | Vendor Specific | | | Reserved | Sense Key | | | |
| 3 | Information | | | | | | | |
| 6 | (Vendor Specific) | | | | | | | |
| 7 | Additional Sense Length (n-7) | | | | | | | |
| 8 | Vendor specific | | | | | | | |
| 11 | | | | | | | | |
| 12 | Additional Sense Code (Mandatory) | | | | | | | |
| 13 | Additional Sense Code Qualifier (Mandatory) | | | | | | | |
| 14 | Field Replaceable Unit Code (Optional) | | | | | | | |
| 15 | SKSV | Sense Key Specific | | | | | | |
| 17 | | | | | | | | |
| 18 | Additional Sense Bytes | | | | | | | |
| n | | | | | | | | |

The Error Code field **shall** contain a value of 70h to indicate current errors.

A Valid bit of zero indicates that the Information field is not valid. A Valid bit of one indicates that the Information field contains valid information.

The Sense Key, Additional Sense Code, and Additional Sense Code Qualifier provide a hierarchy of information. The intention of the hierarchy is to provide a top-down approach for a host computer 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. Host computers 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 host computers where sophisticated error recovery procedures require detailed information describing the error and exception conditions.

The Sense Key field is mandatory and indicates generic information describing an error or exception condition. The sense keys are defined in "Table 53 - Sense Key Descriptions" on page 50.

The contents of the Information field are vendor-specific.

The Additional Sense Length field indicates the number of additional sense bytes to follow. If the Allocation Length of the Command packet is too small to transfer all of the additional sense bytes, the Additional Sense Length is not adjusted to reflect the truncation.

The Additional Sense Code (ASC) field is mandatory and 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 ATAPI Block 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) is mandatory and indicates detailed information related to the Additional Sense Code. If the error or exception condition is reportable by the ATAPI Block Device, the value returned **shall** be as specified in the appropriate section. If the ATAPI Block Device does not have detailed information related to the error or exception condition, the ASCQ **shall** be set to zero.

Non-zero values in the Field Replaceable Unit Code field are used to define a device-specific mechanism or until that has failed. A value of zero in this field *shall* indicate that no specific mechanism or unit has been identified to fail or that the data is not available. The Field Replaceable Unit Code field is optional. The format of this information is not specified by this Specification. Additional information about the field replaceable unit may be available in the ASCII information page, if supported by the ATAPI Block Device.

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.

### 9.7.11.1 Sense-key Specific

The Sense-Key Specific field is defined by this Specification when the value of the Sense-Key Specific Valid (SKSV) bit is one. The Sense-Key Specific Valid bit and Sense-Key Specific fields are optional. The definition of this field is determined by the value of the Sense Key field. This field is reserved for sense keys not described below. A SKSV value of zero indicates that this field is not as defined by this Specification.

If the sense key is NOT READY or NO SENSE and the SKSV bit is one, the Sense-Key Specific field *shall* be as follows.

*Table 52 - Progress indication bytes*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 15 | SKSV | Reserved | | | | | | |
| 16 | (MSB) | Progress indication | | | | | | |
| 17 | | | | | | | | (LSB) |

The progress indication field is a percent complete indication in which the returned value is the numerator that has 65536 (10000h) as its denominator. The progress indication shall based upon the total format operation including any certification or initialization operations.

### 9.7.11.2  Sense-key and Sense Code Definitions

**Table 53 - 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 ATAPI Block 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 ATAPI Block 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 ATAPI Block 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 ATAPI Block 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 ATAPI Block Device detects an invalid parameter in the Command Packet, then it **shall** terminate the command without altering the medium. If the ATAPI Block Device detects an invalid parameter in the additional parameters supplied as data, then the ATAPI Block Device may have already altered the medium. |
| 6h | UNIT ATTENTION. Indicates that the removable medium may have been changed or the ATAPI Block 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 ATAPI Block Device has aborted the command. The host may be able to recover by trying the command again. |
| 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 |

### 9.7.11.3  Using the REQUEST SENSE Command

Whenever an Error is reported, the host computer should issue a REQUEST SENSE command to receive the sense data describing what caused the Error condition. If the host computer issues some other command, the sense data is lost.

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

*Table 54 - Recommended Sense Keys, ASC and ASCQ for All Commands Errors*

| Sense Key | ASC | ASCQ | Description of Error |
|---|---|---|---|
| 01 | 17 | 01 | RECOVERED DATA WITH RETRIES |
| 01 | 18 | 00 | RECOVERED DATA WITH ECC |
| 02 | 3A | 00 | MEDIUM NOT PRESENT |
| 02 | 04 | 01 | LOGICAL DRIVE NOT READY - BECOMING READY |
| 02 | 04 | 04 | LOGICAL DRIVE NOT READY - FORMAT IN PROGRESS |
| 02 | 06 | 00 | NO REFERENCE POSITION FOUND |
| 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 | 14 | 00 | RECORDED ENTITY NOT FOUND |
| 03 | 30 | 00 | INCOMPATIBLE MEDIUM INSTALLED |
| 03 | 30 | 02 | CANNOT READ MEDIUM - INCOMPATIBLE FORMAT |
| 03 | 30 | 01 | CANNOT READ MEDIUM - UNKNOWN FORMAT |
| 03 | 31 | 01 | FORMAT COMMAND FAILED |
| 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 | 53 | 02 | MEDIUM REMOVAL PREVENTED |
| 06 | 28 | 00 | NOT READY TO READY TRANSITION - MEDIA CHANGED |
| 06 | 29 | 00 | POWER ON RESET OR BUS DEVICE RESET OCCURRED |
| 07 | 27 | 00 | WRITE PROTECTED MEDIA |
| 0B | 4E | 00 | OVERLAPPED COMMAND ATTEMPTED |

*Table 55 - Recommended Sense Key, ASC and ASCQ for REQUEST SENSE Command Errors*

| Sense Key | ASC | ASCQ | Description of Error |
|---|---|---|---|
| 05 | 20 | 00 | INVALID COMMAND OPERATION CODE |
| 05 | 25 | 00 | LOGICAL UNIT NOT SUPPORTED |
| 06 | 28 | 00 | NOT READY TO READY TRANSITION - MEDIA CHANGED |
| 06 | 29 | 00 | POWER ON RESET OR BUS DEVICE RESET OCCURRED |
| 0B | 4E | 00 | OVERLAPPED COMMAND ATTEMPTED |

### 9.7.12 SEEK Command

The SEEK command requests that the ATAPI Block 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.

The SEEK Command will always be executed as an immediate command. The command will return completion status as soon as the seek operation has been started.

**Table 56 - SEEK Command**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Operation Code (2Bh) | | | | | | | |
| 1 | Logical Unit Number | | | Reserved | | | | |
| 2 | (MSB) | | | | | | | |
| 3 | Logical Block Address | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | (LSB) |
| 6 | Reserved | | | | | | | |
| 7 | Reserved | | | | | | | |
| 8 | Reserved | | | | | | | |
| 9 | Reserved | | | | | | | |
| 10 | Reserved | | | | | | | |
| 11 | Reserved | | | | | | | |

**Table 57 - Recommended Sense Key, ASC and ASCQ for SEEK Command Errors**

| Sense<br>Key | ASC | ASCQ | Description of Error |
|---|---|---|---|
| 05 | 20 | 00 | INVALID COMMAND OPERATION CODE |
| 05 | 25 | 00 | LOGICAL UNIT NOT SUPPORTED |
| 06 | 28 | 00 | NOT READY TO READY TRANSITION - MEDIA CHANGED |
| 06 | 29 | 00 | POWER ON RESET OR BUS DEVICE RESET OCCURRED |
| 02 | 04 | 01 | LOGICAL DRIVE NOT READY - BECOMING READY |
| 02 | 06 | 00 | NO REFERENCE POSITION FOUND |
| 02 | 3A | 00 | MEDIUM NOT PRESENT |
| 03 | 02 | 00 | NO SEEK COMPLETE |
| 05 | 21 | 00 | LOGICAL BLOCK ADDRESS OUT OF RANGE |
| 03 | 12 | 00 | ADDRESS MARK NOT FOUND FOR ID FIELD |
| 03 | 10 | 00 | ID CRC ERROR |
| 03 | 14 | 00 | RECORDED ENTITY NOT FOUND |
| 03 | 30 | 00 | INCOMPATIBLE MEDIUM INSTALLED |
| 03 | 30 | 02 | CANNOT READ MEDIUM - INCOMPATIBLE FORMAT |
| 0B | 4E | 00 | OVERLAPPED COMMAND ATTEMPTED |

### 9.7.13 START/STOP UNIT Command

The START/STOP UNIT command instructs the ATAPI Block Device to enable or disable media access operations.

*Table 58 - START/STOP UNIT Command*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Operation Code (1Bh) | | | | | | | |
| 1 | Logical Unit Number | | | Reserved | | | | Immed |
| 2 | Reserved | | | | | | | |
| 3 | Reserved | | | | | | | |
| 4 | Reserved | | | | | | LoEj | Start |
| 5 | Reserved | | | | | | | |
| 6 | Reserved | | | | | | | |
| 7 | Reserved | | | | | | | |
| 8 | Reserved | | | | | | | |
| 9 | Reserved | | | | | | | |
| 10 | Reserved | | | | | | | |
| 11 | Reserved | | | | | | | |

An Immediate (Immed) bit of one indicates that status *shall* be returned as soon as the Command Packet has been validated. An Immed bit of zero indicates that status *shall* be returned after the operation is completed.

A Start bit of one request the ATAPI Block Device to be made ready for use. A Start bit of zero requests that the ATAPI Block Device be stopped (media cannot be accessed by the host computer).

*Table 59 - Start/Stop and Eject Operations*

| LoEj | Start | Operation to be Performed |
|---|---|---|
| 0 | 0 | Stop the Disc |
| 0 | 1 | Start the Disc and acquire the format type |
| 1 | 0 | Eject the Disc if possible |
| 1 | 1 | Load the Disc (Close Tray) |

Any attempt to Eject or Load a Disc when the ATAPI Block Device does not support that capability *shall* result in an error being reported to the host (Sense Key 05 ILLEGAL REQUEST, Sense Code 24 INVALID FIELD IN COMMAND PACKET).

A Load Eject (LoEj) bit of zero requests that no action be taken regarding loading or ejecting the medium. A LoEj bit of one requests that the medium be unloaded if the Start bit is zero. A LoEj bit of one requests that the medium be loaded if the start bit is one.

*Table 60 - Action for Eject/Load Disc*

| Operation | Locked / Unlocked | If Drive Not Ready (No Media) | If Drive Ready (Media Present) |
|---|---|---|---|
| Eject | Unlocked | No Error and Tray is opened | No Error: Media Ejects |
|  | Locked | Error: 02 NOT READY, 53 MEDIA REMOVAL PREVENTED | Error: 02 NOT READY, 53 MEDIA REMOVAL PREVENTED |
| Manual Eject | Unlocked | Tray opens (If Tray exists) | Media is Ejected |
|  | Locked | No operation occurs | No operation, Media stays locked in drive |

*Table 61 - Recommended Sense Key, ASC and ASCQ for START/STOP UNIT Command Errors*

| Sense Key | ASC | ASCQ | Description of Error |
|---|---|---|---|
| 05 | 20 | 00 | INVALID COMMAND OPERATION CODE |
| 05 | 25 | 00 | LOGICAL UNIT NOT SUPPORTED |
| 05 | 24 | 00 | INVALID FIELD IN COMMAND PACKET |
| 05 | 53 | 02 | MEDIUM REMOVAL PREVENTED |
| 06 | 28 | 00 | NOT READY TO READY TRANSITION - MEDIA CHANGED |
| 06 | 29 | 00 | POWER ON RESET OR BUS DEVICE RESET OCCURRED |
| 02 | 3A | 00 | MEDIUM NOT PRESENT |
| 03 | 30 | 00 | INCOMPATIBLE MEDIUM INSTALLED |
| 03 | 30 | 02 | CANNOT READ MEDIUM - INCOMPATIBLE FORMAT |
| 0B | 4E | 00 | OVERLAPPED COMMAND ATTEMPTED |

### 9.7.14  TEST UNIT READY Command

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

***Table 62 - TEST UNIT READY Command***

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

### 9.7.14.1  Using the TEST UNIT READY Command

The TEST UNIT READY command is useful in that it allows a host computer to poll a ATAPI Block Device until it is ready without the need to allocate space for returned data. It is especially useful to check cartridge status. ATAPI Block Devices are expected to respond promptly to indicate the current status of the ATAPI Block Device.

***Table 63 - Recommended Sense Key, ASC and ASCQ for TEST UNIT READY Command Errors***

| Sense<br>Key | ASC | ASCQ | Description of Error |
|---|---|---|---|
| 05 | 20 | 00 | INVALID COMMAND OPERATION CODE |
| 05 | 25 | 00 | LOGICAL UNIT NOT SUPPORTED |
| 06 | 28 | 00 | NOT READY TO READY TRANSITION - MEDIA CHANGED |
| 06 | 29 | 00 | POWER ON RESET OR BUS DEVICE RESET OCCURRED |
| 02 | 04 | 01 | LOGICAL DRIVE NOT READY - BECOMING READY |
| 02 | 3A | 00 | MEDIUM NOT PRESENT |
| 03 | 30 | 00 | INCOMPATIBLE MEDIUM INSTALLED |
| 03 | 30 | 02 | CANNOT READ MEDIUM - INCOMPATIBLE FORMAT |
| 0B | 4E | 00 | OVERLAPPED COMMAND ATTEMPTED |

### 9.7.15  VERIFY Command

The VERIFY command requests that the ATAPI Block Device verify the data written on the medium.

***Table 64 - VERIFY Command***

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Operation Code (2Fh) | | | | | | | |
| 1 | Logical Unit Number | | | Reserved | | | ByteChk | Reserve |
| 2 | (MSB) | | | | | | | |
| 3 | Logical Block Address | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | (LSB) |
| 6 | Reserved | | | | | | | |
| 7 | Verification Length (MSB) | | | | | | | |
| 8 | Verification Length (LSB) | | | | | | | |
| 9 | Reserved | | | | | | | |
| 10 | Reserved | | | | | | | |
| 11 | Reserved | | | | | | | |

The Byte Check (ByteChk) bit is optional. A ByteChk bit of zero causes a medium verification to be performed with no data comparison. A ByteChk bit of one causes a byte-by-byte compare of data written on the medium and the data transferred from the host computer. If the comparison is unsuccessful for any reason, the ATAPI Block Device ***shall*** return CHECK CONDITION status with the sense key set to MISCOMPARE.

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 are to be verified. This condition ***shall*** be considered an error-free null operation.

***Table 65 - Recommended Sense Key, ASC and ASCQ for VERIFY Command Errors***

| Sense<br>Key | ASC | ASCQ | Description of Error |
|---|---|---|---|
| 05 | 20 | 00 | INVALID COMMAND OPERATION CODE |
| 05 | 25 | 00 | LOGICAL UNIT NOT SUPPORTED |
| 05 | 24 | 00 | INVALID FIELD IN COMMAND PACKET |
| 06 | 28 | 00 | NOT READY TO READY TRANSITION - MEDIA CHANGED |
| 06 | 29 | 00 | POWER ON RESET OR BUS DEVICE RESET OCCURRED |
| 02 | 04 | 01 | LOGICAL DRIVE NOT READY - BECOMING READY |
| 02 | 06 | 00 | NO REFERENCE POSITION FOUND |
| 02 | 3A | 00 | MEDIUM NOT PRESENT |
| 03 | 02 | 00 | NO SEEK COMPLETE |
| 05 | 21 | 00 | LOGICAL BLOCK ADDRESS OUT OF RANGE |
| 03 | 11 | 00 | UNRECOVERED READ ERROR |
| 03 | 12 | 00 | ADDRESS MARK NOT FOUND FOR ID FIELD |
| 03 | 14 | 00 | RECORDED ENTITY NOT FOUND |
| 03 | 10 | 00 | ID CRC ERROR |
| 03 | 30 | 00 | INCOMPATIBLE MEDIUM INSTALLED |
| 03 | 30 | 02 | CANNOT READ MEDIUM - INCOMPATIBLE FORMAT |
| 0B | 4E | 00 | OVERLAPPED COMMAND ATTEMPTED |

### 9.7.16 WRITE (10) Command

The WRITE (10) command requests that the ATAPI Block Device write the data transferred by the host computer to the medium.

*Table 66 - WRITE (10) Command*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Operation Code (2Ah) | | | | | | | |
| 1 | Logical Unit Number | | | Reserved | | | | |
| 2 | (MSB) | | | | | | | |
| 3 | Logical Block Address | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | (LSB) |
| 6 | Reserved | | | | | | | |
| 7 | Transfer Length (MSB) | | | | | | | |
| 8 | Transfer Length (LSB) | | | | | | | |
| 9 | Reserved | | | | | | | |
| 10 | Reserved | | | | | | | |
| 11 | Reserved | | | | | | | |

The Logical Block Address field specifies the logical block at which the write 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 and no data *shall* be written. Any other value indicates the number of logical blocks that *shall* be transferred.

### 9.7.17  WRITE (12) Command

The WRITE (12) command requests that the ATAPI Block Device write the data transferred by the host computer to the medium.

***Table 67 - WRITE (12) Command***

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Operation Code (AAh) | | | | | | | |
| 1 | Logical Unit Number | | | Reserved | | | | |
| 2 | (MSB) | | | | | | | |
| 3 | Logical Block Address | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | (LSB) |
| 6 | (MSB) | | | | | | | |
| 7 | Transfer Length | | | | | | | |
| 8 | | | | | | | | |
| 9 | | | | | | | | (LSB) |
| 10 | Reserved | | | | | | | |
| 11 | Reserved | | | | | | | |

See "9.7.16  WRITE (10) Command" on page 57 for a definition of the operation of this command.

***Table 68 - Recommended Sense Key, ASC and ASCQ for WRITE (10) (12) Command Errors***

| Sense<br>Key | ASC | ASCQ | Description of Error |
|---|---|---|---|
| 05 | 20 | 00 | INVALID COMMAND OPERATION CODE |
| 05 | 25 | 00 | LOGICAL UNIT NOT SUPPORTED |
| 06 | 28 | 00 | NOT READY TO READY TRANSITION - MEDIA CHANGED |
| 06 | 29 | 00 | POWER ON RESET OR BUS DEVICE RESET OCCURRED |
| 07 | 27 | 00 | WRITE PROTECTED MEDIA |
| 02 | 3A | 00 | MEDIUM NOT PRESENT |
| 02 | 06 | 00 | NO REFERENCE POSITION FOUND |
| 03 | 02 | 00 | NO SEEK COMPLETE |
| 03 | 30 | 01 | CANNOT READ MEDIUM - UNKNOWN FORMAT |
| 03 | 12 | 00 | ADDRESS MARK NOT FOUND FOR ID FIELD |
| 03 | 14 | 00 | RECORDED ENTITY NOT FOUND |
| 05 | 21 | 0 | LOGICAL BLOCK ADDRESS OUT OF RANGE |
| 03 | 10 | 00 | ID CRC ERROR |
| 03 | 30 | 00 | INCOMPATIBLE MEDIUM INSTALLED |
| 03 | 30 | 02 | CANNOT READ MEDIUM - INCOMPATIBLE FORMAT |
| 0B | 4E | 00 | OVERLAPPED COMMAND ATTEMPTED |

### 9.7.18  WRITE AND VERIFY Command

The WRITE AND VERIFY command requests that the ATAPI Block Device write the data transferred from the host computer to the medium and then verify that the data is correctly written. The data is only transferred once from the host computer.

*Table 69 - WRITE AND VERIFY Command*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Operation Code (2Eh) | | | | | | | |
| 1 | Logical Unit Number | | | Reserved | | | ByteChk | Reserve |
| 2 | (MSB) | | | | | | | |
| 3 | Logical Block Address | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | (LSB) |
| 6 | Reserved | | | | | | | |
| 7 | Transfer Length (MSB) | | | | | | | |
| 8 | Transfer Length (LSB) | | | | | | | |
| 9 | Reserved | | | | | | | |
| 10 | Reserved | | | | | | | |
| 11 | Reserved | | | | | | | |

The Byte Check (ByteChk) bit is optional. A ByteChk bit of zero causes a medium verification to be performed with no data comparison. A ByteChk bit of one causes a byte-by-byte compare of data written on the medium and the data transferred from the host computer. If the comparison is unsuccessful for any reason, the ATAPI Block Device **shall** return CHECK CONDITION status with the sense key set to MISCOMPARE.

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.

*Table 70 - Recommended Sense Key, ASC and ASCQ for WRITE AND VERIFY Command Errors*

| Sense Key | ASC | ASCQ | Description of Error |
|---|---|---|---|
| 05 | 20 | 00 | INVALID COMMAND OPERATION CODE |
| 05 | 25 | 00 | LOGICAL UNIT NOT SUPPORTED |
| 05 | 24 | 00 | INVALID FIELD IN COMMAND PACKET |
| 06 | 28 | 00 | NOT READY TO READY TRANSITION - MEDIA CHANGED |
| 06 | 29 | 00 | POWER ON RESET OR BUS DEVICE RESET OCCURRED |
| 07 | 27 | 00 | WRITE PROTECTED MEDIA |
| 02 | 3A | 00 | MEDIUM NOT PRESENT |
| 02 | 06 | 00 | NO REFERENCE POSITION FOUND |
| 03 | 02 | 00 | NO SEEK COMPLETE |
| 03 | 30 | 01 | CANNOT READ MEDIUM - UNKNOWN FORMAT |
| 03 | 12 | 00 | ADDRESS MARK NOT FOUND FOR ID FIELD |
| 03 | 14 | 00 | RECORDED ENTITY NOT FOUND |
| 05 | 21 | 00 | LOGICAL BLOCK ADDRESS OUT OF RANGE |
| 03 | 10 | 00 | ID CRC ERROR |
| 03 | 30 | 00 | INCOMPATIBLE MEDIUM INSTALLED |
| 03 | 30 | 02 | CANNOT READ MEDIUM - INCOMPATIBLE FORMAT |
| 0B | 4E | 00 | OVERLAPPED COMMAND ATTEMPTED |

## *10.0 Non-CD Optical Device Model*

### *10.1 Non-CD Optical Model Description*

#### *10.1.1 Background of Non-CD Optical Device Model*

The connection rate of CD-ROM drive in computer systems has reached almost to 100%. However, due to the READ Only restriction of CD-ROM drive, the need for large rewritable capacity and lack of real estate in the computer systems, the multi-function drives are inevitably demanded by the computer users. Also, increasing user data capacity due to multimedia applications with digital audio and video information, and internet environment require high capacity removable data storage device with CD-ROM function as data input device.

#### *10.1.2 Model Description*

Non-CD Optical Model such as PD drive has two portions which are able to read CD/CD-ROM media and able to read and write sector formatted media. The former portion is the same as conventional CD-ROM model and latter portion is a removable and rewritable random data storage device. Rewritable sector formatted media used in this model has direct overwrite capability by phase change recording material and same data reproducing method as conventional CD-ROM media enable to handle both CD-ROM media and rewritable media in the same device.

These two portions of this model can be selected by Logical Unit Number (LUN) value in certain bit in packet command described in "10.1.3 Description for Logical Unit Concept" on page 61.

Rewritable portion of this model can read and write from/to sector formatted media which has 512bytes sector capacity and support defect management function in the device which can be enabled to allocate data from defective sector to replacement sector automatically.

Direct overwrite operation using rewritable media in this model is executed by making amorphous marks and crystallized (erased) area with a single laser beam. The read-out signal is obtained from the difference of their reflectivity between two phases, i.e. amorphous and crystalline phase. Data mark is stored by one-path overwrite process without erase operation before data writing.

Rewritable sector formatted media used in this model has its cartridge case to protect the user data on the rewritable media from un-intentional scratches, dusts and fingerprints.

The principal technologies developed for this type of model are listed as follows:

(1) Optical head capable of conducting read/write operations for phase change rewritable optical disk and read operation for conventional CD-ROM media.
(2) Phase change rewritable optical disk with high sensitivity and high reliability.
(3) A single common tray loading mechanism capable of accommodating both cartridge media and bare disk like CD-ROM's.

#### *10.1.3 Description for Logical Unit Concept*

The implementation of dual functionality in this model is via a support for multiple Logical Unit concept.

The Logical Unit concept is similar to the one used in SCSI interface. This device model assigns a separate Logical Unit Number for each function such as rewritable function and CD-ROM function.

This device model can support both dual Logical Unit mode called TWO LUN mode and single Logical Unit mode called ONE LUN mode. This two types of LUN mode is defined in Drive Operation Mode Page described in " 10.4.1 Drive Operation Mode Page" on page 67.

In the case of supporting Two-LUN mode, Rewritable Logical Unit (Device Type is 07h) and CD-ROM Logical Unit (Device Type is 05h) are supported. Rewritable Logical Unit behaves according to Block Device Model documented in this draft proposal. Rewritable Logical Unit permits reading and writing from/to rewritable optical media. CD-ROM Logical Unit behaves according to CD-ROM model documented in SFF-8020i Rev. 2.6. CD-ROM Logical Unit permits reading from CD media.

In the case of supporting Two-LUN mode, Rewritable and CD-ROM Logical Units are accessed by two different Logical Unit Numbers, i.e. 0 or 1.

In the case of One-LUN mode, both Rewritable and CD-ROM Logical Units are supported and accessed by the same Logical Unit Number 0. This Device Model will automatically switch to Rewritable Logical Unit or CD-ROM Logical Unit, when the appropriate cartridge or Disc is inserted.

The Value of 2 is returned in the TLUN field of Removable Block Access Capability Page.

### 10.1.4  Format of rewritable Optical Disk

The rewritable optical disk used in this Model is physically formatted prior to a MCAV format with 512 bytes sector.
In contrary to a 2048 Bytes sector size of CD/CD-ROM, 512 byte sector is chosen to conform with the current OS in rewritable optical disk format. MCAV format with ten zones is also adopted with logical address starting from outer diameter in order to have high data transfer rate. The MCAV format and 1.2 um track pitch realize a capacity of 650MB.

Sector structure is similar to ISO 10089 format and has ID information in each sector physically. Recording method is a pulse position modulation (PPM) and the modulation scheme is 2, 7 RLL code.

For details information on the physical format, please see ECMA - 240: Data Interchange on 120mm Optical Disk Cartridges using Phase Change PD Format - Capacity: 650MBytes per cartridge.

### 10.1.5  Defect Management

Defect management procedure for rewritable optical media *shall* be performed by Non-CD Optical Device Model.
The method of defect management is sector slipping and linear replacement. Sector slipping algorithm will be used for pre- certified disk and linear replacement method will be used in both certified and non-certified disk. The control information about defect management procedure is recorded in innermost area and outermost area of the disk.

The spare areas used in both sector slipping and linear replacement algorithm are located in each of ten MCAV zones.

These informations about defect management procedure are also described in ECMA - 240 in details.

### 10.1.6  Optical Disk and Cartridge

Phase change rewritable optical disk used in the Non-CD optical device model has its cartridge to protect it from any unintentional scratches, dusts and fingerprints. The disk is 120mm diameter and 1.2mm thickness single-sided disk that is the same as CD/CD-ROM disc. Disk has physically formatted spiral groove for producing tracking and accessing signal. The spiral track made by the groove is starting from outer diameter of the disk.

The phase change recording material is used in the rewritable optical disk. This material generates reflectivity difference depending on recorded mark and unrecorded area after heating the recorded layer by modulated and focused laser beam. The recorded mark becomes amorphous state and unrecorded area becomes crystalline state.  Amorphous state has lower reflectivity than crystalline state. These reflectivity differences can be detected by focused laser beam of a weak power.  This reading mechanism generates read out signal from the phase change rewritable disk.

## 10.2  Non-CD Block Model Ready Condition / Not Ready Condition

The ready condition occurs after a cartridge is inserted and the Non-CD Optical Device has performed its initialization task.  This  "Ready" is different from and *shall not* be confused with the ATA Ready status. A check condition status will be returned for the Not Ready condition only for commands that require or imply a disk access.

A Not Ready condition may occur for the following reasons:
1. There is no cartridge inserted.
2. The drive is spinning up.
3. There is a disc for CD inserted.

### 10.2.1  Packet Command Not Ready Status Utilization

*Table 71 - Not Ready Error Reporting (by Command)*

| Command Description | Code | May Return Not Ready Error |
|---|---|---|
| FORMAT UNIT | 04h | Yes |
| INQUIRY | 12h | No |
| MODE SELECT | 55h | No |
| MODE SENSE | 5Ah | No |
| PREVENT ALLOW MEDIUM REMOVAL | 1Eh | No |
| READ(10) | 28h | Yes |
| READ(12) | A8h | Yes |
| READ CAPACITY | 25h | Yes |
| READ FORMAT CAPACITY | 23h | No |
| REQUEST SENSE | 03h | No |
| SEEK | 2Bh | Yes |
| START STOP UNIT | 1Bh | *1 |
| TEST UNIT READY | 00h | Yes |
| VERIFY | 2Fh | Yes |
| WRITE(10) | 2Ah | Yes |
| WRITE(12) | AAh | Yes |
| WRITE AND VERIFY | 2Eh | Yes |

*1: Not ready error for START STOP UNIT command is defined in "Table 72 - Not Ready Error Reporting for START STOP COMMAND" on page 64.

*Table 72 - Not Ready Error Reporting for START STOP COMMAND*

|  | No Disk | Spinning | Other Disk (CD) |
|---|---|---|---|
| START | Yes | No | Yes |
| STOP | Yes | No | Yes |
| LOAD | No | No | No |
| EJECT | No | No | No |

## 10.3  Error Reporting

If any of the following conditions occur during the execution of a command for Rewritable Logical Unit, Non-CD Optical Device **shall** return CHECK CONDITION status. The appropriate sense key and additional sense code **shall** be set. The following list illustrates some error conditions and the applicable sense keys. The list does not provide an exhaustive enumeration of all conditions that may cause the CHECK CONDITION status.

*Table 73 - Error Conditions and Sense Keys for Non-CD Optical Device*

| Condition | Sense Key |
|---|---|
| INVALID LOGICAL BLOCK ADDRESS | ILLEGAL REQUEST |
| UNSUPPORTED OPTION REQUESTED | ILLEGAL REQUEST |
| NON-CD OPTICAL DEVICE RESET OR MEDIUM CHANGE SINCE LAST COMMAND FROM THE HOST | UNIT ATTENTION |
| UNRECOVERED READ / WRITE ERROR | MEDIUM ERROR or HARDWARE ERROR |
| RECOVERED ERROR | RECOVERED ERROR |
| OVERRUN OR OTHER ERROR THAT MIGHT BE RESOLVED BE REPEATING THE COMMAND | ABORTED COMMAND |
| ATTEMPT TO WRITE ON WRITE PROTECTED MEDIUM | DATA PROTECT |

### 10.3.1  READ (10) (12) Command

*Table 74 - Recommended Sense Key, ASC and ASCQ for READ (10) (12) Command Errors*

| Sense Key | ASC | ASCQ | Description of Error |
|---|---|---|---|
| 03 | 16 | 00 | DATA SYNCHRONIZATION MARK ERRORS |
| 01 | 17 | 05 | RECOVERED DATA USING PREVIOUS SECTOR ID |
| 01 | 18 | 01 | RECOVERED DATA WITH ERROR CORRECTION & RETRIES APPLIED |
| 03 | 31 | 00 | MEDIUM FORMAT CORRUPTED |

### 10.3.2  READ CAPACITY Command

*Table 75 - Recommended Sense Key, ASC and ASCQ for READ CAPACITY Command Errors*

| Sense Key | ASC | ASCQ | Description of Error |
|-----------|-----|------|----------------------|
| 03 | 31 | 00 | MEDIUM FORMAT CORRUPTED |

### 10.3.3  SEEK Command

*Table 76 - Recommended Sense Key, ASC and ASCQ for SEEK Command Errors*

| Sense Key | ASC | ASCQ | Description of Error |
|-----------|-----|------|----------------------|
| 03 | 31 | 00 | MEDIUM FORMAT CORRUPTED |

### 10.3.4  VERIFY Command

*Table 77 - Recommended Sense Key, ASC and ASCQ for VERIFY Command Errors*

| Sense Key | ASC | ASCQ | Description of Error |
|-----------|-----|------|----------------------|
| 03 | 16 | 00 | DATA SYNCHRONIZATION MARK ERRORS |
| 03 | 31 | 00 | MEDIUM FORMAT CORRUPTED |

### 10.3.5  WRITE (10) (12), WRITE AND VERIFY  Command

*Table 78 - Recommended Sense Key, ASC and ASCQ for WRITE (10) (12) Command Errors*

| Sense Key | ASC | ASCQ | Description of Error |
|-----------|-----|------|----------------------|
| 03 | 0C | 02 | WRITE ERROR – AUTO REALLOCATION FAILED |
| 03 | 16 | 00 | DATA SYNCHRONIZATION MARK ERRORS |
| 03 | 31 | 00 | MEDIUM FORMAT CORRUPTED |
| 03 | 32 | 00 | NO DEFECT SPACE LOCATION AVAILABLE |
| 03 | 32 | 01 | DEFECT LIST UPDATE FAILURE |

### 10.4  Mode Select / Sense Parameters for Non-CD Optical Device

Non-CD Optical Device **shall** support the following Mode Page Codes for Rewritable Logical Unit.

*Table 79 - Mode Page Codes for Non-CD Optical Device*

| Page Code | Definition | Reference | Type |
|---|---|---|---|
| 00h | Drive Operation Mode Page | 10.4.1 on page 67 | O |
| 01h | Read-Write Error Recovery Page | 9.7.5.1 on page 35 | M |
| 08h | Caching Page | 9.7.5.2 on page 36 | M |
| 1Bh | Removable Block Access Capacities Page | 9.7.5.3 on page 37 | M |
| 1Ch | Timer & Protect Page | 9.7.5.4 on page 38 | O |
| 20h | Format Parameters Page | 10.4.2 on page 68 | O |
| 3Fh | Return all pages (valid only for MODE SENSE command) |  | M |

When Non-CD Optical Device has TWO Logical Units, Mode Page of 00h **shall** be common for both Logical Units. Non-CD Optical Device **shall** hold only one copy of this Mode Page and have it apply to both Logical Units. Mode Pages of 01h and 08h **shall** be separated for each Logical Unit. Mode Pages of 1Bh, 1Ch and 20h **shall** be applied for Rewritable Logical Unit. Non-CD Optical Device **shall** hold only one copy of these Mode Pages. When Non-CD Optical Device has ONE Logical Unit, all Mode Pages **shall** be common. Non-CD Optical Device **shall** hold only one copy of these Mode Pages.

*Table 80 - Medium Type Codes for Non-CD Optical Device*

| Code | Medium Type Definition |
|---|---|
| 00h | Door closed, medium type unknown |
| 01h | 120mm CD-ROM data only |
| 02h | 120mm CD-DA audio only |
| 03h | 120mm CD-ROM data and audio combined |
| 04h | 120mm CD-ROM Hybrid disc (Photo CD) |
| 05h | 80mm CD-ROM data only |
| 06h | 80mm CD-DA audio only |
| 07h | 80mm CD-ROM data and audio combined |
| 08h | 80mm CD-ROM Hybrid disc (Photo CD) |
| 09h-3Fh | Reserved |
| 40h | Block Device unknown type |
| 41h | Block Device Read only |
| 42h | Block Device Read / Write |
| 43h-69h | Reserved |
| 70h | Door closed, no disc present |
| 71h | Door open |
| 72h | Door closed, medium format error |
| 73h-8Fh | Reserved |
| 90h-FFh | Vendor Specific |

### 10.4.1 Drive Operation Mode Page

ATAPI Block Device Operation Mode Page specifies parameters for Non-CD Optical Device operation mode.

*Table 81 - Drive Operation Mode Page*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | PS | Reserved | Page Code (00h) | | | | | |
| 1 | Page Length (02h) | | | | | | | |
| 2 | SLM | SLR | DVW | Vendor Specific | | | | |
| 3 | Vendor Specific | | | DDE | Vendor Specific | | | |

Disable Verify for WRITE (DVW) bit specifies the operation of WRITE (10), (12) and WRITE AND VERIFY commands. This bit of zero indicates that the Non-CD Optical Device *shall* perform the verify operation for WRITE (10), (12) commands and the write cache operation for WRITE AND VERIFY command is enabled. This bit of one indicates that the Non-CD Optical Device *shall not* perform verify operation for WRITE (10), (12) commands and the write cache operation for WRITE AND VERIFY command is disabled.

A Select LUN Mode (SLM) bit of one indicates that Non-CD Optical Device *shall* have TWO Logical Unit. When TWO LUN Mode is selected, Rewritable Logical Unit Number depends on the Select LUN for Rewritable bit (**SLR**) described below. A SLM bit of zero indicates that Non-CD Optical Device *shall* have only ONE Logical Unit.

A Select LUN for Rewritable (SLR) bit is valid when the SLM bit is set to one (TWO LUN Mode). This bit of zero indicates that Rewritable Logical Unit can be used as LUN 0. This bit of one indicates that Rewritable Logical Unit can be used as LUN 1.

A disable deferred error (DDE) bit of one indicates that the Non-CD Optical Device *shall* be disabled to report any error as an deferred error even if the error has been detected during the write back operation. The error detected during the write back operation is reported as a current error. A DDE bit of zero is ignored. Although this bit is set to zero by a MODE SELECT command, the Non-CD Optical Device *shall* report the error detected during the write back operation as a current error.

### 10.4.2   Format Parameters Page

The Format Parameters Page defines the information and the parameters of the defect management.

*Table 82 - Format Parameters Page*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | PS | Reserved | Page Code (20h) | | | | | |
| 1 | Page Length (12h) | | | | | | | |
| 2-19 | Vendor Specific | | | | | | | |

## 11.0   Removable Direct Access Model

Removable Direct Access devices permit reading and writing from a removable media that is directly addressable by logical block. Data transfer can begin with any of the consecutively numbered logical blocks. The actual data may be stored in different physical formats, but all devices **shall** be addressable by logical blocks.

Some Removable Direct Access devices may be physically and logically compatible with existing HD and DD floppy disks. This chapter specifies several features these devices **shall** implement.

### 11.1  Removable Direct Access Media Organization

The physical format of the data is not specified in this document. Please refer to the appropriate OEM manual for the actual storage method and data layout. All devices must present a uniform and contiguous logical block layout to the host.

### 11.2  Commands

Removable Direct Access Devices **shall** support the following packet commands.

**Table 83 - Packet Commands for Removable Direct Access Devices**

| Command Description | Code | Reference |
|---|---|---|
| FORMAT UNIT | 04h | Section 9.7.1 on page 22 |
| INQUIRY | 12h | Section 9.7.2 on page 25 |
| MODE SELECT | 55h | Section 9.7.3 on page 28 |
| MODE SENSE | 5Ah | Section 9.7.4 on page 30 |
| PREVENT/ALLOW MEDIUM REMOVAL | 1Eh | Section 9.7.6 on page 39 |
| READ (10) | 28h | Section 9.7.7 on page 41 |
| READ (12) | A8h | Section 9.7.8 on page 42 |
| READ CAPACITY | 25h | Section 9.7.9 on page 43 |
| READ FORMAT CAPACITIES | 23h | Section 9.7.9 on page 43 |
| REQUEST SENSE | 03h | Section 9.7.11 on page 47 |
| SEEK | 2Bh | Section 9.7.12 on page 52 |
| START STOP UNIT | 1Bh | Section 9.7.13 on page 53 |
| TEST UNIT READY | 00h | Section 9.7.14 on page 55 |
| VERIFY | 2Fh | Section 9.7.15 on page 56 |
| WRITE (10) | 2Ah | Section 9.7.16 on page 57 |
| WRITE (12) | AAh | Section 9.7.17 on page 58 |
| WRITE AND VEIRIFY | 2Eh | Section 9.7.18 on page 59 |

### 11.2.1  Identify Device Packet Command

Removable Direct Access devices **shall** report the ASCII string "Floppy" in Words 44-46 of the Packet Identify Drive ('A1h') command, regardless whether the device is actually a floppy or not. This allows device drivers to recognize the device class, without needing a list of the strings from every device. The purpose of this is to allow device drivers to identify Removable Direct Access Devices, when ATAPI CD-ROMs and other ATAPI devices are installed in the same host computer.

### 11.2.2  FORMAT UNIT Command

If the device is not physically compatible with a 3.5 inch HD floppy, then the device **shall** implement the Format Unit command as described in "9.7.1 FORMAT UNIT Command" on page 22.  The device only needs to implement the Format Unit command described here if it is intended to be, or replace, a system floppy.

The differences between the Format Unit command as described in "9.7.1 FORMAT UNIT Command" on page 22 and as described here are to enable compatibility with existing host computer format utilities.  This description adds 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 84 - FORMAT UNIT (04h) Command*

| Bit Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Operation Code (04h) | | | | | | | |
| 1 | Reserved | | | FmtData (1) | CmpList (0) | Defect List Format (7) | | |
| 2 | Track Number | | | | | | | |
| 3 | Interleave (MSB) | | | | | | | |
| 4 | Interleave (LSB) | | | | | | | |
| 5 | Reserved | | | | | | | |
| 6 | Reserved | | | | | | | |
| 7 | Reserved | | | | | | | |
| 8 | Reserved | | | | | | | |
| 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** return a Check Condition with the Sense Key set to ILLEGAL REQUEST and the Sense Code set to INVALID FIELD IN COMMAND PACKET.

**Track Number:** This field **shall** be valid for existing HD and DD single-track formats.  It specifies which track is to be formatted.  It may be ignored for other media types.

**Interleave:**  This specifies the interleave that **shall** be used when formatting.  A value of 0 specifies that ATAPI Block Device uses the default value.  A 1:1 interleave specifies that consecutive logical blocks be placed in contiguous ascending order.

After sending the command packet, the host **shall** then transfer the 12 bytes of the Format Descriptor.

*Table 85 - FORMAT UNIT (04h) Parameter List*

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

*Table 86 - Defect List Header*

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | Reserved | | | | | | | |
| 1 | FOV | Reserved | Disable Cert | Single Track | Reserved | | Immediate | Side |
| 2 | Defect List Length (MSB) [0] | | | | | | | |
| 3 | Defect List Length (LSB) [8] | | | | | | | |

If the Disable Cert bit is set, ATAPI Block Device *shall not* certify this disk (or track, if the Single Track bit is set).

The Single Track bit, when set, specifies that only the track specified in the Track Number field (See "Table 84 - FORMAT UNIT (04h) Command" on page 70) *shall* be formatted.  This bit is only required when formatting a compatible HD or DD floppy disk.

The Immediate bit specifies that this command *shall* return status immediately.  The command will then proceed, and set ATAPI Block Device Ready bit when the Format Unit command has actually finished.

The Side bit specifies which side is to be formatted on a Single-Track format.  If the Side bit is set, the topside 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 Defect List Length *shall* be set to 8.  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 13 - Formattable Capacity Descriptor" on page 23) 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, ATAPI Block 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.

### 11.2.3 MODE SENSE / MODE SELECT Command

Removable Direct Access devices **shall** support the following mode page, the Flexible Disk Page, in addition to all pages defined at Table 25 on page 33. The Flexible Disk Page specifies parameters relating to the currently installed medium type.

**Table 87 - Flexible Disk Page**

| Bit<br>Byte | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 0 | PS | Rsvd | 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<br>19 | Reserved | | | | | | | |
| 20 | Motor off Delay | | | | | | | |
| 21<br>27 | Reserved | | | | | | | |
| 28 | Medium Rotation Rate (MSB) | | | | | | | |
| 29 | Medium Rotation Rate (LSB) | | | | | | | |
| 30 | Reserved | | | | | | | |
| 31 | Reserved | | | | | | | |

The parameters savable (PS) bit is only used with the MODE SENSE command. This bit is reserved with the MODE SELECT command. A PS bit of one indicates that the Removable Direct Access Device is capable of saving the page in a non-volatile vendor-specific location. If the PS is set to one in MODE SENSE data the page is savable by issuing a MODE SELECT command with SP set to one.

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.

The Sectors per Track field specifies the number of sectors per revolution per head. For zoned media, this number may be an average.

The Number of Cylinders field specifies the number of cylinders used for data storage.

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.

The Medium Rotation Rate field indicates the speed at which the medium rotates. The unit of measure is rotations per minute (rpm).

*Implementers note: The number of Heads, Cylinders, and Sectors per Track do not have to match the physical values of the installed media. They may have values that, when multiplied together, give the total capacity for the device. Some host systems will use these numbers to obtain total capacity, rather than obtaining the capacity from Read Format Capacities.*

### 11.3   Removable Direct Access Ready Condition / Not Ready Condition

The ready condition occurs after a cartridge is inserted and ATAPI Block Device has performed its initialization tasks.  This "ready" is different from and *shall not* be confused with the ATA Ready Status.  A check condition status will be returned for the not ready condition only for commands that require or imply a disk access.

A not ready condition may occur for the following reasons:

1. There is no cartridge inserted.
2. A cartridge was just inserted.

ATAPI Block Device *shall* spin up and make the disk ready for media access when a new disk is detected.

### 11.3.1   Packet Command Not Ready Status Utilization

*Table 88 - Not Ready Error Reporting (by Command)*

| Command | Opcode | May Return Not Ready Error |
|---|---|---|
| FORMAT UNIT | 04h | Yes |
| INQUIRY | 12h | No |
| MODE SELECT | 55h | No |
| MODE SENSE | 5Ah | No |
| READ (10) | 28h | Yes |
| READ (12) | A8h | Yes |
| READ CAPACITY | 25h | Yes |
| READ FORMAT CAPACITIES | 23h | No |
| REQUEST SENSE | 03h | No |
| PREVENT ALLOW MEDIUM REMOVAL | 1Eh | See 9.7.6 on page 39 |
| SEEK | 2Bh | Yes |
| START STOP UNIT | 1Bh | Yes |
| TEST UNIT READY | 00h | Yes |
| VERIFY | 2Fh | Yes |
| WRITE (10) | 2Ah | Yes |
| WRITE (12) | Aah | Yes |
| WRITE AND VERIFY | 2Eh | Yes |

### 11.4   Removable Media Issues

Because many operating systems need to control when the media may be removed, this document defines several methods.  One method is the PREVENT/ALLOW MEDIA REMOVAL command.  Another method is Media Status Notification along with the START/STOP UNIT command.

### 11.5   Error Reporting

If any of the following conditions occur during the execution of a command, ATAPI Block Device *shall* return CHECK CONDITION status.  The appropriate sense key and additional sense code *shall* be set.  The following list illustrates some error conditions and the applicable sense keys.  The list does not provide an exhaustive enumeration of all conditions that may cause the CHECK CONDITION status.

*Table 89 - Error Conditions and Sense Keys*

| CONDITION | SENSE KEY |
|---|---|
| INVALID LOGICAL BLOCK ADDRESS | ILLEGAL REQUEST |
| UNSUPPORTED OPTION REQUESTED | ILLEGAL REQUEST |
| DRIVE RESET OR MEDIUM CHANGE SINCE LAST COMMAND | UNIT ATTENTION |
| SELF DIAGNOSTIC FAILED | HARDWARE ERROR |
| UNRECOVERED READ OR WRITE ERROR | MEDIUM ERROR |
| RECOVERED READ OR WRITE ERROR | RECOVERED ERROR |
| OVERRUN OR ERROR THAT MIGHT BE RESOLVED BY REPEATING  THE COMMAND | ABORTED COMMAND |

In the case of an invalid logical block address, the sense data information field **shall** be set to the logical block address of the first invalid address.

In the case of a read or write error, the sense data information field **shall** be set to the logical block address of the block that caused the error.

### *12.0    Magneto Optical Device Model*

### *12.1   Magneto Optical Model Description*

### *12.1.1  Background of Magneto Optical Device Model*

The 3.5 inches Magneto Optical drive offers the removable rewritable function of high speed and high reliability with 3.5 inches small size optical disk cartridge corresponding to the demand by the computer users in removable rewriteble devices platform.
There are ISO specification for 90mm Magneto Optical disk, which has 512B, and 2KB sector size. And there are huge amounts of disks in the marketplace.
The kind of disk includes four kinds up to 640MB capacity now.  There are two kinds of kinds of the disk and direct over write disk, which does not operate erase, is offered. It might be a thing that large capacity disk is offered to the uses when the future.
Basically as for Magneto Optical disk achieves though erase, write and verify operation. But Direct Over Write disk achieves speed-up though write and verify operates.

### *12.1.2  Model Description*

Magneto Optical Device Model is removable random readable and rewritable data storage device. The rewritable sector formatted disk used in this model has Magneto Optical or Direct Over Write capability material.
The rewritable portion of this model can read and write from/to sector formatted disk which has 512bytes or 2048bytes sector capacity and support defect management function in the device which can be enabled to allocate data from defective sector to replacement sector automatically.
The rewritable sector formatted disk used in this model has its cartridge case to protect the user data on the rewritable disk from un-intentional scratches, dusts and fingerprints.
The principal technologies developed for this type of model are listed as follows:

(1) Optical head capable of conducting erase/read/write operations for rewritable magneto optical disk.
(2) Magneto Optical disk with high reliability.
(3) Magneto Optical disk has two type of disk;
     Sector Length of 512bytes diskette: 128MB/230MB/540MB
     Sector Length of 2048bytes diskette: 640MB
   Even if 512B and 2KB medium is alternately inserted, the OS should be able to be read and written unquestionable. It's removability, it is important that ATAPI spec has large-sector-size-disk capability same as SCSI environment.

### *12.1.3  Description for Logical Unit Concept*

The implementation of functionality in this model is single Logical Unit concept.

### *12.1.4  Format of rewritable Magneto Optical Disk*

The rewritable optical disk used in this Model is physically formatted 512 bytes or 2048 bytes sector. In contrary to a 2048 Bytes sector size of 640MB, 512 byte sector of 128MB/230MB/540MB is chosen to conform with the legacy OS like DOS or Windows3.1 in rewritable magneto optical disk format.

    ISO/IEC  10090: 128 Mbytes 512bytes
    ISO/IEC  13963: 230 Mbytes 512bytes
    ISO/IEC  15041: 540 Mbytes 512bytes, 640 Mbytes 2048bytes

### *12.1.5  Defect Management*

Defect management procedure for rewritable magneto optical disk **shall** be performed by Magneto Optical Device Model.

The method of defect management is sector slipping and linear replacement. Sector slipping algorithm will be used for pre-certified disk and linear replacement method will be used in both certified and non-certified disk.

The control information about defect management procedure is recorded in the specific area of the disk.

The spare areas used in both sector slipping and linear replacement algorithm are located in each zone.

### 12.1.6  Magneto Optical Disk and Cartridge

Magneto Optical disk used in the Magneto Optical Device Model has its cartridge to protect it from any unintentional scratches, dusts and fingerprints.

The disk is 3.5inches single-sided disk.

Disk has physically formatted spiral groove for producing tracking and accessing signal.

## 12.2  Mode Page codes for Magneto Optical Device

Magneto Optical Device **shall** support the following Mode Page Codes.

**Table 90 - Mode Page Codes for Magneto Optical Device**

| Page Code | Definition | Reference | Type |
|-----------|------------|-----------|------|
| 00h | Drive Operation Mode Page | 10.4.1 on page 67 | O |
| 01h | Read-Write Error Recovery Page | 9.7.5.1 on page 35 | M |
| 08h | Caching Page | 9.7.5.2 on page 36 | M |
| 1Bh | Removable Block Access Capacities Page | 9.7.5.3 on page 37 | M |
| 1Ch | Timer & Protect Page | 9.7.5.4 on page 38 | O |
| 20h | Format Parameters Page | 10.4.2 on page 68 | O |
| 3Fh | Return all pages (valid only for MODE SENSE command) | | M |

## 12.3  Recommended Sense Key, ASC and ASCQ

3.5 inches Magneto Optical drive supports as following information. It's containing same as SCSI environment.

**Table 91 - Recommended Sense Key, ASC and ASCQ**

| Sense Key | ASC | ASCQ | Description of Error |
|-----------|-----|------|----------------------|
| 00 | 00 | 00 | NO SENSE |
| 02 | 04 | 00 | NOT READY |
| 02 | 3A | 00 | NOT READY(OPTICAL DISK CARTRIDGE NOT INSERTED) |
| 03 | 10 | 00 | ID READ ERROR |
| 03 | 11 | 00 | UNCORRECTABLE |
| 03 | 0C | 00 | WRITE ERROR |
| 03 | 0C | 02 | WRITE ERROR(SPARE BLOCK) |
| 03 | 30 | 00 | UN-SUPPORTED DISK |
| 03 | 31 | 00 | FORMAT ERROR |
| 03 | 32 | 00 | DEFECT OVER |
| 04 | 09 | 01 | TRACKING SERVO FAILURE |
| 04 | 15 | 02 | POSITIONING ERROR DETECTED BY READ OF MEDIUM |
| 04 | 44 | 00 | INTERNAL TARGET FAILURE |
| 05 | 24 | 00 | INVALID FIELD IN CDB |
| 05 | 25 | 00 | LOGICAL UNIT NOT SUPPORTED |
| 05 | 26 | 00 | INVALID FIELD IN PARAMETER LIST |
| 06 | 28 | 00 | NOT READY TO READY TRANSITION |
| 06 | 29 | 00 | POWER ON RESET |
| 07 | 27 | 00 | WRITE PROTECT |

## 13.0   Annex

# Regacy specification about LUN in Revision 1.2

### A.1.   ATAPI Block Device Select Register (ATA Drive/Head Select Register)

***Table 92  - ATAPI Block Device Select Register***

| D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|----|----|----|----|----|----|----|----|
| 1 | Reserved | 1 | DRV | Reserved | LUN | | |

LUN (Logical Unit Number) ***shall*** be used when communicating with the ATAPI Block Device capable of supporting multiple LUN. For those devices capable of supporting LUN, they ***shall*** report the Total LUN field as a Non-zero value in Removable Block Access Capabilities Page (See "9.7.5.3 Removable Block Access Capabilities Page (1Bh)" on page 37).

Bit 7 and Bit 5 have been obsoleted by X3T13/1153D (ATA/ATAPI-4) at the time of publication.

The LUN value is sent to/from the ATAPI Block Device. When the LUN is sent from the host to the ATAPI Block Device there are two fields that can be used. The LUN in ATAPI Block Device Select Register and the LUN in Command Packet. When the LUN in Command Packet is used for a non-zero, then the LUN in ATAPI Block Device Select Register ***shall*** contain either zero or the same value. When the LUN in Command Packet is not used, then the value ***shall*** be zero.

***Table 93 - Definitions for LUN***

| LUN in ATAPI Block Device Select Register | LUN in Command Packet | Action |
|---|---|---|
| 0 | 0 | Select LUN 0 |
| 0 | 1-7 | Select LUN 1-7 |
| 1-7 | 0 | Select LUN 1-7 |
| 1-7 | 1-7 | if different then action is vendor-specific |

### A.2.   Identify Device Packet (A1h)

***Table 94 - Identify Device Information for ATAPI Block Device***

| Word | Bits | Description | Used | Fixed/Variable |
|---|---|---|---|---|
| 0 | | General Configuration | Mandatory | Fixed |
| 1 | | Cylinders | No | |
| 2 | | Reserved | No | |
| 3 | | Heads | No | |
| 4 | | Number of unformatted bytes per track - vendor specific | No | |
| 5 | | Number of unformatted bytes per sector - vendor specific | No | |
| 6 | | Number of sectors per track | No | |
| 7-9 | | Reserved | No | |
| 10-19 | | Serial Number | Optional | Fixed |

| | | | | |
|---|---|---|---|---|
| 20 | | Vendor specific | No | |
| 21 | | Vendor specific | No | |
| 22 | | ECC bytes available | No | |
| 23-26 | | Firmware revision (18 ASCII characters) | Mandatory | Fixed |
| 27-46 | | Model Number (40 ASCII characters) | Mandatory | |
| 47 | | Multiple Sector Command, Sector Count | No | |
| 48 | | Reserved | No | |
| 49 | | Capabilities:<br>LBA bit **shall** be supported; DMA, IORDY, Overlap and Standby bits are optional. | Mandatory | |
| 50 | | Reserved | No | |
| 51 | | PIO Cycle Timing | Mandatory | Fixed |
| 52 | | DMA Cycle Timing | Mandatory | Fixed |
| 53 | 15 - 2<br>1<br>0 | Reserved<br>Fields in words 64-70 valid<br>Fields in words 54-58 valid | Mandatory | Fixed<br>Fixed<br>Variable |
| 54 – 56 | | Current Cylinder/Heads/Sectors | No | |
| 57-58 | | Current Capacity | No | |
| 59 | | Reserved | No | |
| 60-61 | | User Addressable Sectors | No | |
| 62 | 15 - 8<br>7 - 0 | Single word DMA transfer mode active<br>Single word DMA transfer modes supported | Mandatory | Variable<br>Fixed |
| 63 | 15 - 8<br>7 - 0 | Multiword DMA Transfer Mode Active<br>Multiword DMA Transfer Modes Supported | Mandatory | Variable<br>Fixed |
| 64 | 15 - 8<br>7 - 0 | Reserved<br>Advanced PIO Transfer Mode Supported | Mandatory | Fixed |
| 65 | | Minimum Multiword DMA Transfer Cycle Time Per Word (ns) | Mandatory | Fixed |
| 66 | | Manufacturer's Recommended Multiword DMA Transfer Cycle Time (ns) | Optional | Fixed |
| 67 | | Minimum PIO Transfer Cycle Time without Flow Control | Optional | Fixed |
| 68 | | Minimum PIO Transfer Cycle Time with IORDY Flow Control | Optional | Fixed |
| 69 – 70 | | Reserved (for advanced PIO support) | No | |
| 71 | | Typical time (  s) for release when processing an overlapped command | Optional | Fixed |
| 72 | | Typical time (  s) for release after receiving the service command | Optional | Fixed |
| 73 | | Major Revision Number (0000h or FFFFh Device does not report version. | Optional | Fixed |
| 74 | | Minor Version Number (0000h or FFFFh Device does not report version. | Optional | Fixed |
| 75-125 | | Reserved | | |
| 126 | 15-3<br>2-0 | Reserved<br>Last LUN Identifier | Mandatory | Variable |
| 127 | 15-9<br>8<br>7-2<br>1-0 | Reserved<br>Device Write Protect<br>Reserved<br>Media Status Notification | Mandatory<br><br>Mandatory | Fixed<br><br>Fixed |
| 128 - 159 | | Vendor Unique | No | |
| 160 - 255 | | Reserved | No | |

"Optional" Identify Device words, which are not supported, *shall* be set to zero.

The Identify Device command *shall not* delay the transfer of the Identify Drive Information by more than 200 ms after receipt of the command.

### A.2.1. Last LUN Identifier (Word 126)

| | | |
|---|---|---|
| Bit 15-3 | Reserved | This is reserved for future enhancement. |
| Bit 2-0 | Last LUN Identifier | This field indicates the last LUN that is supported by the Device.<br>This field of zero indicates that the Device does not support Multiple LUN. Then the LUN in the ATAPI Block Device Select Register is reserved.<br>This field of one to seven indicates that the Device supports multiple LUN. |