Working Draft American National Standard

T13 Project 1699D

Revision 2b
January 10, 2006

Information Technology - AT Attachment - 8 ATA/ATAPI Command Set (ATA8-ACS)

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DOCUMENT STATUS

Revision History		
Revision	**Date**	**Description**
0	August 17, 2004	1. Initial revision created from ATA/ATAPI-7 Volume 1 (1532D Rev 4b). 2. Removed 3 volume structure and changed abstract to reflect a command set document 3. Removed sections on signal, bit, and timing conventions 4. Removed clause 5, I/O register descriptions 5. Kept informative annex's A-C
1	September 7, 2004	1. Restructured all commands to conform to format agreed to in e04139r4. 2. Added a section defining status bits 3. Added a section defining error bits 4. Added a section describing protocols 5. Added a section describing interrupt reason 6. Incorporated single log table e04143r0 table. Did not add wording to status that host VS pages are common between SMART and GPL. 7. Removed prohibited statements from command definitions. These reside in the feature set definitions. **8. [Editors Note: Fix N/A vs Reserved]** **9. [Editors Note: Do a consistency pass for Body Text]** **10. [Editors Note: Do a consistency pass on mandatory and optional statements]** **11. [Editors Note: Add section and diagrams to make clear the realationship of this doc to other documents.]** **12. [Editors Note: Under Error Outputs, error bit 0 is sometimes obsolete, and sometimes N/A. I do not think this inconsistent documentation is correct. Bit 1 should always be obsolete, N/A, or is it time for reserved]**
1a	October 6, 2004	1. Replaced duplicate normal outputs tables with a see clause to the first usage. 2. Replaced many error outputs with a see clause. **3. [Editors Note: Fix N/A vs Reserved]** **4. [Editors Note: Do a consistency pass for Body Text]** **5. [Editors Note: Do a consistency pass on mandatory and optional statements]** **6. [Editors Note: Add section and diagrams to make clear the realationship of this doc to other documents.]** **7. [Editors Note: Under Error Outputs, error bit 0 is sometimes obsolete, and sometimes N/A. I do not think this inconsistent documentation is correct. Bit 1 should always be obsolete, N/A, or is it time for reserved]**
1b	February 17, 2005	1. Stripped unused informative references 2. Changed the definition of ordered and unordered lists to make the numeric form ordered. 3. Changed all the lists to conform to the changes in #2 4. Reserved 5Ch-5Fh for TCG. This was done by added command headers and a reserved statement in the command section. Also maerked the commands with T in the command matrix table. 5. Moved Normal and Error Outputs to their own section. Commands now have a hotlink to the tables. 6. Moved IDENTIFY (PACKET) DATA to its own section (Input Data) 7. Changed more of the titles to be consistent with the front cover. 8. Deleted unused definitions 9. Changed the general feature set to only apply to non-packet devices 10. Changed the packet feature set to include all the commands in the packet feature set.

Revision History		
Revision	**Date**	**Description**
		11. The command prohibitions are now found in the feature set description and not with each command. 12. Integrated e04127r0 – This makes SATA signatures reserved with no description.
1c	April 15, 2005	1. Added proposal e04143r1 – Notes that the Host Vendor Specific pages are common to both SMART READ LOG and READ LOG EXTENDED 2. Added e04130r2 – Tightens the definition of SMART first polling time. Also adds a field that enables longer times. 3. Added proposal e05103r0 – Changes the features register to log page specific for read and write log commands 4. Added e04153r1 – Historical annex of command documentation to Annex B 5. Added e05102r1 as amended – Reserves some set features and DCO fields as vendor specific 6. Added back in FEATURE SET Clause infront of the description
1d	June 20, 2005	1. Added code 1Dh to IDENTFY DEVICE for ATA/ATAPI-7 Table 13. 2. Added placeholder for reporting alignment 3. Updated SET FEATURES table 41 to include reserved entries instead of just saying all other entries are reserved. 4. Partially Incorporated e04129r5. Assigned Set Features 0Bh and 8Bh for the enable and disable capability. Had to make several modifications to the proposal to fill in missing pieces. Unable to fill in IDENTIFY DEVICE info, data is incomplete. Stopped incorporation
1e	June 21, 2005	1. Modified Selective self-test description last sentence to be more clear. 2. Updated definition based on WG review. 3. Integrated e05133r3. This conflicts with the definition of IDENTIFY DEVICE which is defined to not return an error. 4. Incorporated e04129r6. Assigned IDENTIFY DEVICE words 210-213 and DCO word 7 bit 14.
1f	July 5, 2005	1. Added several technical reports to the approved references. They need to be there since they are mentioned in the body of the document. 2. Updated DCO to refer to TR-37 (TLC) for word 7 bit 10. 3. Updated the Scope to match ATA8-AAM 4. Replaced sector with logical sector in many places 5. [Editors Note: I do not think we should refer to logs as sectors, they are really pages] 6. Replaced all references to the Features register with features field. 7. Replaced all references to the Sector Count register with Count field. There are some places that use the count field in calculations. These places refer to the register. I have chosen to keep the word field although I think it may read better just saying cound. 8. Replaced archaic references to sector number register with references to the LBA field. 9. Replaced references to LBA Low, LBA Mid, and LBA high to LBA field. 10. Replaced all references to device/head or device register 11. Deleted references to the device control register. 12. Updated overview in clause 7. 13. Updated security commands to have an output data structure where appropriate 14. Updated SETMAX commands to have an output data structure where appropriate. 15. Removed remaining hardware references from commands.

Revision History		
Revision	**Date**	**Description**
		Transport documents will have to reference 1e for notes on information that needs to move. This includes most references to BSY, RDY, DRQ, and bus. 16. Implemented e04161r0 (obsoleted ATAPI overlap and queue) 17. Moved host vendor specific log description into its own clause. 18. Integrated e05130r0 19. Integrated e05131r1 20. Integrated e05120r2 – Needed to add text to 4.21 to support the examples.
2	August 22, 2005	1. Updated SET MAX ADDRESS to indicate that on drives with a capacity that is greater than 28 bits, that issues SET MAX ADDRESS to the NATIVE MAX address clears the HPA and returns the full capacity of the drive, not just 137GB. 2. Added e04132r1 – Defines subcommand 03 for download microcode 3. Incorporated e04162r0 – Obsolete Download Microcode 4. Incorporated e05151r1 – Reserve opcodes for e05106. The following resources were assigned: a. CHECK POWER MODE normal returns 40h and 41h b. IDENTIFY DEVICE data words 214-221 c. New opcode B6h – NV CACHE (Sorry, B8h is reserved for CFA) d. DCO data structure Word 21 bits 14 and 15 5. Incorporated e02126r6 – WRITE UNCORRECTABLE. The following resources were assigned: a. Opcode 45h b. IDENTIFY DEVICE data words 119/120 bit 2 c. DCO Data word 21 bit 13 6. Modified DCO to indicate that the data is not an overly, it is just data that can be used to enable or disable reporting of features as well as responding to features. 7. Incorporated e05127r2 – Updated the definition of the DF bit. 8. Incorporated e05129r1 – READ/WRITE LOG DMA EXT. The following resources were assigned: a. Opcodes 47h and 57h b. IDENTIFY DEVICE data words 119/120 bit 2 9. Incorporated e05132r1 – Report transport standard. IDENTIFY DEVICE words 222 and 223 were assigned for this purpose. 10. Incorporated e05140r0 – Media Serial Number Endianess 11. Performed a major re-work of the IDENTIFY DEVICE table data. Added a column to indicate applicable transport. 12. Received side-band E-Mail comments from yamini@medusalabs.com resulting in the following changes: a. CFA Translate Sector Features and Count fields S/B N/A as in ATA7 b. Page number was deleted from the clause reference in 4.4.1 13. Marked bits 15:13 obsolete. This was accidently left out when e04161 was incorporated. 14. Reformatted Table 116, Table 117, Table 118, Table 119. The command code table serves as the master. All of the command codes are now listed. I believe this will cause the table to be maintained better. I also discovered some inconsistencies in the table during the reformat. 15. Performed consnstency pass on command tables, several links have been corrupted.
2a	December 10, 2005	1. Added cross reference to tables. This is required since several commands point to the same tables. 2. Fixed command tables to match ATA7.

Revision History		
Revision	**Date**	**Description**
		3. e05141r2 was voted in however, no document has been posted. 4. Incorporated e05162r0 5. Incorporated e05161r0 6. Incorporated e05167r0. 7. Incorporated e05109r3 as modified by Mark Evans 8. Addressed ATA/ATAPI-7 public review comment by inserting the statement “If write cache is enabled unrecoverable errors may not be reliably reported as they may occur after the completion of the command. “ after the statement that says the first error block is returned in the response fields. 9. Replaced Masterpassword with Master password as per E-Mail review comment. Replaced isspecified with is specified as per E-Mail review comment
2b	January 10, 2006	1. Made READ and WRITE LOG EXT optional for ATAPI devices 2. Reincorporated SCT using e05109r4 3. Changed Long Segment Access to Write Same 4. Incorporated e05170r1 5. Incorporated e05154r4 6. Incorporated e05150r2

American National Standard
for Information Technology —

AT Attachment - 8 ATA/ATAPI Command Set (ATA8-ACS)

Secretariat
Information Technology Industry Council

Approved mm dd yy

American National Standards Institute, Inc.

Abstract

This standard specifies the AT Attachment command set between host systems and storage devices. It provides a common command set for systems manufacturers, system integrators, software suppliers, and suppliers of intelligent storage devices. It includes the Packet Command feature set implemented by devices commonly known as ATAPI devices.

This standard maintains a high degree of compatibility with the AT Attachment Interface with Packet Interface - 7 (ATA/ATAPI-7) volume 1, INCITS 397-2004, and while providing additional functions, is not intended to require changes to presently installed devices or existing software.

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Foreword

(This foreword is not part of this standard.)

Requests for interpretation, suggestions for improvement and addenda, or defect reports are welcome. They should be sent to the INCITS Secretariat, ITI, 1250 Eye Street, NW, Suite 200, Washington, DC 20005-3922.
This standard was processed and approved for submittal to ANSI by InterNational Committee for Information Technology Standards (INCITS). Committee approval of this standard does not necessarily imply that all committee members voted for approval. At the time it approved this standard, INCITS had the following members:
Karen Higginbottom, Chair
David Michael, Vice-chair
Monica Vago, Secretary

Technical Committee T13 on ATA Interfaces, that reviewed this standard, had the following members and additional participants:

Dan Colgrove, Chairman

Jim Hatfield, Vice-Chairman

Mark Overby, Secretary
[Editors Note: Insert T13 Membership List Here]

Introduction

This standard encompasses the following:

Clause 1 describes the scope.

Clause 2 provides normative references for the entire standard.

Clause 3 provides definitions, abbreviations, and conventions used within the entire standard.

Clause 4 describes the general operating requirements of the command layer.

Clause 5 describes the ATA protocols used by the commands in this standard

Clause 6 describes status and error bits

Clause 7 describes commands

Clause 8 describes the SCT Command Transport

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American National Standard
for Information Systems —

Information Technology —
AT Attachment - 8 ATA/ATAPI Command Set (ATA8-ACS)

1 Scope

The set of AT Attachment standards consists of this standard and the ATA implementation standards described in ATA8-AAM. The AT Attachment ATA Command Set (ATA8-ACS) specifies the command set host systems use to access storage devices. It provides a common command set for systems manufacturers, system integrators, software suppliers, and suppliers of intelligent storage devices. Figure 1 shows the relationship of this standard to the other standards and related projects in the ATA and SCSI families of standards and specifications.

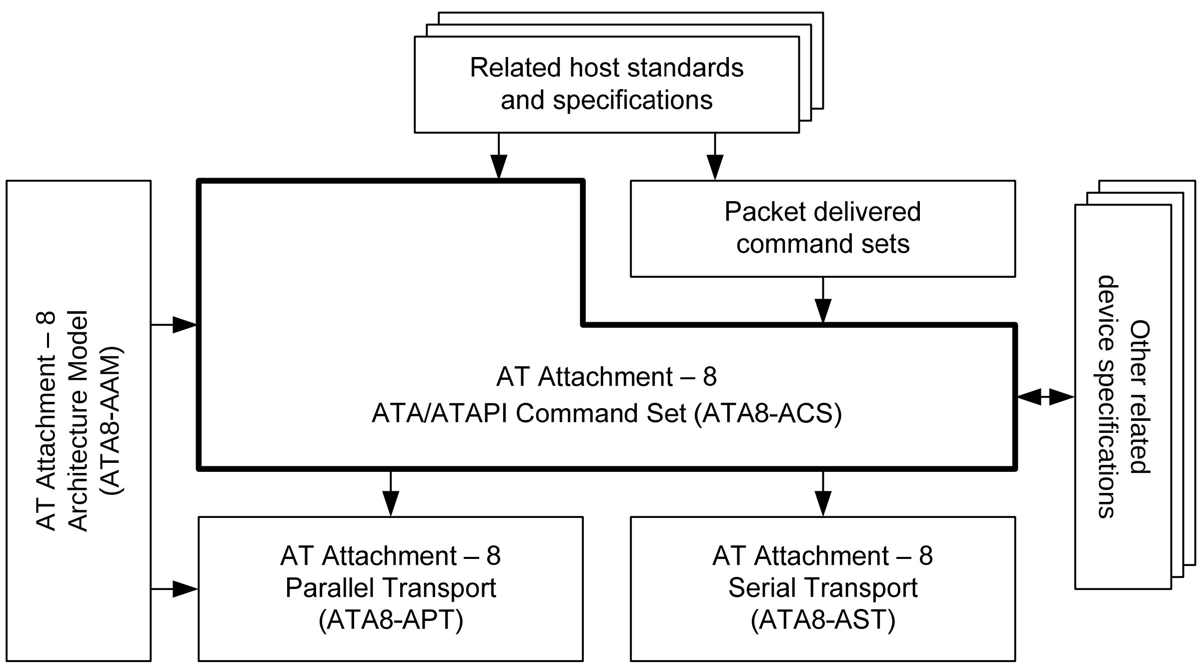


Figure 1 - ATA document relationships

ATA8-ACS maintains compatibility with the AT Attachment with Packet Interface - 7 standard (ATA/ATAPI-7), INCITS 397-2005 volume 1, and while providing additional functions. ATA8-ACS is not intended to require changes to presently installed devices or existing software.

2 Normative references

The following standards contain provisions that, through reference in the text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below.

Copies of the following documents can be obtained from ANSI: Approved ANSI standards, approved and draft international and regional standards (ISO, IEC, CEN/CENELEC, ITUT), and approved and draft foreign standards (including BSI, JIS, and DIN). For further information, contact ANSI Customer Service Department at 212-642-4900 (phone), 212-302-1286 (fax), or via the World Wide Web at http://www.ansi.org.

Additional availability contact information is provided below as needed.

2.1 Approved references

The following approved ANSI standards, approved international and regional standards (ISO, IEC, CEN/CENELEC, ITUT), may be obtained from the international and regional organizations who control them.

2.1.1 ANSI References

ISO/IEC 14776 – 321, SCSI-3 Block Commands (SBC)	[ANSI INCITS 306-1998]
ISO/IEC 14776 – 332, SCSI Streaming Commands - 2 (SSC-2)	[ANSI INCITS 380-2003]
ISO/IEC 14776 – 363, Multimedia Commands - 3 (MMC-3)	[ANSI INCITS 360-2002]
Protected Area Run Time Interface Extensions (PARTIES)	[ANSI INCITS 346-2001]
ISO/IEC 14776 – 452, SCSI Primary Commands - 2 (SPC-2)	[ANSI INCITS 351-2001]
AT Attachment with Packet Interface Extension (ATA/ATAPI-4)	[ANSI INCITS.317-1998]
AT Attachment with Packet Interface Extension (ATA/ATAPI-5)	[ANSI INCITS.340-2000]
AT Attachment with Packet Interface Extension (ATA/ATAPI-6)	[ANSI INCITS.361-2002]
AT Attachment with Packet Interface Extension (ATA/ATAPI-7)	[ANSI INCITS.397-2005]
Time Limited Commands (TLC)	[ANSI INCITS.TR37-2004]
SMART Command Transport (SCT)	[ANSI INCITS TR38-2005]
Address Offset Alternate Boot Feature	[ANSI INCITS TR27-2001]

2.1.2 ISO References

Acousics – Measurement of airborne noise emitted by information technology and telecommunications equipment [ISO/IEC 7779:1999(E)]

To obtain copies of these documents, contact Global Engineering or INCITS. Additional information may be available at http://www.t10.org and http://www.t13.org.

2.2 References under development

At the time of publication, the following referenced standards were still under development. For information on the current status of the document, or regarding availability, contact the relevant standards body or other organization as indicated.

ISO/IEC 14776 – 322, SCSI Block Commands - 2 (SBC-2)	[T10/1417-D]
ISO/IEC 14776 – 313, SCSI Primary Commands - 3 (SPC-3)	[T10/1416-D]
ISO/IEC 14776 – 333, SCSI Streaming Commands – 3 (SSC-3)	[T10/1611-D]
ISO/IEC 14776 – 364, Multimedia Commands - 4 (MMC-4)	[ANSI INCITS 401-200x]

For more information on the current status of the T10 documents, contact INCITS. To obtain copies of T10 or SFF documents, contact Global Engineering.

2.3 Other references

The following standards and specifications are also referenced.

ATAPI for Rewritable Media [SFF8070i]
For the SFF documents contact SFF at www.sffcommittee.org.

PC Card Standard, February 1995, PCMCIA (68-pin Connector)

For the PC Card Standard published by the Personal Computer Memory Card International Association, contact PCMCIA at 408-433-2273 or http://www.pc-card.org.

CompactFlash™ Association Specification, Revision 1.4

For the CompactFlash™ Association Specification published by the CompactFlash™ Association, contact the CompactFlash™ Association at http://www.compactflash.org.

ATA Packet Interface (ATAPI) for Streaming Tape QIC-157 revision D

For QIC specifications published by Quarter-Inch Cartridge Drive Standards, Inc., contact them at 805 963-3853 or http://www.qic.org.

3 Definitions, abbreviations, and conventions

3.1 Definitions and abbreviations

For the purposes of this standard, the following definitions apply:

3.1.1 **ASCII Character:** Designates 8-bit value that is encoded using the ASCII Character set.

3.1.2 **acoustics:** Measurement of airborne noise emitted by information technology and telecommunications equipment [ISO 7779:1999(E)]

3.1.3 **ATA:** A device implementing the General feature set. An ATA device shall not implement the Packet Command feature set.

3.1.4 **ATA8-ASC device:** A device that complies with this standard.

3.1.5 **ATAPI (AT Attachment Packet Interface) device:** A device implementing the Packet Command feature set. An ATAPI device shall not implement the General feature set.

3.1.6 **AU (Allocation Unit):** The minimum number of logically contiguous sectors on the media as used in the Streaming feature set. An Allocation Unit may be accessed with one or more requests.

3.1.7 **AV (Audio-Video):** Audio-Video applications use data that is related to video images and/or audio. The distinguishing characteristic of this type of data is that accuracy is of lower priority than timely transfer of the data.

3.1.8 **Block Data:** Block Data is the data transferred to or from the device using SCT read/write log capabilities.

3.1.9 **CFA (CompactFlash™ Association):** The CompactFlash™ Association which created the specification for compact flash memory that uses the ATA interface.

3.1.10 **check condition:** For ATAPI devices, this indicates an error or exception condition has occurred.

3.1.11 **CHS (cylinder-head-sector):** An obsolete method of addressing the data on the device by cylinder number, head number, and sector number.

3.1.12 **command aborted:** Command completion with ERR set to one in the Status field and ABRT set to one in the Error field.

3.1.13 **command acceptance:** Positive acknoweledgement of a command being received by a device. See the appropriate transport standard for a definition of positive acknoweledgement.

3.1.14 **Command Block:** In a parallel implementation this is the interface registers used for delivering commands to the device or posting status from the device. In a serial implementation, the command block registers are FIS payload fields.

3.1.15 **command completion:** The completion by the device of the action requested by the command or the termination of the command with an error, the setting of the appropriate bits in the Error field, and the setting of the appropriate bits in the Status field.

3.1.16 **command packet:** A data structure transmitted to the device during the execution of a PACKET command that includes the command and command parameters.

3.1.17 **command released:** When a device supports overlap or queuing, a command is considered released when a release occurs before command completion.

3.1.18 **Control Block:** In a parallel implementation, interface registers used for device control and to post alternate status. In a serial interface implementation, the logical field of a FIS corresponding to the Device Register bits of a parallel implementation.

3.1.19 **device:** A storage peripheral. Traditionally, a device on the interface has been a hard disk drive, but any form of storage device may be placed on the interface provided the device adheres to this standard.

3.1.20 **DMA (direct memory access) data transfer:** A means of data transfer between device and host memory without host processor intervention.

3.1.21 **don’t care:** A term to indicate that a value is irrelevant for the particular function described.

3.1.22 **DRQ data block:** A unit of data words associated with available status when using either the PIO data-in command protocol or the PIO data-out command protocol.

3.1.23 **FUA (Forced Unit Access):** Forced Unit Access requires that user data shall be transferred to or from the device media before command completion even if caching is enabled.

3.1.24 **host:** The computer system executing the software BIOS and/or operating system device driver controlling the device and the adapter hardware for the ATA interface to the device.

3.1.25 **host adapter:** The implementation of the host transport, link, and physical layers.

3.1.26 **LBA (logical block address):** The value used to reference a logical sector.

3.1.27 **logical sector:** A set of logical words accessed and referenced as a unit (see IDENTIFY DEVICE words 117-118). These units are referenced by LBAs.

3.1.28 **native max address:** The highest address a device accepts in the factory default condition, that is, the highest address that is accepted by the SET MAX ADDRESS command.

3.1.29 **overlap:** A protocol that allows devices that require extended command time to perform a release so that commands may be executed by the other device (if present) on the bus.

3.1.30 **packet delivered command:** A command that is delivered to the device using the PACKET command via a command packet that contains the command and the command parameters. See also register delivered command.

3.1.31 **Pass-Through Command:** SCT commands are referred to as “pass-through” commands because they piggy-back on standard ATA command.

3.1.32 **physical sector:** One or more contiguous logical sectors that are read from or written to the device media in a single operation.

3.1.33 **PIO (programmed input/output) data transfer:** PIO data transfers are performed using PIO commands and protocol.

3.1.34 **queued:** Command queuing allows the host to issue concurrent commands to the same device. Only commands included in the Overlapped feature set may be queued. In this standard, the queue contains all commands for which command acceptance has occurred but command completion has not occurred.

3.1.35 **read command:** A command that causes the device to transfer data from the device to the host (e.g., READ SECTOR(S), READ DMA, etc.).

3.1.36 **Release:** The action by a device implementing the overlap feature set that allows a host to select an alternate device or deliver another queued command.

3.1.37 **sector:** See logical sector.

3.1.38 **signature:** A unique set of values placed in the return parameters used to distinguish command sets (e.g. General, ATAPI device, Port Multiplier)

3.1.39 Stream: a set of operating parameters specified by a host using the CONFIGURE STREAM command (see 7.9) to be used for subsequent READ STREAM commands and WRITE STREAM commands.

3.1.40 **transport:** The mechanism used to communicate with a device. See ATA8-APT and ATA8-AST.

3.1.41 **unaligned write:** A write command that does not start at the first logical sector of a physical sector or does not end at the last logical sector of a physical sector.

3.1.42 **unrecoverable error:** When the device sets either the ERR bit or the DF bit to one in the Status field at command completion.

3.1.43 **VS (vendor specific):** Bits, bytes, fields, and code values that are reserved for vendor specific purposes. These bits, bytes, fields, and code values are not described in this standard, and implementations may vary among vendors. This term is also applied to levels of functionality whose definition is left to the vendor.

3.1.44 **write command:** A command that causes the device to transfer data from the host to the device (e.g., WRITE SECTOR(S), WRITE DMA, etc.).

3.1.45 **WWN (world wide name):** A 64-bit worldwide unique name based upon a company’s IEEE identifier. (See IDENTIFY DEVICE Words (108:111) in Volume 1 Clause 6).

3.2 Conventions

Lowercase is used for words having the normal English meaning. Certain words and terms used in this standard have a specific meaning beyond the normal English meaning. These words and terms are defined either in Clause 3 or in the text where they first appear.

The names of abbreviations, commands, fields, and acronyms used as signal names are in all uppercase (e.g., IDENTIFY DEVICE). Fields containing only one bit are usually referred to as the "name" bit instead of the "name" field. (See 3.2.5 for the naming convention used for naming bits.)

Names of device fields begin with a capital letter (e.g., Count).

The expression “word n” or “bit n” shall be interpreted as indicating the content of word n or bit n.

3.2.1 Precedence

If there is a conflict between text, figures, and tables, the precedence shall be tables, figures, then text.

3.2.2 Lists

Unordered lists, those lists describing a sequence, are of the form:

a)
b)
c)

Ordered list are of the form:

1)
2)
3)

3.2.3 Keywords

Several keywords are used to differentiate between different levels of requirements and optionality.

3.2.3.1 expected: A keyword used to describe the behavior of the hardware or software in the design models assumed by this standard. Other hardware and software design models may also be implemented.

3.2.3.2 mandatory: A keyword indicating items to be implemented as defined by this standard.

3.2.3.3 may: A keyword that indicates flexibility of choice with no implied preference.

3.2.3.3a N/A: A keyword the indicates a field has no defined value in this standard and should not be checked by the host or device. N/A fields should be cleared to zero.

3.2.3.4 obsolete: A keyword indicating that the designated bits, bytes, words, fields, and code values that may have been defined in previous standards are not defined in this standard and shall not be reclaimed for other uses in future standards. However, some degree of functionality may be required for items designated as “obsolete” to provide for backward compatibility.

Obsolete commands should not be used by the host. Commands defined as obsolete may be command aborted by devices conforming to this standard. However, if a device does not command abort an obsolete command, the minimum that is required by the device in response to the command is command completion.

3.2.3.5 optional: A keyword that describes features that are not required by this standard. However, if any optional feature defined by the standard is implemented, the feature shall be implemented in the way defined by the standard.

3.2.3.6 prohibited: A keyword indicating that an item shall not be implemented by an implementation.

3.2.3.7 reserved: A keyword indicating reserved bits, bytes, words, fields, and code values that are set aside for future standardization. Their use and interpretation may be specified by future extensions to this or other standards. A reserved bit, byte, word, or field shall be cleared to zero, or in accordance with a future extension to this standard. The recipient shall not check reserved bits, bytes, words, or fields. Receipt of reserved code values in defined fields shall be treated as a command parameter error and reported by returning command aborted.

3.2.3.8 retired: A keyword indicating that the designated bits, bytes, words, fields, and code values that had been defined in previous standards are not defined in this standard and may be reclaimed for other uses in future standards. If retired bits, bytes, words, fields, or code values are used before they are reclaimed, they shall have the meaning or functionality as described in previous standards.

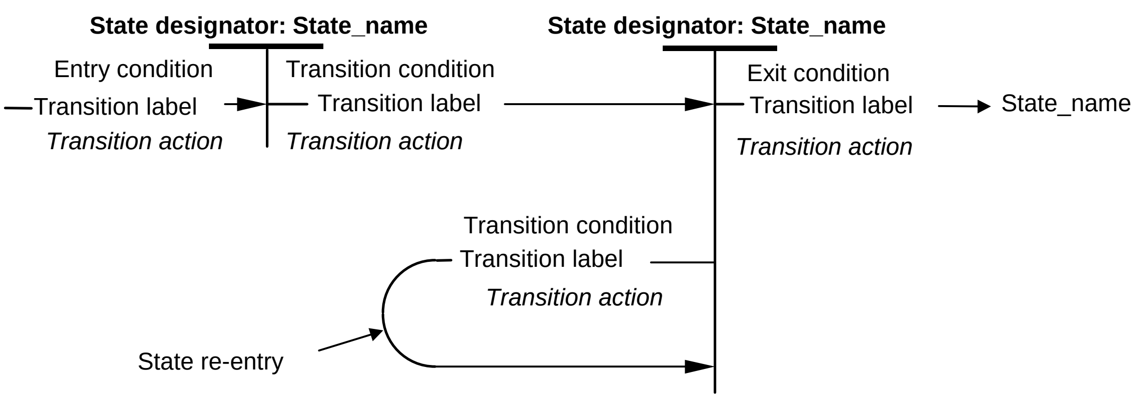
3.2.3.9 shall: A keyword indicating a mandatory requirement. Designers are required to implement all such mandatory requirements to ensure interoperability with other products that conform to this standard.

3.2.3.10 should: A keyword indicating flexibility of choice with a strongly preferred alternative. Equivalent to the phrase “it is recommended”.

3.2.4 Numbering
Numbers that are not immediately followed by a lowercase "b" or "h" are decimal values. Numbers that are immediately followed by a lowercase "b" (e.g., 01b) are binary values. Numbers that are immediately followed by a lowercase "h" (e.g., 3Ah) are hexadecimal values.

3.2.5 Bit conventions
Bit names are shown in all uppercase letters except where a lowercase n precedes a bit name. If there is no preceding n, then when BIT is set to one the meaning of the bit is true, and when BIT is cleared to zero the meaning of the bit is false. If there is a preceding n, then when nBIT is cleared to zero the meaning of the bit is true and when nBIT is set to one the meaning of the bit is false. Bit (n:m) denotes a set of bits, for example, bits (7:0).

3.2.6 State diagram conventions
State diagrams shall be as shown in Figure 2.



BSY	DRQ	REL	SERV	C/D	I/O	INTRQ	DMARQ	PDIAG-	DASP-
v	v	v	v	v	v	V	V	V	V

Figure 2 - State diagram convention

Each state is identified by a state designator and a state name. The state designator is unique among all states in all state diagrams in this document. The state designator consists of a set of letters that are capitalized in the title of the figure containing the state diagram followed by a unique number. The state name is a brief description of the primary action taken during the state, and the same state name may appear in other state diagrams. If the same primary function occurs in other states in the same state diagram, they are designated with a unique letter at the end of the name. Additional actions may be taken while in a state and these actions are described in the state description text.

In device command protocol state diagrams, the state of bits and signals that change state during the execution of this state diagram are shown under the state designator:state_name, and a table is included that shows the state of all bits and signals throughout the state diagram as follows:

v = bit value changes.
1 = bit set to one.
0 = bit cleared to zero.
x = bit is don't care.
V = signal changes.
A = signal is asserted.
N = signal is negated.
R = signal is released.
X = signal is don't care.

Each transition is identified by a transition label and a transition condition. The transition label consists of the state designator of the state from which the transition is being made followed by the state designator of the state to which the transition is being made. In some cases, the transition to enter or exit a state diagram may come from or go to a number of state diagrams, depending on the command being executed. In this case, the state designator is labeled xx. The transition condition is a brief description of the event or condition that causes the transition to occur and may include a transition action, indicated in italics, that is taken when the transition occurs. This action is described fully in the transition description text.

Upon entry to a state, all actions to be executed in that state are executed. If a state is re-entered from itself, all actions to be executed in the state are executed again.

Transitions from state to state shall be instantaneous.

3.2.7 Byte ordering for data transfers

Data is transferred in blocks using either PIO or DMA protocols. PIO data transfers occur when the BSY bit is cleared to zero and the DRQ bit is set to one. These transfers are usually 16-bit but CFA devices may implement 8-bit PIO transfers. Data is transferred in blocks of one or more bytes known as a DRQ block. DMA data transfers occur when the host asserts DMACK- in response to the device asserting DMARQ. DMA transfers are always 16-bit. Each assertion of DMACK- by the host defines a DMA data burst. A DMA data burst is two or more bytes.

Assuming a DRQ block or a DMA burst of data contains "n" bytes of information, the bytes are labeled Byte(0) through Byte(n-1), where Byte(0) is first byte of the block, and Byte(n-1) is the last byte of the block. Table 1 shows the order the bytes shall be presented in when such a block of data is transferred on the interface using 16-bit PIO and DMA transfers. Table 2 shows the order the bytes shall be presented in when such a block or burst of data is transferred on the interface using 8-bit PIO.

Table 1 - Byte order [Editors Note: Need to rename]

	DD 15	DD 14	DD 13	DD 12	DD 11	DD 10	DD 9	DD 8	DD 7	DD 6	DD 5	DD 4	DD 3	DD 2	DD 1	DD 0
First transfer	Byte (1)								Byte (0)							
Second transfer	Byte (3)								Byte (2)							
....																
Last transfer	Byte (n-1)								Byte (n-2)							

Table 2 - Byte order

	DD 7	DD 6	DD 5	DD 4	DD 3	DD 2	DD 1	DD 0
First transfer	Byte (0)							
Second transfer	Byte (1)							
....								
Last transfer	Byte (n-1)							

NOTE – The above description is for data on the interface. Host systems and/or host adapters may cause the order of data as seen in the memory of the host to be different.

Some parameters are defined as a string of ASCII characters. ASCII data fields shall contain only code values 20h through 7Eh. For the string “Copyright”, the character “C” is the first byte, the character “o” is the second byte, etc. When such fields are transferred, the order of transmission is:

the 1st character (“C”) is on DD(15:8) of the first word,
the 2nd character (“o”) is on DD(7:0) of the first word,
the 3rd character (“p”) is on DD(15:8) of the second word,
the 4th character (“y”) is on DD(7:0) of the second word,
the 5th character (“r”) is on DD(15:8) of the third word,
the 6th character (“i”) is on DD(7:0) of the third word,
the 7th character (“g”) is on DD(15:8) of the fourth word,
the 8th character (“h”) is on DD(7:0) of the fourth word,
the 9th character (“t”) is on DD(15:8) of the fifth word,
the 10th character (“space”) is on DD(7:0) of the fifth word,
etc.

Word (n:m) denotes a set of words, for example, words (103:100).

3.2.8 Byte, word and DWORD Relationships

Figure 3 illustrates the relationship between bytes, words and DWORDs for serial interface implementations.

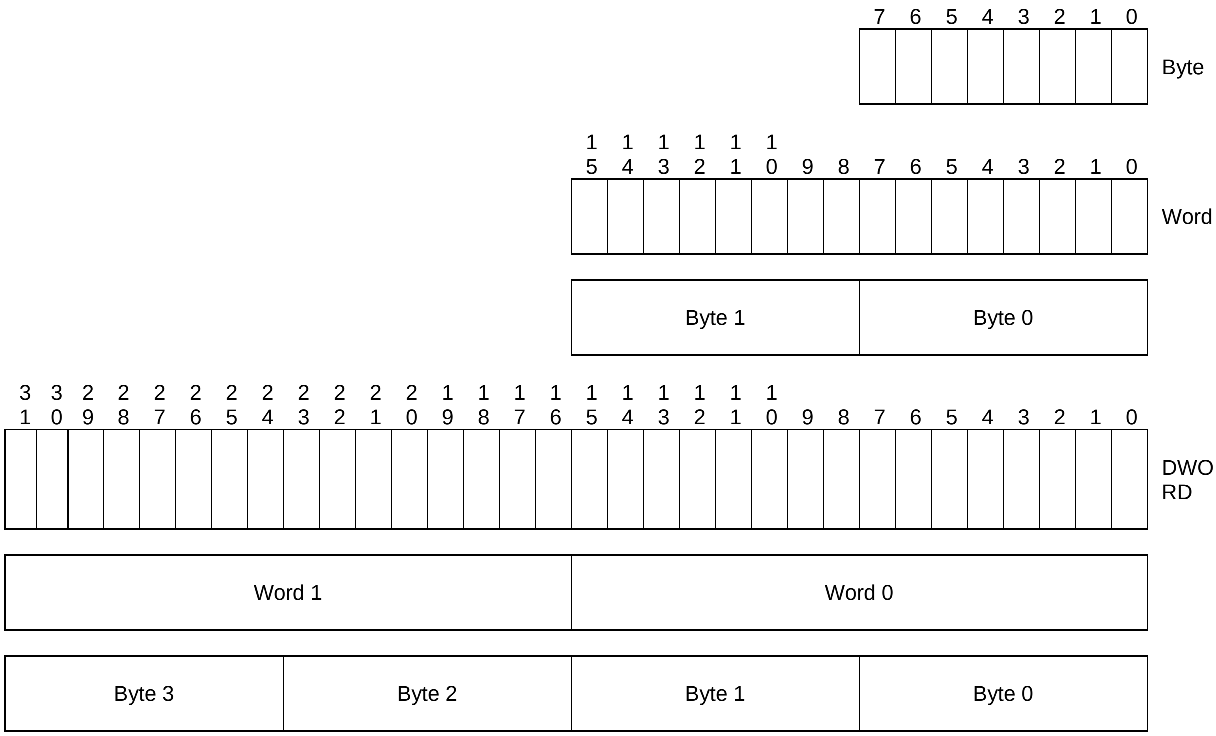


Figure 3 - Byte, word and DWORD relationships

4 General operational requirements

4.1 Command delivery

Commands may be delivered in two forms. For devices that do not implement the PACKET Command feature set, all commands and command parameters are delivered by writing the device Command Block registers. Such commands are defined as register delivered commands.

Devices that implement the PACKET Command feature set use packet delivered commands as well as some register delivered commands.

All register delivered commands and the PACKET command are described in Clause 5.

NOTE – The content of command packets delivered during execution of the PACKET command are not described in this standard. See Clause 1 for standards and specifications that define command packet content.

4.2 Data transfer command logical sector addressing

For data transfer commands all addressing of data sectors recorded on the device's media is by a logical sector address. There is no implied relationship between logical sector addresses and the actual physical location of the data sector on the media. All devices shall support LBA translation.

In standards ATA/ATAPI-5 and earlier, a CHS translation was defined. This translation is obsolete but if implemented it shall be implemented as defined in ATA/ATAPI-5.

4.2.1 Definitions and value ranges of IDENTIFY DEVICE data words

(Also See Clause 7.17)

a) Words (61:60) shall contain the value one greater than the total number of user-addressable logical sectors in 28-bit addressing and shall not exceed 0FFFFFFFh. The content of words (61:60) shall be greater than or equal to one and less than or equal to 268,435,455.
b) Words (103:100) shall contain the value one greater than the total number of user-addressable logical sectors in 48-bit addressing and shall not exceed 0000FFFFFFFFFFFFh.
c) The contents of words (61:60) and (103:100) may be affected by the host issuing a SET MAX ADDRESS or SET MAX ADDRESS EXT command.
d) The contents of words (61:60) and (103:100) shall not be used to determine if 48-bit addressing is supported. IDENTIFY DEVICE bit 10 word 83 indicates support for 48-bit addressing.

4.2.2 Addressing constraints and error reporting

Devices shall set IDNF to one or ABRT to one in the Error register and ERR to one in the Status register in response to any command where the requested LBA number is greater than or equal to the content of words (61:60) for a 28-bit addressing command or greater or equal to the contents of words (103:100) for a 48-bit addressing command.

4.3 General feature set

The following General feature set commands are mandatory for all devices that are capable of both reading and writing their media and do not implement the PACKET feature set:

- EXECUTE DEVICE DIAGNOSTIC
- FLUSH CACHE
- IDENTIFY DEVICE
- READ DMA

- READ MULTIPLE
- READ SECTOR(S)
- READ VERIFY SECTOR(S)
- SET FEATURES
- SET MULTIPLE MODE
- WRITE DMA
- WRITE MULTIPLE
- WRITE SECTOR(S)

The following General feature set commands are mandatory for all devices that are capable of only reading their media and do not implement the PACKET command feature set:

- EXECUTE DEVICE DIAGNOSTIC
- IDENTIFY DEVICE
- READ DMA
- READ MULTIPLE
- READ SECTOR(S)
- READ VERIFY SECTOR(S)
- SET FEATURES
- SET MULTIPLE MODE

The following General feature set commands are optional for devices not implementing the PACKET command feature set:

- DOWNLOAD MICROCODE
- NOP
- READ BUFFER
- WRITE BUFFER
- WRITE UNCORRECTABLE

The following Packet feature set command is prohibited for use by devices not implementing the PACKET command feature set:

- DEVICE RESET

[Editors Note: Reset requirement need to be in each transport]

4.4 The PACKET feature set

The following commands are mandatory for all devices implementing the PACKET feature set:

- PACKET
- DEVICE RESET
- EXECUTE DEVICE DIAGNOSTIC
- IDENTIFY DEVICE
- IDENTIFY PACKET DEVICE
- NOP
- READ SECTOR(S)
- SET FEATURES

The following General feature set commands are optional for all devices implementing the PACKET command feature set:

- FLUSH CACHE
- READ LOG EXT
- WRITE LOG EXT

- READ LOG DMA EXT
- WRITE LOG DMA EXT

The following General feature set commands are prohibited for use by devices implementing the PACKET command feature set.

- DOWNLOAD MICROCODE
- READ BUFFER
- READ DMA
- READ MULTIPLE
- READ VERIFY
- SET MULTIPLE MODE
- WRITE BUFFER
- WRITE DMA
- WRITE MULTIPLE
- WRITE SECTOR(S)
- WRITE UNCORRECTABLE

[Editors Note: Reset requirement need to be in each transport]

4.4.1 Identification of PACKET Command feature set devices

When executing a power-on, hardware, DEVICE RESET, or software reset, a device implementing the PACKET Command feature set shall perform the same reset protocol as other devices, but leaves the registers with a signature unique to PACKET Command feature set devices (See the appropriate transport documentation for a details).

In addition, the IDENTIFY DEVICE command shall not be executed but shall be command aborted and shall return a signature unique to devices implementing the PACKET Command feature set. The IDENTIFY PACKET DEVICE command is used by the host to get identifying parameter information for a device implementing the PACKET Command feature set (See 7.17.5 and 7.18).

4.4.2 PACKET Command feature set resets

Devices implementing the PACKET Command feature set respond to power-on, hardware, and software resets as any other device except for the resulting contents in the fields described above.

The DEVICE RESET command is provided to allow the device to be reset without affecting the other device on the bus.

4.4.3 The PACKET command

The PACKET command allows a host to send a command to the device via a command packet. The command packet contains the command and command parameters that the device is to execute (See Clause 1).

Upon receipt of the PACKET command the device sets BSY to one and prepares to receive the command packet. When ready, the device sets DRQ to one and clears BSY to zero. The command packet is then transferred to the device by PIO transfer. When the last word of the command packet is transferred, the device sets BSY to one, and clears DRQ to zero (See 7.26 as well as the appropriate transport documentation for a details).
[Editors Note: add a table the lists the feature sets and how they apply to both General and Packet devices]

4.5 Power Management feature set

A device shall implement power management. A device implementing the PACKET Command feature set may implement the power management as defined by the PACKET command set implemented by the device. Otherwise, the device shall implement the Power Management feature set as described in this standard.

The Power Management feature set permits a host to modify the behavior of a device in a manner that reduces the power required to operate. The Power Management feature set provides a set of commands and a timer that enable a device to implement low power consumption modes. A register delivered command device that implements the Power Management feature set shall implement the following minimum set of functions: See also 4.6 and 4.12.

- A Standby timer
- CHECK POWER MODE command
- IDLE command
- IDLE IMMEDIATE command
- SLEEP command
- STANDBY command
- STANDBY IMMEDIATE command

A device that implements the PACKET Command feature set and implements the Power Management feature set shall implement the following minimum set of functions:

- CHECK POWER MODE command
- IDLE IMMEDIATE command
- SLEEP command
- STANDBY IMMEDIATE command

4.5.1 Power management commands

The CHECK POWER MODE command allows a host to determine if a device is currently in, going to or leaving Standby or Idle mode. The CHECK POWER MODE command shall not change the power mode or affect the operation of the Standby timer.

The IDLE and IDLE IMMEDIATE commands move a device to Idle mode immediately from the Active or Standby modes. The IDLE command also sets the Standby timer count and enables or disables the Standby timer.

The STANDBY and STANDBY IMMEDIATE commands move a device to Standby mode immediately from the Active or Idle modes. The STANDBY command also sets the Standby timer count and enables or disables the Standby timer.

The SLEEP command moves a device to Sleep mode. The device's interface becomes inactive at command completion of the SLEEP command. A hardware or software reset or DEVICE RESET command is required to move a device out of Sleep mode.

4.5.2 Standby timer

The Standby timer provides a method for the device to automatically enter Standby mode from either Active or Idle mode following a host programmed period of inactivity. If the Standby timer is enabled and if the device is in the Active or Idle mode, the device waits for the specified time period and if no command is received, the device automatically enters the Standby mode.

If the Standby timer is disabled, the device may automatically enter Standby mode.

4.5.3 Power modes

Figure 4 shows the set of mode transitions that shall be implemented.

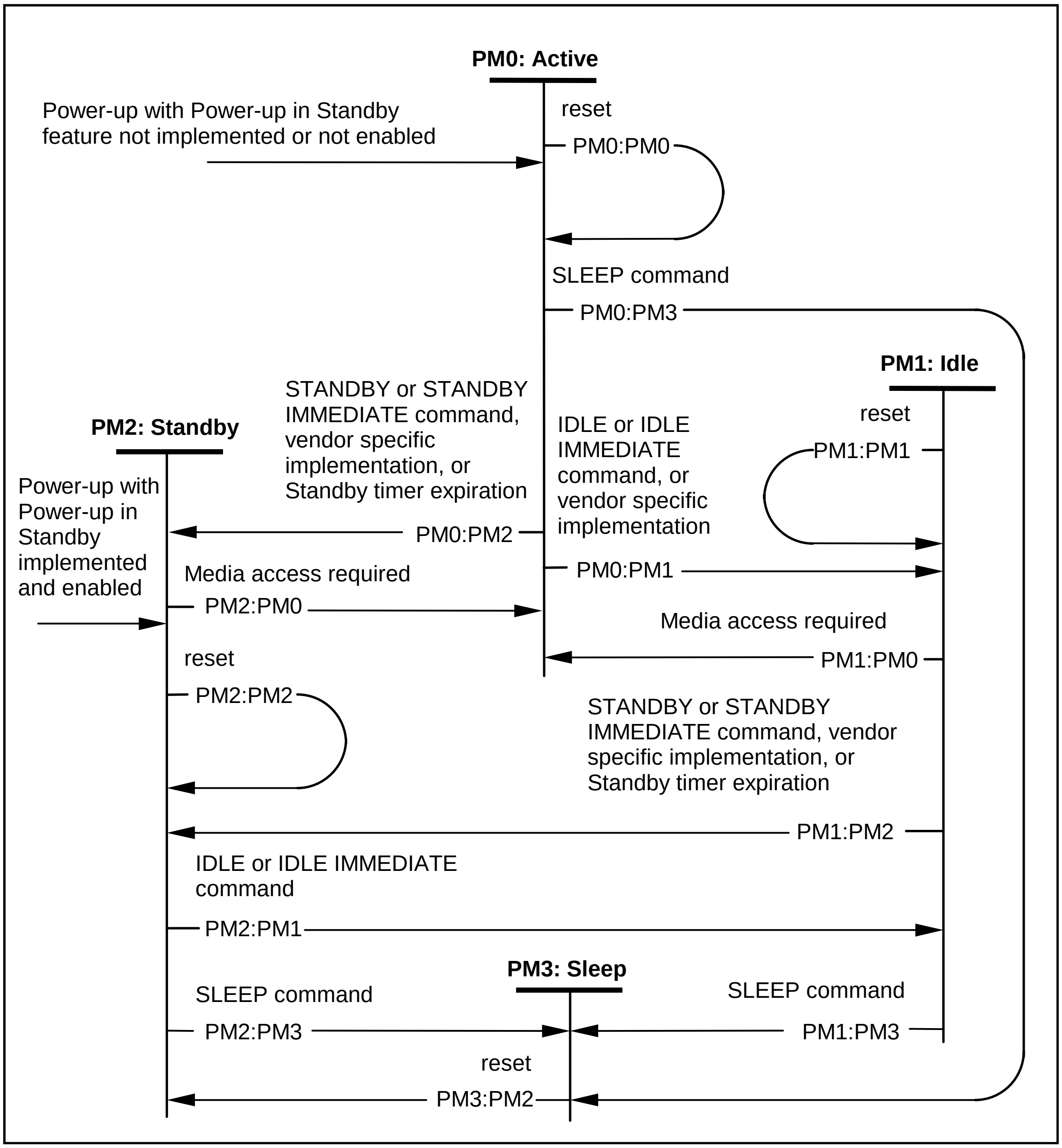


Figure 4 - Power management state diagram

PM0: Active: This mode shall be entered when the device receives a media access command while in Idle or Standby mode. This mode shall also be entered when the device is powered-up with the Power-Up In Standby feature not implemented or not enabled (See 4.12).

In Active mode the device is capable of responding to commands. During the execution of a media access command a device shall be in Active mode. Power consumption is greatest in this mode.

Transition PM0:PM0: When hardware reset, software reset, or DEVICE RESET command is received, the device shall make a transition to the PM0: Active mode when the reset protocol is completed.

Transition PM0:PM1: When an IDLE or IDLE IMMEDIATE command is received or when a vendor specific implementation determines a transition is required, then the device shall make a transition to the PM1:Idle mode.

Transition PM0:PM2: When a STANDBY or STANDBY IMMEDIATE command is received, the Standby timer expires, or a vendor specific implementation determines a transition is required, then the device shall make a transition to the PM2:Standby mode.

Transition PM0:PM3: When a SLEEP command is received, the device shall make a transition to the PM3:Sleep mode.

PM1: Idle: This mode shall be entered when the device receives an IDLE or IDLE IMMEDIATE command. Some devices may perform vendor specific internal power management and make a transition to the Idle mode without host intervention.

In Idle mode the device is capable of responding to commands but the device may take longer to complete commands than when in the Active mode. Power consumption may be reduced from that of Active mode.

Transition PM1:PM0: When a media access is required, the device shall make a transition to the PM0:Active mode.

Transition PM1:PM1: When hardware reset, software reset, or DEVICE RESET command is received, the device shall make a transition to the PM1:Idle mode when the reset protocol is completed.

Transition PM1:PM2: When a STANDBY or STANDBY IMMEDIATE command is received, the Standby timer expires, or a vendor specific implementation determines a transition is required, then the device shall make a transition to the PM2:Standby mode.

Transition PM1:PM3: When a SLEEP command is received, the device shall make a transition to the PM3:Sleep mode.

PM2: Standby: This mode shall be entered when the device receives a STANDBY command, a STANDBY IMMEDIATE command, or the Standby timer expires. Some devices may perform vendor specific internal power management and make a transition to the Standby mode without host intervention. This mode shall also be entered when the device is powered-up with the Power-Up In Standby feature implemented and enabled.

In Standby mode the device is capable of responding to commands but the device may take longer to complete commands than in the Idle mode. The time to respond could be as long as 30 s. Power consumption may be reduced from that of Idle mode.

Transition PM2:PM0: When a media access is required, the device shall make a transition to the PM0:Active mode.

Transition PM2:PM1: When an IDLE or IDLE IMMEDIATE command is received, or a vendor specific implementation determines a transition is required, then the device shall make a transition to the PM1:Idle mode.

Transition PM2:PM2: When hardware reset, software reset, or DEVICE RESET command is received, the device shall make a transition to the PM2:Standby mode when the reset protocol is completed.

Transition PM2:PM3: When a SLEEP command is received, the device shall make a transition to the PM3:Sleep mode.

PM3: Sleep: This mode shall be entered when the device receives a SLEEP command.

In Sleep mode the device requires a hardware or software reset or a DEVICE RESET command to be activated. The time to respond could be as long as 30 s. Sleep mode provides the lowest power consumption of any mode.

In Sleep mode, the device's interface is not active. The content of the Status register is invalid in this mode.

Transition PM3:PM2:, When hardware reset, software reset, or DEVICE RESET command is received the device shall make a transition to the PM2:Standby mode.

4.6 Advanced Power Management feature set

The Advanced Power Management feature set is an optional feature set that allows the host to select a power management level. The power management level is specified using a scale from the lowest power consumption setting of 01h to the maximum performance level of FEh. Device performance may increase with increasing power management levels. Device power consumption may increase with increasing power management levels. A device may implement one power management method for two or more contiguous power management levels. For example, a device may implement one power management method from level 80h to A0h and a higher performance, higher power consumption method from level A1h to FEh. Advanced power management levels 80h and higher do not permit the device to spin down to save power.

The Advanced Power Management feature set uses the following functions:

- A SET FEATURES subcommand to enable Advanced Power Management
- A SET FEATURES subcommand to disable Advanced Power Management

Advanced Power Management is independent of the Standby timer setting. If both Advanced Power Management and the Standby timer are set, the device will go to the Standby state when the timer times out or the device’s Advanced Power Management algorithm indicates that the Standby state should be entered.

The IDENTIFY DEVICE command indicates that Advanced Power Management is supported, whether Advanced Power Management is enabled, and the current advanced power management level if Advanced Power Management is enabled.

4.7 Security Mode feature set

The optional Security Mode feature set is a password system that restricts access to user data stored on a device. The system has two passwords, User and Master, and two security levels, High and Maximum. The security system is enabled by sending a user password to the device with the SECURITY SET PASSWORD command. When the security system is enabled, access to user data on the device is denied after a power cycle until the User password is sent to the device with the SECURITY UNLOCK command.

A Master password may be set in addition to the User password. The purpose of the Master password is to allow an administrator to establish a password that is kept secret from the user, and which may be used to unlock the device if the User password is lost. Setting the Master password does not enable the password system.

The security level is set to High or Maximum with the SECURITY SET PASSWORD command. The security level determines device behavior when the Master password is used to unlock the device. When the security level is set to High the device requires the SECURITY UNLOCK command and the Master password to unlock. When the security level is set to Maximum the device requires a SECURITY ERASE PREPARE command and a SECURITY ERASE UNIT command with the master password to unlock. Execution of the SECURITY ERASE UNIT command erases all user data on the device.

The SECURITY FREEZE LOCK command prevents changes to passwords until a following power cycle. The purpose of the SECURITY FREEZE LOCK command is to prevent password setting attacks on the security system.

A device that implements the Security Mode feature set shall implement the following minimum set of commands:

- SECURITY SET PASSWORD
- SECURITY UNLOCK
- SECURITY ERASE PREPARE
- SECURITY ERASE UNIT
- SECURITY FREEZE LOCK
- SECURITY DISABLE PASSWORD

Support of the Security Mode feature set is indicated in IDENTIFY DEVICE data word 82 and data word 128.

4.7.1 Security mode initial setting

When the device is shipped by the manufacturer, the state of the Security Mode feature shall be disabled. The initial Master password value is not defined by this standard.

If the Master Password Revision Code feature is supported, the Master Password Revision Code shall be set to FFFEh by the manufacturer.

4.7.2 User password lost

If the User password sent to the device with the SECURITY UNLOCK command does not match the user password previously set with the SECURITY SET PASSWORD command, the device shall not allow the user to access data.

If the Security Level was set to High during the last SECURITY SET PASSWORD command, the device shall unlock if the Master password is received.

If the Security Level was set to Maximum during the last SECURITY SET PASSWORD command, the device shall not unlock if the Master password is received. The SECURITY ERASE UNIT command shall erase all user data and unlock the device if the Master password matches the last Master password previously set with the SECURITY SET PASSWORD command.

4.7.3 Attempt limit for SECURITY UNLOCK command

The device shall have an attempt limit counter. The purpose of this counter is to defeat repeated trial attacks. After each failed User or Master password SECURITY UNLOCK command, the counter is decremented. When the counter value reaches zero the EXPIRE bit (bit 4) of IDENTIFY DEVICE data word 128 is set to one, and the SECURITY UNLOCK and SECURITY UNIT ERASE commands are command aborted until the device is powered off or hardware reset. The EXPIRE bit shall be cleared to zero after power-on or hardware reset. The counter shall be set to five after a power-on or hardware reset.

4.7.4 Security mode states

Figure 5 decribes security mode states and state transitions.

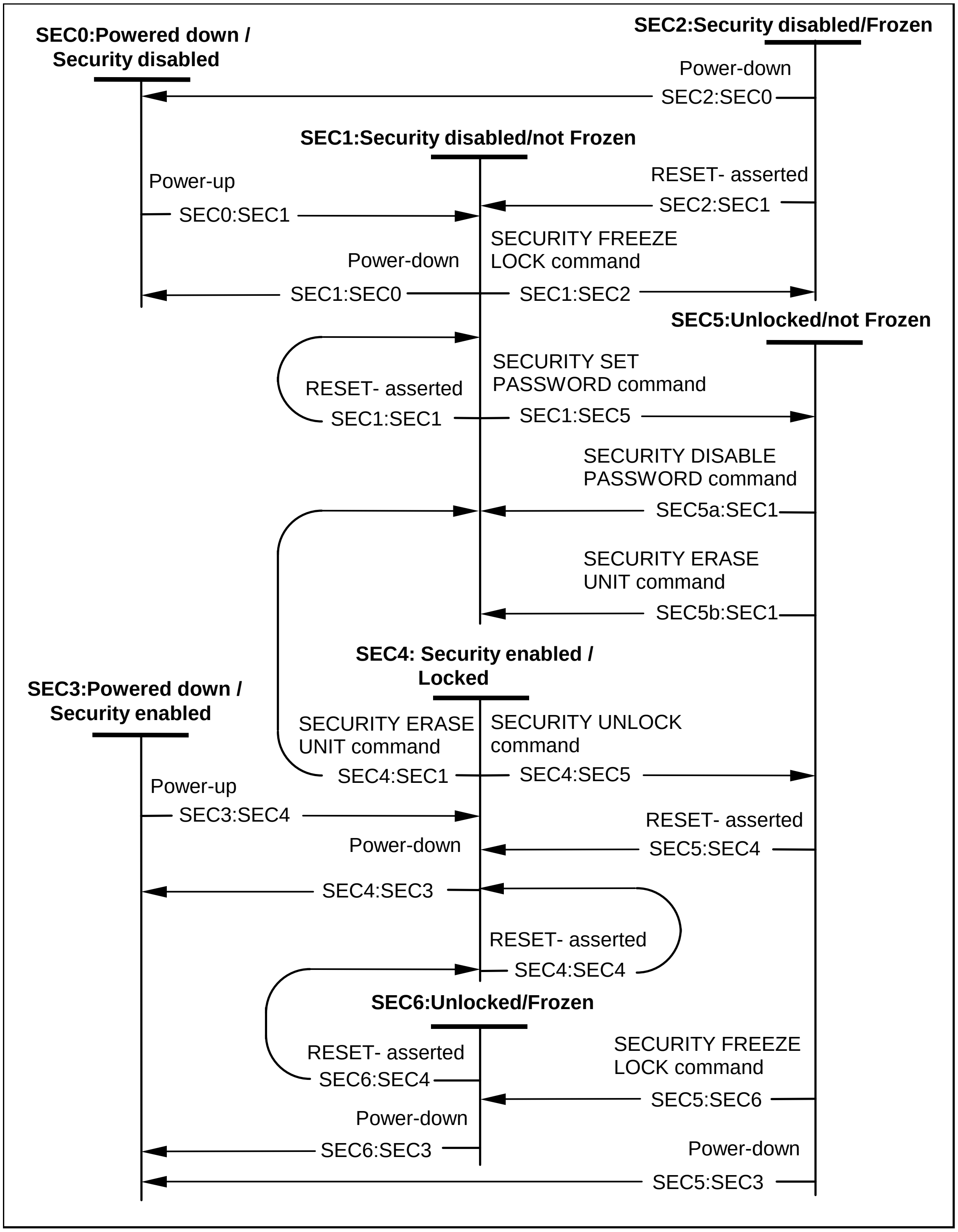


Figure 5 - Security mode state diagram

SEC0: Powered down/Security disabled: This mode shall be entered when the device is powered-down with the Security Mode feature set disabled.

Transition SEC0:SEC1: When the device is powered-up, the device shall make a transition to the SEC1: Security disabled/not Frozen state.

SEC1: Security disabled/not Frozen: This mode shall be entered when the device is powered-up or a hardware reset is received with the Security Mode feature set disabled or when the Security Mode feature set is disabled by a SECURITY DISABLE PASSWORD or SECURITY ERASE UNIT command.

In this state, the device is capable of responding to all commands (See Table 3 Unlocked column).

Transition SEC1:SEC0: When the device is powered-down, the device shall make a transition to the SEC0: Powered down/Security disabled state.

Transition SEC1:SEC1: When the device receives a hardware reset, the device shall make a transition to the SEC1: Security disabled/not Frozen state.

Transition SEC1:SEC2: When a SECURITY FREEZE LOCK command is received, the device shall make a transition to the SEC2: Security disabled/Frozen state.

Transition SEC1:SEC5: When a SECURITY SET PASSWORD command is received, the device shall make a transition to the SEC5: Unlocked/not frozen state

SEC2: Security disabled/Frozen: This mode shall be entered when the device receives a SECURITY FREEZE LOCK command while in Security disabled/not Frozen state.

In this state, the device is capable of responding to all commands except those indicated in Table 3 Frozen column.

Transition SEC2:SEC0: When the device is powered-down, the device shall make a transition to the SEC0: Powered down/Security disabled state.

Transition SEC2:SEC1: When the device receives a hardware reset, the device shall make a transition to the SEC1: Security disabled/not Frozen state.

SEC3: Powered down/Security enabled: This mode shall be entered when the device is powered-down with the Security Mode feature set enabled.

Transition SEC3:SEC4: When the device is powered-up, the device shall make a transition to the SEC4: Security enabled/locked state.

SEC4: Security enabled/Locked: This mode shall be entered when the device is powered-up or a hardware reset is received with the Security Mode feature set enabled.

In this state, the device shall only respond to commands that do not access data in the user data area of the media (See Table 3 Locked column).

Transition SEC4:SEC3: When the device is powered-down, the device shall make a transition to the SEC3: Powered down/Security enabled state.

Transition SEC4:SEC4: When the device receives a hardware reset, the device shall make a transition to the SEC4: Security enabled/locked state.

Transition SEC4:SEC5: When a valid SECURITY UNLOCK command is received, the device shall make a transition to the SEC5: Unlocked/not Frozen state.

Transition SEC4:SEC1: When a SECURITY ERASE PREPARE command is received and is followed by a SECURITY ERASE UNIT command, the device shall make a transition to the SEC1: Security disabled/not Frozen state.

SEC5: Unlocked/not Frozen: This mode shall be entered when the device receives a SECURITY SET PASSWORD command to enable the lock or a SECURITY UNLOCK command.

In this state, the device shall respond to all commands (See Table 3 Unlocked column).

Transition SEC5a:SEC1: When a valid SECURITY DISABLE PASSWORD command is received, the device shall make a transition to the SEC1: Security disabled/not Frozen state.

Transition SEC5b:SEC1: When a SECURITY ERASE PREPARE command is received and is followed by a SECURITY ERASE UNIT command, the device shall make a transition to the SEC1: Security disabled/not Frozen state.

Transition SEC5:SEC6: When a SECURITY FREEZE LOCK command is received, the device shall make a transition to the SEC6: Unlocked/Frozen state.

Transition SEC5:SEC3: When the device is powered-down, the device shall make a transition to the SEC3: Powered down/Security enabled state.

Transition SEC5:SEC4: When the device receives a hardware reset, the device shall make a transition to the SEC4: Security enabled/Locked state.

SEC6: Unlocked/ Frozen: This mode shall be entered when the device receives a SECURITY FREEZE LOCK command while in Unlocked/Locked state.

In this state, the device is capable of responding to all commands except those indicated in Table 3 Frozen column.

Transition SEC6:SEC3: When the device is powered-down, the device shall make a transition to the SEC3: Powered down/Security enabled state.

Transition SEC6:SEC4: When the device receives a hardware reset, the device shall make a transition to the SEC4: Security enabled/Locked state.

Table 3 - Security mode command actions

Command	Locked	Unlocked	Frozen
CFA ERASE SECTORS	Command aborted	Executable	Executable
CFA REQUEST EXTENDED ERROR CODE	Executable	Executable	Executable
CFA TRANSLATE SECTOR	Executable	Executable	Executable
CFA WRITE MULTIPLE WITHOUT ERASE	Command aborted	Executable	Executable
CFA WRITE SECTORS WITHOUT ERASE	Command aborted	Executable	Executable
CHECK MEDIA CARD TYPE	Command aborted	Executable	Executable
CHECK POWER MODE	Executable	Executable	Executable
CONFIGURE STREAM	Command aborted	Executable	Executable
DEVICE CONFIGURATION	Command aborted	Executable	Executable
DEVICE RESET	Executable	Executable	Executable
DOWNLOAD MICROCODE	Vendor Specific	Vendor Specific	Vendor Specific
EXECUTE DEVICE DIAGNOSTIC	Executable	Executable	Executable
FLUSH CACHE	Command aborted	Executable	Executable
FLUSH CACHE EXT	Command aborted	Executable	Executable
GET MEDIA STATUS	Command aborted	Executable	Executable
IDENTIFY DEVICE	Executable	Executable	Executable
IDENTIFY PACKET DEVICE	Executable	Executable	Executable
IDLE	Executable	Executable	Executable
IDLE IMMEDIATE	Executable	Executable	Executable
MEDIA EJECT	Command aborted	Executable	Executable
MEDIA LOCK	Command aborted	Executable	Executable
MEDIA UNLOCK	Command aborted	Executable	Executable
NOP	Executable	Executable	Executable
PACKET	Command aborted	Executable	Executable
READ BUFFER	Executable	Executable	Executable
READ DMA	Command aborted	Executable	Executable
READ DMA EXT	Command aborted	Executable	Executable
READ DMA QUEUED	Command aborted	Executable	Executable
READ DMA QUEUED EXT	Command aborted	Executable	Executable
READ LOG EXT	Command aborted	Executable	Executable
READ MULTIPLE	Command aborted	Executable	Executable
READ MULTIPLE EXT	Command aborted	Executable	Executable
READ NATIVE MAX ADDRESS	Executable	Executable	Executable
READ NATIVE MAX ADDRESS EXT	Executable	Executable	Executable
READ SECTOR(S)	Command aborted	Executable	Executable
READ SECTOR(S) EXT	Command aborted	Executable	Executable
READ STREAM DMA EXT	Command aborted	Executable	Executable
READ STREAM EXT	Command aborted	Executable	Executable
READ VERIFY SECTOR(S)	Command aborted	Executable	Executable
READ VERIFY SECTOR(S) EXT	Command aborted	Executable	Executable
SECURITY DISABLE PASSWORD	Command aborted	Executable	Command aborted
SECURITY ERASE PREPARE	Executable	Executable	Command aborted
SECURITY ERASE UNIT	Executable	Executable	Command aborted
SECURITY FREEZE LOCK	Command aborted	Executable	Executable
SECURITY SET PASSWORD	Command aborted	Executable	Command aborted
SECURITY UNLOCK	Executable	Executable	Command aborted
SERVICE	Command aborted	Executable	Executable
SET FEATURES	Executable	Executable	Executable
SET MAX ADDRESS	Command aborted	Executable	Executable
SET MAX ADDRESS EXT	Command aborted	Executable	Executable
SET MAX SET PASSWORD	Command aborted	Executable	Executable
SET MAX LOCK	Command aborted	Executable	Executable
SET MAX FREEZE LOCK	Command aborted	Executable	Executable
SET MAX UNLOCK	Command aborted	Executable	Executable
SET MULTIPLE MODE	Executable	Executable	Executable
SLEEP	Executable	Executable	Executable
SMART DISABLE OPERATIONS	Executable	Executable	Executable
SMART ENABLE/DISABLE AUTOSAVE	Executable	Executable	Executable
SMART ENABLE OPERATIONS	Executable	Executable	Executable
SMART EXECUTE OFF-LINE IMMEDIATE	Executable	Executable	Executable
SMART READ DATA	Executable	Executable	Executable

(continued)

Table 3 - Security mode command actions *(continued)*

Command	Locked	Unlocked	Frozen
SMART READ LOG	Executable	Executable	Executable
SMART RETURN STATUS	Executable	Executable	Executable
SMART WRITE LOG	Executable	Executable	Executable
STANDBY	Executable	Executable	Executable
STANDBY IMMEDIATE	Executable	Executable	Executable
WRITE BUFFER	Executable	Executable	Executable
WRITE DMA	Command aborted	Executable	Executable
WRITE DMA EXT	Command aborted	Executable	Executable
WRITE DMA FUA EXT	Command aborted	Executable	Executable
WRITE DMA QUEUED	Command aborted	Executable	Executable
WRITE DMA QUEUED EXT	Command aborted	Executable	Executable
WRITE DMA QUEUED FUA EXT	Command aborted	Executable	Executable
WRITE LOG EXT	Command aborted	Executable	Executable
WRITE MULTIPLE	Command aborted	Executable	Executable
WRITE MULTIPLE EXT	Command aborted	Executable	Executable
WRITE MULTIPLE FUA EXT	Command aborted	Executable	Executable
WRITE SECTOR(S)	Command aborted	Executable	Executable
WRITE SECTOR(S) EXT	Command aborted	Executable	Executable
WRITE STREAM DMA EXT	Command aborted	Executable	Executable
WRITE STREAM EXT	Command aborted	Executable	Executable

(concluded)

4.8 SMART (Self-monitoring, analysis, and reporting technology) feature set

The intent of self-monitoring, analysis, and reporting technology (the SMART feature set) is to protect user data and minimize the likelihood of unscheduled system downtime that may be caused by predictable degradation and/or fault of the device. By monitoring and storing critical performance and calibration parameters, SMART feature set devices attempt to predict the likelihood of near-term degradation or fault condition. Providing the host system the knowledge of a negative reliability condition allows the host system to warn the user of the impending risk of a data loss and advise the user of appropriate action. Support of this feature set is indicated in the IDENTIFY DEVICE data.

Devices that implement the PACKET Command feature set shall not implement the SMART feature set as described in this standard. Devices that implement the PACKET Command feature set and SMART shall implement SMART as defined by the command packet set implemented by the device. This feature set is optional if the PACKET Command feature set is not supported.

4.8.1 Device SMART data structure

SMART feature set capability and status information for the device are stored in the device SMART data structure. The off-line data collection capability and status data stored herein may be useful to the host if the SMART EXECUTE OFF-LINE IMMEDIATE command is implemented (See 7.56.5).

4.8.2 On-line data collection

Collection of SMART data in an “on-line” mode shall have no impact on device performance. The SMART data that is collected or the methods by which data is collected in this mode may be different than those in the off-line data collection mode for any particular device and may vary from one device to another.

4.8.3 Off-line data collection

The device shall use off-line mode for data collection and self-test routines that have an impact on performance if the device is required to respond to commands from the host while performing that data collection. This impact on performance may vary from device to device. The data that is collected or the methods by which the data is collected in this mode may be different than those in the on-line data collection mode for any particular device and may vary from one device to another.

4.8.4 Threshold exceeded condition

This condition occurs when the device’s SMART reliability status indicates an impending degrading or fault condition.

4.8.5 SMART feature set commands

These commands use a single command code and are differentiated from one another by the value placed in the Feature field (See 7.56).

If the SMART feature set is implemented, the following commands shall be implemented.

- SMART DISABLE OPERATIONS
- SMART ENABLE/DISABLE AUTOSAVE
- SMART ENABLE OPERATIONS
- SMART RETURN STATUS

If the SMART feature set is implemented, the following commands may be implemented.

- SMART EXECUTE OFF-LINE IMMEDIATE
- SMART READ DATA

- SMART READ LOG
- SMART WRITE LOG
- READ LOG EXT
- WRITE LOG EXT

4.8.6 SMART operation with power management modes

When used with a host that has implemented the Power Management feature set, a SMART enabled device should automatically save the device accumulated SMART data upon receipt of an IDLE IMMEDIATE, STANDBY IMMEDIATE, or SLEEP command or upon return to an Active or Idle mode from a Standby mode (See 7.56.6).

If a SMART feature set enabled device has been set to use the Standby timer, the device should automatically save the device accumulated SMART data prior to going from an Idle mode to the Standby mode or upon return to an Active or Idle mode from a Standby mode.

A device shall not execute any routine to automatically save the device accumulated SMART data while the device is in a Standby or Sleep mode.

4.8.7 SMART device error log reporting

Logging of reported errors is an optional SMART feature. If error logging is supported by a device, it is indicated in byte 370 of the SMART READ DATA command response and bit 0 of word 84 of the IDENTIFY DEVICE response. If error logging is supported, the device shall provide information on the last five errors that the device reported as described in the SMART READ LOG command (See 7.56.7). The device may also provide additional vendor specific information on these reported errors.

If error logging is supported, it shall not be disabled when SMART is disabled. Error log information shall be gathered when the device is powered-on except that logging of errors when in a reduced power mode is optional. If errors are logged when in a reduced power mode, the reduced power mode shall not change. Disabling SMART shall disable the delivering of error log information via the SMART READ LOG command.

If a device receives a firmware modification, all error log data shall be discarded and the device error count for the life of the device shall be reset to zero.

4.9 Host Protected Area feature set

A reserved area for data storage outside the normal operating system file system is required for several specialized applications. Systems may wish to store configuration data or save memory to the device in a location that the operating systems cannot change. The optional Host Protected Area feature set allows a portion of the device to be reserved for such an area when the device is initially configured. A device that implements the Host Protected Area feature set shall implement the following minimum set of commands:

- READ NATIVE MAX ADDRESS
- SET MAX ADDRESS

A device that implements the Host Protected Area feature set and supports the 48-bit Address feature set shall implement the following additional set of commands:

- READ NATIVE MAX ADDRESS EXT
- SET MAX ADDRESS EXT

Devices supporting this feature set shall set bit 10 of word 82 to one in the data returned by the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE command.

In addition, a device supporting the Host Protected Area feature set may optionally include the security extensions. The Host Protected Area security commands use a single command code and are differentiated from one another by the value placed in the Feature field.

- SET MAX SET PASSWORD
- SET MAX LOCK
- SET MAX FREEZE LOCK
- SET MAX UNLOCK

Devices supporting these extensions shall set bit 10 of word 82 and bit 8 of word 83 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE data to one.

The READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT command allows the host to determine the maximum native address space of the device even when a protected area has been allocated.

The SET MAX ADDRESS or SET MAX ADDRESS EXT command allows the host to redefine the maximum address of the user accessible address space. That is, when the SET MAX ADDRESS or SET MAX ADDRESS EXT command is issued with a maximum address less than the native maximum address, the device reduces the user accessible address space to the maximum specified by the command, providing a protected area above that maximum address. The SET MAX ADDRESS or SET MAX ADDRESS EXT command shall be immediately preceded by a READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT command. After the SET MAX ADDRESS or SET MAX ADDRESS EXT command has been issued, the device shall report only the reduced user address space in response to an IDENTIFY DEVICE command in words 60, 61, 100, 101, 102, and 103. Any read or write command to an address above the maximum address specified by the SET MAX ADDRESS or SET MAX ADDRESS EXT command shall cause command completion with the IDNF bit set to one and ERR set to one, or command aborted. A volatility bit in the Sector Count field allows the host to specify if the maximum address set is preserved across power-on or hardware reset cycles. On power-on or hardware reset the device maximum address returns to the last non-volatile address setting regardless of subsequent volatile SET MAX ADDRESS or SET MAX ADDRESS EXT commands. If the SET MAX ADDRESS or SET MAX ADDRESS EXT command is issued with a value that exceeds the native maximum address command aborted shall be returned.

Typical use of these commands would be:

On reset

1) BIOS receives control after a system reset;
2) BIOS issues a READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT command to find the max capacity of the device;
3) BIOS issues a SET MAX ADDRESS or SET MAX ADDRESS EXT command to the values returned by READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT;
4) BIOS reads configuration data from the highest area on the disk;
5) BIOS issues a READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT command followed by a SET MAX ADDRESS or SET MAX ADDRESS EXT command to reset the device to the size of the file system.

On save to disk

1) BIOS receives control prior to shut down;
2) BIOS issues a READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT command to find the max capacity of the device;
3) BIOS issues a volatile SET MAX ADDRESS or SET MAX ADDRESS EXT command to the values returned by READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT;
4) Memory is copied to the reserved area;
5) Shut down completes;
6) On power-on or hardware reset the device max address returns to the last non-volatile setting.

These commands are intended for use only by system BIOS or other low-level boot time process. Using these commands outside BIOS controlled boot or shutdown may result in damage to file systems on the device. Devices should return command aborted if a subsequent non-volatile SET MAX ADDRESS or SET MAX ADDRESS EXT command is received after a power-on or hardware reset.

The SET MAX SET PASSWORD command allows the host to define the password to be used during the current power-on cycle. The password does not persist over a power cycle but does persist over a hardware or software reset. This password is not related to the password used for the Security Mode Feature set. When the password is set the device is in the Set_Max_Unlocked mode.

The SET MAX LOCK command allows the host to disable the SET MAX commands (except SET MAX UNLOCK) until the next power cycle or the issuance and acceptance of the SET MAX UNLOCK command. When this command is accepted the device is in the Set_Max_Locked mode.

The SET MAX UNLOCK command changes the device from the Set_Max_Locked mode to the Set_Max_Unlocked mode.

The SET MAX FREEZE LOCK command allows the host to disable the SET MAX commands (including SET MAX UNLOCK) until the next power cycle. When this command is accepted the device is in the Set_Max_Frozen mode.

4.9.1 BIOS determination of SET MAX security exension status

When the device is locked bit 8 of word 86 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE data shall be set to one.

4.9.2 BIOS locking SET MAX

To allow for multiple BIOSs to gain access to the protected area the host BIOS should only lock the protected area immediately prior to booting the operating system.

Figure 6 is the SET MAX state diagram.

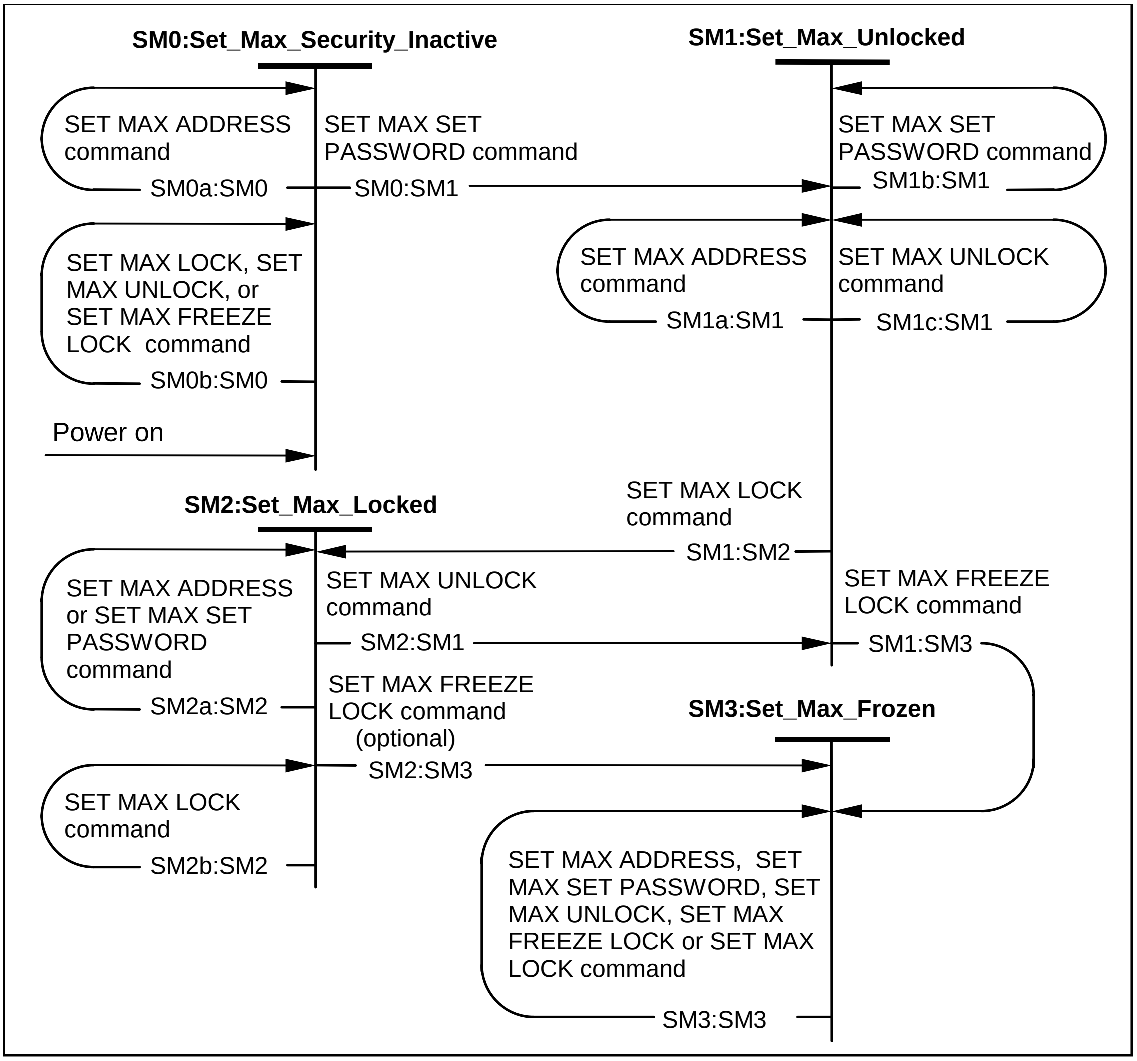


Figure 6 - SET MAX security state diagram

SM0: Set_Max_Security_Inactive: This state shall be entered when the device is powered-on.

When in this state, SET MAX security is disabled.

Transition SM0a:SM0: When a SET MAX ADDRESS command is received, the command shall be executed and the device shall make a transition to the SM0: Set_MAX_Security_Inactive state.

Transition SM0b:SM0: When a SET MAX LOCK, SET MAX UNLOCK, or SET MAX FREEZE LOCK command is received, the device shall abort the command and make a transition to the SM0: Set_MAX_Security_Inactive state.

Transition SM0:SM1: When a SET MAX SET PASSWORD command is received, the device shall make a transition to the SM1: Set_Max_Unlocked state.

SM1: Set_Max_Unlocked: This state is entered when a SET MAX SET PASSWORD or a SET MAX UNLOCK command is received.

When in this state, a SET MAX security password has been established and the SET MAX security is unlocked. Bit 8 of word 86 of the IDENTIFY DEVICE data shall be set to one.

Transition SM1a:SM1: When a SET MAX ADDRESS command is received, the command shall be executed and the device shall make a transition to the SM1: Set_MAX_Unlocked state.

Transition SM1b:SM1: When a SET MAX SET PASSWORD is received, the password stored by the device shall be changed to the new value and the device shall make a transition to the SM1: Set_MAX_Unlocked state.

Transition SM1c:SM1: When a SET MAX UNLOCK command is received, the command shall not be executed and the device shall make a transition to the SM1: Set_MAX_Unlocked state.

Transition SM1:SM2: When a SET MAX LOCK command is received, the device shall make a transition to the SM2: Set_Max_Locked state.

Transition SM1:SM3: When a SET MAX FREEZE LOCK command is received, the device shall make a transition to the SM3: Set_Max_Frozen state.

SM2: Set_Max_Locked: This state is entered when a SET MAX LOCK command is received.

When in this state, a SET MAX security password has been established and the SET MAX security is locked. Bit 8 of word 86 of the IDENTIFY DEVICE data shall be set to one.

Transition SM2a:SM2: When a SET MAX ADDRESS or SET MAX SET PASSWORD command is received, the command shall be aborted and the device shall make a transition to the SM2: Set_Max_Locked state.

Transition SM2b:SM2: When a SET MAX LOCK command is received, the command shall be executed and the device shall make a transition to the SM2: Set_Max_Locked state.

Transition SM2:SM1: When a SET MAX UNLOCK command is received, the device shall make a transition to the SM1: Set Max Unlocked state.

Transition SM2:SM3: When a SET MAX FREEZE LOCK command is received, the device may make a transition to the SM3: Set_Max_Frozen state. Hosts should not issue the SET MAX FREEZE LOCK command when in this state.

SM3: Set_Max_Frozen: This state is entered when a SET MAX FREEZE LOCK command is received.

In this state, the device may not transition to any other state except by a power cycling. When in this mode bit 8 of word 86 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE data shall be set to one.

Transition SM3:SM3: When a SET MAX ADDRESS, SET MAX SET PASSWORD, SET MAX UNLOCK, SET MAX FREEZE LOCK, or SET MAX LOCK command is received, the command shall be aborted and the device shall make a transition to the SM3: Set_Max_Frozen state.

4.10 CompactFlash™ Association (CFA) feature set

The optional CompactFlash™ Association (CFA) feature set provides support for solid state memory devices. A device that implements the CFA feature set shall implement the following minimum set of commands:

- CFA REQUEST EXTENDED ERROR CODE
- CFA WRITE SECTORS WITHOUT ERASE
- CFA ERASE SECTORS
- CFA WRITE MULTIPLE WITHOUT ERASE
- CFA TRANSLATE SECTOR
- SET FEATURES Enable/Disable 8-bit transfer

Devices reporting the value 848Ah in IDENTIFY DEVICE data word 0 or devices having bit 2 of IDENTIFY DEVICE data word 83 set to one shall support the CFA feature Set. If the CFA feature set is implemented, all five commands shall be implemented.

Support of DMA commands is optional for devices that support the CFA feature set.

The CFA ERASE SECTORS command preconditions the logical sector for a subsequent CFA WRITE SECTORS WITHOUT ERASE or CFA WRITE MULTIPLE WITHOUT ERASE command to achieve higher performance during the write operation. The CFA TRANSLATE SECTOR command provides information about a logical sector such as the number of write cycles performed on that sector and an indication of the logical sector's erased precondition. The CFA REQUEST EXTENDED ERROR CODE command provides more detailed error information.

Command codes B8h through BFh are reserved for assignment by the CompactFlash™ Association.

4.11 Removable Media Status Notification and Removable Media feature sets

This section describes two feature sets that secure the media in removable media storage devices using the ATA/ATAPI interface protocols. The Removable Media Status Notification feature set is intended for use in both devices implementing the PACKET Command feature set and those not implementing the PACKET Command feature set. The Removable Media feature set is intended for use only in devices not implementing the PACKET Command feature set. Only one of these feature sets shall be enabled at any time. If the Removable Media Status Notification feature set is in use then the Removable Media feature set is disabled and vice versa.

The reasons for implementing the Removable Media Status Notification feature Set or the Removable Media feature set are:

- to prevent data loss caused by writing to new media while still referencing the previous media's information.
- to prevent data loss by locking the media until completion of a cached write.
- to prevent removal of the media by unauthorized persons.

4.11.1 Removable Media Status Notification feature set

The Removable Media Status Notification feature set is the preferred feature set for securing the media in removable media storage devices. This feature set uses the SET FEATURES command to enable Removable Media Status Notification. Removable Media Status Notification gives the host system maximum control of the media. The host system determines media status by issuing the GET MEDIA STATUS command and controls the device eject mechanism via the MEDIA EJECT command (for devices not implementing the PACKET Command feature set) or the START/STOP UNIT command (for devices implementing the PACKET Command feature set, See Clause 1). While Removable Media Status Notification is enabled devices not implementing the PACKET Command feature set execute MEDIA LOCK and MEDIA UNLOCK commands without changing the media lock state (no-operation). While Removable Media Status Notification is enabled the eject button does not eject the media.

Removable Media Status Notification is persistent through medium removal and insertion and is only disabled via the SET FEATURES command, hardware reset, software reset, the DEVICE RESET command, the EXECUTE DEVICE DIAGNOSTIC command, or power-on reset. Removable Media Status Notification shall be re-enabled after any of the previous reset conditions occur. All media status is reset when Removable Media Status Notification is disabled because a reset condition occurred. Any pending media change or media change request is cleared when the Removable Media Status Notification reset condition occurs.

The following commands are defined to implement the Removable Media Status Notification feature set.

- GET MEDIA STATUS
- MEDIA EJECT
- SET FEATURES (Enable media status notification)

- SET FEATURES (Disable media status notification)

NOTE – Devices implementing the PACKET Command feature set control the media eject mechanism via the START/STOP UNIT command packet.

The preferred sequence of events to use the Removable Media Status Notification feature set is as follows:

1) Host system checks whether or not the device implements the PACKET Command feature set via the device signature in the Command Block registers.
2) Host system issues the IDENTIFY DEVICE command or the IDENTIFY PACKET DEVICE command and checks that the device is a removable media device and that the Removable Media Status Notification feature set is supported.
3) Host system uses the SET FEATURES command to enable Media Status Notification that gives control of the media to the host. At this time the host system checks the LBA field (23:16) register to determine if:
   - the device is capable of locking the media.
   - the device is capable of power ejecting the media.
   - Media Status Notification was enabled prior to this command.
4) Host system periodically checks media status using the GET MEDIA STATUS command to determine if any of the following events occurred:
   - no media is present in the device (NM).
   - media was changed since the last command (MC).
   - a media change request has occurred (MCR).
   - media is write protected (WP).

4.11.2 Removable Media feature set

The Removable Media feature set is intended only for devices not implementing the PACKET Command feature set. This feature set operates with Media Status Notification disabled. The MEDIA LOCK and MEDIA UNLOCK commands are used to secure the media and the MEDIA EJECT command is used to remove the media. While the media is locked, the eject button does not eject the media. Media status is determined by checking the media status bits returned by the MEDIA LOCK and MEDIA UNLOCK commands.

Power-on reset, hardware reset, and the EXECUTE DEVICE DIAGNOSTIC command clear the Media Lock (LOCK) state and the Media Change Request (MCR) state. Software reset clears the Media Lock (LOCK) state, clears the Media Change Request (MCR) state, and preserves the Media Change (MC) state.

The following commands are defined to implement the Removable Media feature set.

- MEDIA EJECT
- MEDIA LOCK
- MEDIA UNLOCK

The preferred sequence of events to use the Removable Media feature set is as follows:

1) Host system checks whether or not the device implements the PACKET Command feature set via the device signature in the Command Block registers.
2) Host system issues the IDENTIFY DEVICE command and checks that the device is a removable media device and that the Removable Media feature set is supported.
3) Host system periodically issues MEDIA LOCK commands to determine if:
   - no media is present in the device (NM) - media is locked if present.
   - a media change request has occurred (MCR).

4.12 Power-Up In Standby feature set

The optional Power-Up In Standby feature set allows devices to be powered-up into the Standby power management state to minimize inrush current at power-up and to allow the host to sequence the spin-up of devices. This optional feature set may be enabled or disabled via the SET FEATURES command or may be enabled by use of a jumper or similar means, or both. When enabled by a jumper, the feature set shall not be disabled via the SET FEATURES command. The IDENTIFY DEVICE or IDENTIFY PACKET DEVICE data indicates whether this feature set is implemented and/or enabled.

The enabling of this feature set shall be persistent after power-down and power-up. When this feature set is enabled, the device shall power-up into Standby.

A device may implement a SET FEATURES subcommand that notifies the device to spin-up to the Active state when the device has powered-up into Standby. If the device implements this SET FEATURES subcommand and power-up into Standby is enabled, the device shall remain in Standby until the SET FEATURES subcommand is received. If the device implements this SET FEATURES subcommand, the fact that the feature is implemented is reported in the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response.

If the device:

- implements the Enable/disable Power-up in Standby subcommand,
- power-up into Standby is enabled, and
- an IDENTIFY DEVICE or IDENTIFY PACKET DEVICE is received while the device is in Standby as a result of powering up into Standby,

the device shall respond to the command and remain in Standby without spinning-up.

If the device has IDENTIFY DEVICE or IDENTIFY PACKET DEVICE data that requires access to the media, the device shall set word 0 bit 2 to one to indicate that the response is incomplete. At a minimum, word 0 and word 2 shall be correctly reported. Those fields that cannot be provided shall be filled with zeros. Once the full IDENTIFY DEVICE or IDENTIFY PACKET DEVICE data has been accessed, a full response shall be returned until the next power-down/power-up sequence has taken place.

If the device does not implement the SET FEATURES subcommand to spin-up the device after power-up and power-up into Standby is enabled, the device shall spin-up upon receipt of the first command that requires the device to access the media.

4.13 Automatic Acoustic Management (AAM) feature set

The Automatic Acoustic Management feature set is an optional feature set that allows the host to select an acoustic management level. The acoustic management level ranges from the setting of 00h to FFh, although many levels are currently reserved (See Table 36). Device performance and acoustic emanation may increase with increasing acoustic management levels. The acoustic management levels may contain discrete bands. For example, a device may implement one acoustic management method from level 80h to A0h, and a higher performance, higher acoustic emanation method from level A1h to FEh.

The Automatic Acoustic Management feature set uses the following functions:

- A SET FEATURES subcommand to enable the Automatic Acoustic Management feature set
- A SET FEATURES subcommand to disable the Automatic Acoustic Management feature set

The IDENTIFY DEVICE or IDENTIFY PACKET DEVICE data indicates if the Automatic Acoustic Management feature set is supported, if the Automatic Acoustic Management feature set is enabled, and the current automatic acoustic management level if the Automatic Acoustic Management feature set is enabled.

4.14 48-bit Address feature set

The optional 48-bit Address feature set allows devices with capacities up to 281,474,976,710,655 logical sectors. This allows device capacity up to 144,115,188,075,855,360 bytes for a 512 byte sector. In addition, the number of logical sectors that may be transferred by a single command are increased by increasing the allowable logical sector count to 16 bits.

The commands in the 48-bit Address feature set are prohibited from use for devices implementing the PACKET Command feature set.

Commands unique to the 48-bit Address feature set are:

- FLUSH CACHE EXT
- READ DMA EXT
- READ DMA QUEUED EXT
- READ MULTIPLE EXT
- READ NATIVE MAX ADDRESS EXT
- READ SECTOR(S) EXT
- READ VERIFY SECTOR(S) EXT
- SET MAX ADDRESS EXT
- WRITE DMA EXT
- WRITE DMA FUA EXT
- WRITE DMA QUEUED EXT
- WRITE DMA QUEUED FUA EXT
- WRITE MULTIPLE EXT
- WRITE MULTIPLE FUA EXT
- WRITE SECTOR(S) EXT

The 48-bit Address feature set operates in LBA only. Devices implementing the 48-bit Address feature set shall also implement commands that use 28-bit addressing. 28-bit and 48-bit commands may be intermixed. Support of the 48-bit Address feature set is indicated in the IDENTIFY DEVICE response.

In a device implementing the 48-bit Address feature set, the Feature field, the Count field, the and LBA field are all 16 bits long.

The device shall indicate support of the 48-bit Address feature set in the IDENTIFY DEVICE response. In addition, IDENTIFY DEVICE data words (103:100) contain the maximum user LBA + 1 that is accessible by 48-bit addressable commands .

If the value contained in IDENTIFY DEVICE data words (103:100) is equal to or less than 268,435,455, then the content of words (61:60) shall be as described in 4.2.1. If the value in contained IDENTIFY DEVICE data words (103:100) is greater than 268,435,455, then the maximum value in words (61:60) shall be 268,435,455. That is, if the device contains greater than the capacity addressable with 28-bit commands, words (61:60) shall describe the maximum capacity that can be addressed by 28-bit commands.

When the 48-bit Address feature set is implemented, the native maximum address is the highest address accepted by the device in the factory default condition using a 48-bit Address feature set command. The native maximum address is the value returned by a READ NATIVE MAX ADDRESS EXT command. If the native maximum address of a device is equal to or less than 268,435,455, a READ NATIVE MAX ADDRESS shall return the native maximum address. If the native maximum address is greater than 268,435,455, a READ NATIVE MAX ADDRESS command shall cause the device to return a maximum value of 268,435,454.

When the 48-bit Address feature set is implemented, the SET MAX ADDRESS command shall execute as described in 7.52.2. However, in addition to modifying the content of words (61:60), the new content of (61:60) shall also be placed in words (103:100). When a SET MAX ADDRESS EXT command is issued and the address requested is greater than 268,435,455, words (103:100) shall be modified to reflect the requested value but words 60, and 61 shall not be modified. When a SET MAX ADDRESS EXT command is issued and the address requested is equal to or less than 268,435,455, words (103:100) shall be modified to reflect the requested value and words 60, and 61 shall be modified as described in 7.52.2.1.

If a Host Protected Area has been created using the SET MAX ADDRESS command, all SET MAX ADDRESS EXT commands shall result in command aborted until the Host Protected Area is eliminated by use of the SET MAX ADDRESS command with the address value returned by the READ NATIVE MAX ADDRESS command. If a Host Protected Area has been created using the SET MAX ADDRESS EXT command, all SET MAX ADDRESS commands shall result in command aborted until the Host Protected Area is eliminated by use of the SET MAX ADDRESS EXT command with the address value returned by the READ NATIVE MAX ADDRESS EXT command.

The WRITE DMA FUA EXT, WRITE DMA QUEUED FUA EXT, and WRITE MULTIPLE FUA EXT commands are unique in that regardless whether or not caching is enabled in the device, the user data shall be written to the media before ending status for the command is reported.

4.15 Device Configuration Overlay feature set

The optional Device Configuration Overlay feature set allows a utility program to modify some of the optional commands, modes, and feature sets that a device reports as supported in the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE command data as well as the capacity reported.

Commands unique to the Device Configuration Overlay feature set use a single command code and are differentiated from one another by the value placed in the Feature field. These commands are:

- DEVICE CONFIGURATION FREEZE LOCK
- DEVICE CONFIGURATION IDENTIFY
- DEVICE CONFIGURATION RESTORE
- DEVICE CONFIGURATION SET

The Device Configuration Overlay feature set may affect words (61:60), 63, 119, (88:82), and(103:100) of the IDENTIFY DEVICE and IDENTIFY PACKET DEVICE command responses. Certain bits in these words that indicate that a command, mode, capacity, or feature set is supported and enabled may be cleared by a DEVICE CONFIGURATION SET command. For a particular command, mode, capacity, or feature set, when a bit is cleared indicating that the device does not support the feature, the device shall not provide the feature. Also, the maximum capacity of the device may be reduced. Since a Host Protected Area may be lost if the capacity of the device is reduced, when a Host Protected Area is set the DEVICE CONFIGURATION SET command shall cause the device to return command aborted. The address value returned by a READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT command is modified by the DEVICE CONFIGURATION SET command modifying the maximum capacity of the device. If a DEVICE CONFIGURATION FREEZE LOCK command has been issued since the device powered-up, the DEVICE CONFIGURATION SET command shall cause the device to return command aborted. The settings made by a DEVICE CONFIGURATION SET command are maintained over power-down and power-up.

A DEVICE CONFIGURATION IDENTIFY command specifies the selectable commands, modes, capacity, and feature sets that the device is capable of supporting. After the execution of a DEVICE CONFIGURATION SET command this information is no longer available from an IDENTIFY DEVICE or IDENTIFY PACKET DEVICE command.

A DEVICE CONFIGURATION RESTORE command enables all capabilities that have been disabled by DEVICE CONFIGURATION SET command and returns the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE command data to that indicated by the DEVICE CONFIGURATION IDENTIFY command. Since a Host Protected Area may be lost if the capacity of the device is reduced, when a Host Protected Area is set the DEVICE CONFIGURATION RESTORE command shall cause the device to return command aborted. If a DEVICE CONFIGURATION FREEZE LOCK command has been issued since the device powered-up, the DEVICE CONFIGURATION RESTORE command shall cause the device to return command aborted.

A DEVICE CONFIGURATION FREEZE LOCK command prevents accidental modification of the state of the Device Configuration Overlay feature set. A device always powers-up with configuration freeze lock not set. After a successful DEVICE CONFIGURATION FREEZE LOCK command is executed, all DEVICE CONFIGURATION SET, DEVICE CONFIGURATION IDENTIFY, and DEVICE CONFIGURATION RESTORE commands are aborted by the device until the device is powered-down and powered-up again. The freeze locked state is not affected by hardware or software reset.

Figure 7 and the text following the figure describe the operation of the Device Configuration Overlay feature set.

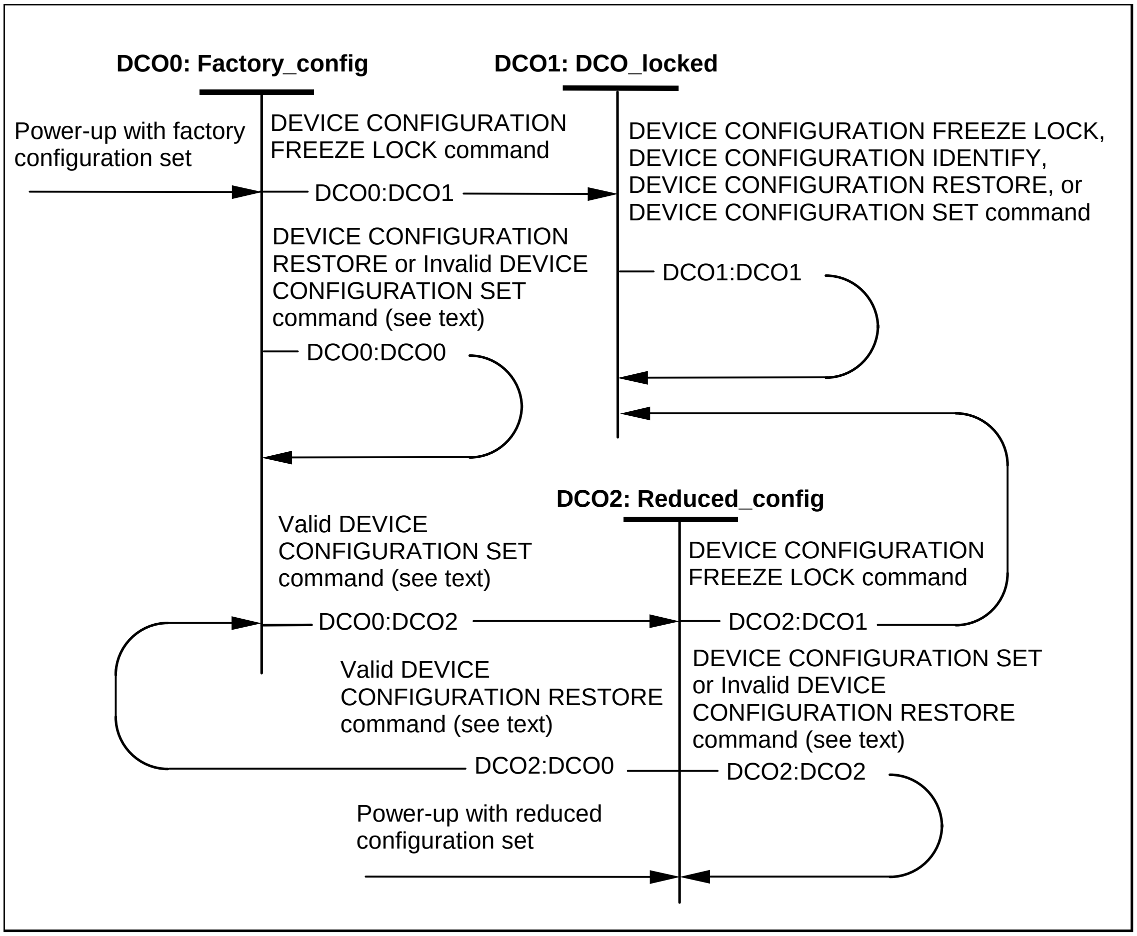


Figure 7 - Device Configuration Overlay state diagram

DCO0: Factory_config State: This state is entered when the device powers-up with the factory configuration set or a valid DEVICE CONFIGURATION RESTORE command is received.

When in this state, the device shall support all commands, modes, features sets, and the capacity indicated by the response to a DEVICE CONFIGURATION IDENTIFY command.

Transition DCO0:DCO1: When a DEVICE CONFIGURATION FREEZE LOCK command is received, the device shall return successful command completion and make a transition to the DCO1: DCO_locked state.

Transition DCO0:DCO2: When a valid DEVICE CONFIGURATION SET command is received, the device shall return successful command completion and make a transition to the DCO2: Reduced_config state. See Transition DCO0:DCO0 for the definition of conditions that make a DEVICE CONFIGURATION SET command invalid. This transition is made even if the configuration described by the DEVICE SET CONFIGURATION SET command is the same as the factory configuration.

Transition DCO0:DCO0: When a DEVICE CONFIGURATION RESTORE command is received, the device shall return command aborted and make a transition to the DCO0: Factory_config state. When an invalid DEVICE CONFIGURATION SET command is received, the device shall return command aborted and make a transition to the DCO0: Factory_config state. A DEVICE CONFIGURATION SET command is invalid if the DEVICE CONFIGURATION SET command requests:

- a Host Protected Area has been established using the SET MAX ADDRESS command.
- the elimination of support of a Multiword or Ultra DMA mode if that mode is currently selected or a higher numbered mode is currently selected.
- the elimination of support of the Host Protected Area feature set if a Host Protected Area has been established using a SET MAX ADDRESS command.
- the elimination of support of the Power-up in Standby feature set if the feature set has been enables by a jumper.
- the elimination of support of the Security feature set if the feature set has been enabled.

- the elimination of support of the SMART feature set if bits (2:1) of word 7 are not cleared to zero or if the SMART feature set has been enabled by use of the SMART ENABLE OPERATIONS command.

DCO1: DCO_locked State: This state is entered when a DEVICE CONFIGURATION RESTORE command is received.

When in this state, all DEVICE CONFIGURATION FREEZE LOCK, DEVICE CONFIGURATION IDENTIFY, DEVICE CONFIGURATION SET, or DEVICE CONFIGURATION RESTORE commands shall return command abort and shall remain in the locked state.

Transition DCO1:DCO1: When a DEVICE CONFIGURATION FREEZE LOCK, DEVICE CONFIGURATION IDENTIFY, DEVICE CONFIGURATION SET, or DEVICE CONFIGURATION RESTORE command is received, the device shall return command aborted and make a transition to the DCO1: DCO_locked state.

DCO2: Reduced_config State: This state is entered when the device powers-up with a reduced configuration set or a valid DEVICE CONFIGURATION SET command is received.

When in this state, the device shall support all commands, modes, features sets, and the capacity specified by the DEVICE CONFIGURATION SET command that caused this state to be entered.

Transition DCO2:DCO1: When a DEVICE CONFIGURATION FREEZE LOCK command is received, the device shall return successful command completion and make a transition to the DCO1: DCO_locked state.

Transition DCO2:DCO0: When a valid DEVICE CONFIGURATION RESTORE command is received, the device shall return successful command completion and make a transition to the DCO0: Factory_config state. See Transition DCO2:DCO2 for the definition of conditions that make a DEVICE CONFIGURATION RESTORE command invalid.

Transition DCO2:DCO2: When a DEVICE CONFIGURATION SET command is received, the device shall return command aborted and make a transition to the DCO2: Reduced_config state. When an invalid DEVICE CONFIGURATION RESTORE command is received, the device shall return command aborted and make a transition to the DCO2: Reduced_config state. A DEVICE CONFIGURATION RESTORE command is invalid if a Host Protected Area has been established using the SET MAX ADDRESS command.

4.16 Media Card Pass Through Command feature set

The Media Card Pass Through commands are implemented by a Media Pass Through device. A device implementing the Media Card Pass Through Command feature set is a bridge to one or more types of media card storage devices. The bridge device responds to the same command set as described in 4.3 and to the commands included in this feature set.

Use of the Media Card Pass Through Command feature set is prohibited for PACKET devices.

The Media Card Pass Through Command feature set uses the command codes D1h, D2h, D3h, and D4h and bits in word 84 and word 87 of the IDENTIFY DEVICE response. The command codes D2h through D4h are reserved for the Media Card Pass Through Command feature set if this feature set is enabled by the CHECK MEDIA CARD TYPE command (D1h). This feature set embeds small-format flash memory card commands inside the ATA commands. The adapter’s firmware passes the embedded memory card’s command to the memory card as is from the ATA command. The Media Card Pass Through Command feature set reduces the number of commands required for this feature set regardless of the number or type of memory card commands. It also reduces the adapter’s firmware overhead in processing them. As new memory cards types are defined in the market, they can all be supported within this one feature.

The commands unique to the Media Card Pass Through Command feature set are:

- CHECK MEDIA CARD TYPE
- Command codes D2h through D4h

The CHECK MEDIA CARD TYPE command returns the supporting status of the device to this feature set. It also enables and disables the device from running the Media Card Pass Through Command feature set. When the Media Card Pass Through Command feature set is disabled, the command codes D2h through D4h shall not be interpreted as Media Card Pass Through Command feature set commands and the device shall return command aborted. Power-on, hardware, or software reset shall disable the Media Card Pass Through Command feature set.

The definitions of the commands D2h-D4h are media card type dependent. Table 4 lists the Media card types and their associated reference document:

Table 4 - Media Card type references

Media Card Type	Reference Document
SD Card	SD Card ATA Command Extension (SDA 3C)
Smart Media	Smart Media ATA Command Extension (SSFDC Forum)

4.17 Streaming feature set

4.17.1 Streaming feature set overview

The Streaming feature set is an optional feature set that allows a host to request delivery of data within an allotted time, placing a priority on the time to transfer the data rather than the integrity of the data. This feature set is defined to satisfy the requirements for AV type applications. While processing commands in the Streaming feature set, devices may execute background tasks so long as the specified command processing time limits for the commands are met. The Streaming feature set only defines commands that use 48-bit addressing.

A device that implements the Streaming feature set shall implement the following commands:

- CONFIGURE STREAM
- READ STREAM EXT
- WRITE STREAM EXT
- READ STREAM DMA EXT
- WRITE STREAM DMA EXT
- READ LOG EXT
- WRITE LOG EXT
- READ LOG DMA EXT
- WRITE LOG DMA EXT

Support of the Streaming feature set is indicated in IDENTIFY DEVICE data word 84 bit 4.

4.17.2 Streaming commands

4.17.2.1 Streaming command overview

The CONFIGURE STREAM command is used by a host to define the properties of a stream to assist the device in configuring its caching for best performance. The Stream Identifier (Stream ID) in the CONFIGURE STREAM command is used by the host to specify the number of the stream to which the operating parameters in the command apply. Up to a total of eight streams may be configured. The Stream ID may be used by the device to configure its resources to support the streaming requirements of the AV content.

A host may use both READ STREAM and WRITE STREAM commands to access any stream.

The Default Command Completion Time Limit (Default CCTL) provides a method for a host to set the time limit for a device to process READ STREAM and WRITE STREAM commands (see7.9.3.4). If the host does not use a CONFIGURE STREAM command to set Default CCTL, the host may specify the time limit for command processing by using the Command Completion Time Limit (CCTL) in each READ STREAM or WRITE STREAM command, where the time limit is effective for that command only (see 7.40.3.2). Each stream may be configured for with different command completion time limits by each CONFIGURE STREAM command.

The READ STREAM and WRITE STREAM commands may access any user LBA on a device. These commands may be interspersed with commands not in the Streaming feature set, but, if commands not in the Streaming feature set are interspersed with READ STREAM or WRITE STREAM commands, there may be an impact on performance due to the unknown time required to complete the commands not in the Streaming feature set.

READ STREAM or WRITE STREAM commands should be issued using a specified minimum number of logical sectors to be transferred per command. This number is the Stream Minimum Request Size indicated in word 95 of the IDENTIFY DEVICE data. The transfer length of a request should be a multiple of the minimum number of logical sectors per transfer.

4.17.2.2 Flush bit

The Flush bit (Flush) in the WRITE STREAM commands (see 7.77.3.4) specifies that the device flushes all data for the specified stream to the media before command completion. If a host requests flushes at times other than the end of each Allocation Unit, streaming performance may be degraded. The SET FEATURES command to enable and disable caching (see 7.51.4) may affect caching for commands in the Streaming feature set.

4.17.2.3 Not Sequential bit

The Not Sequential bit (NS) in the READ STREAM commands (see 7.40.3.4) specifies that the next READ STREAM command with the same Stream ID may not be sequential in LBA space. This information helps the device with pre-fetching decisions.

4.17.2.4 Read Continuous bit

The Read Continuous bit (RC) in the READ STREAM commands (see 7.40.3.3) specifies that the device shall transfer the requested amount of data to the host within the time specified by Default CCTL or CCTL even if an error occurs. The data sent to the host by the device in an error condition is vendor specific.

4.17.2.5 Write Continuous bit

If the Write Continuous bit (WC) in the WRITE STREAM commands (see 7.77.3.3) specifies that the device shall transfer the requested amount of data to the host within the time specified by Default CCTL or CCTL even if an error occurs. If an error cannot be resolved by the device within the time specified by Default CCTL or CCTL, the erroneous section on the media may be unchanged or may contain undefined data. A future read of this area may not report as an error, even though the data is erroneous.

4.17.2.6 Handle Streaming Error

The Handle Streaming Error feature allows a device to continue its error recovery sequence for a stream from where it left off earlier. The Handle Streaming Error feature is vendor-specific and may be always enabled in devices conforming to this standard.

4.17.2.7 Streaming Logs

A device implementing the Streaming feature set shall implement a Read Stream Error Log (see 7.32.2.4) and a Write Stream Error Log (see 7.32.2.5). These logs are accessed by a host via the READ LOG EXT command (see 7.32).

The Read Stream and Write Stream Error logs are 512 bytes in length. The Read Stream Error log retains the last 31 errors that occurred during any READ STREAM command. The Write Stream Error log retains the last 31 errors that occurred during any WRITE STREAM command. The information included in the error logs is volatile and is not maintained across power cycles, hard resets, or after a device enters the Sleep mode.

4.18 General Purpose Logging feature set

The General Purpose Logging feature set provides a mechanism for accessing logs in a device. These logs are associated with specific feature sets such as SMART. Support of the individual logs is determined by support of the associated feature set. If the device supports a particular feature set, support for any associated log(s) is mandatory.

Support for the General Purpose Logging feature set shall not be disabled. If the feature set associated with a requested log is disabled, the device shall return command abort.

If the General Purpose Logging feature set is implemented, the following commands shall be supported:

-- READ LOG EXT
-- WRITE LOG EXT

The following commands are optional:

-- READ LOG DMA EXT
-- WRITE LOG DMA EXT"

4.19 Overlapped feature set

The optional Overlap feature set allows devices that require extended command time to perform a release so that the other device on the bus may be used. [Editors note: The deleted material needs to appear in the parallel transport]

The only commands that may be overlapped are:

- NOP (with a subcommand code other than 00h)
- READ DMA QUEUED
- READ DMA QUEUED EXT
- SERVICE
- WRITE DMA QUEUED
- WRITE DMA QUEUED EXT
- WRITE DMA QUEUED FUA EXT

For the READ DMA QUEUED and WRITE DMA QUEUED commands, the device may or may not perform a release. If the device is ready to complete execution of the command, the device may complete the command immediately. If the device is not ready to complete execution of the command, the device may perform a release and complete the command via a service request.

If a device has an outstanding command that has been released, the device can only indicate that service is required when the device is selected. This implies that the host has to poll each device to determine if a device is requesting service. The polling can be performed at the host either by hardware or by a software routine. The latter implies a considerable host processor overhead. Hardware polling is initiated by the NOP Auto Poll command.

The NOP Poll command is a host adapter function and is ignored by the device. The host software can test for the support of this feature by issuing the NOP Auto Poll subcommand and examining the Status register. If the host adapter does not support this feature, the response received by the host will be from the device with the ERR bit set to one. If the host adapter does support the command, the response will be from the host adapter with the ERR bit cleared to zero. The only action taken by a device supporting the Overlapped feature set will be to return the error indication in the Status register and to not abort any outstanding commands. **[Editors Note: Need to rework this]**

When this command is received, the user data shall be written to the device media before ending status for the command is reported regardless of the state of any write cache or queue. A queue shall not be aborted.

4.20 Queued feature set

The Queued feature set allows the host to issue concurrent commands to the same device. The Queued feature set is optional if the Overlap feature set is supported. Only commands included in the Overlapped feature set may be queued. The queue contains all commands for which command acceptance has occurred but command completion has not occurred. If a queue exists when a non-queued command is received, the non-queued command shall be command aborted and the commands in the queue shall be discarded. The ending status shall be command aborted and the results are indeterminate.

The maximum queue depth supported by a device shall be indicated in word 75 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response.

A queued command shall have a Tag provided by the host in the Count field to uniquely identify the command. When the device restores register parameters during the execution of the SERVICE command, this Tag shall be restored so that the host may identify the command for which status is being presented. A Tag value may be any value between 0 and 31, regardless of the queue depth supported. If a queued command is issued with a Tag value that is identical to the Tag value for a command already in the queue, the entire queue shall be aborted including the new command. The ending status shall be command aborted and the results are indeterminate. If any error occurs, the command queue shall be aborted.

When the device is ready to continue the processing of a released command, the device requests service by setting SERV to one.. SERV shall remain set until all commands ready for service have been serviced. When the device is ready to continue the processing of a released command the device requests service by setting SERV to one. SERV shall remain set until all commands ready for service have been serviced.

When the device receives a new command while queued commands are ready for service, the device shall execute the new command per the protocol for the new command. If the queued commands ready for service still exist at command completion of this command, SERV remains set to one.

When reading status at command completion of a command, the host shall check the SERV bit since the SERV bit may be set because the device is ready for service associated with another command.

4.21 Long Physical Sector Feature Set for Non-Packet Devices

The purpose of the long physical sector feature set is to allow increased media format efficiency. During write operations devices calculate and error correction code, ECC, and write the ECC on the media following the data. ECC encoding is more efficient when used over a larger amount of data.

The long physical sector feature set allows a device to be formatted so that there are multiple logical sectors per physical sector on the media. Each physical sector has an ECC field. This allows, for example, a device to have 2048 word physical sectors each containing 8 logical sectors, or one ECC field per 8 256 word logical sectors, See Figure 8 example 3.

A performance penalty may be incurred when writing to devices that implement long physical sector feature set. A physical sector is read or written in a single operation. If a host system does not write all of the logical sectors in a physical sector during a single command the device may need to read the logical sectors that are not to be changed into memory and then write the entire physical sector, see Appendix C.

If the device reports a long physical sector and a smaller logical sector, the device may report the alignment of the the first logical sector (LBA 0) within the first physical sector. The following paragraphs give examples of logical/physical sector alignments.

There are 2 logical sectors within one physical sector, and the first logical sector is in the first half.
The proposed offset would be: 0, and the value in word 209 would be 4000h.

physical sector 0		physical sector 1	
logical sector 0	logical sector 1	logical sector 2	logical sector 3

Example 2:
There are 2 logical sectors within one physical sector, and the first logical sector is in the second half.
The proposed offset would be: 1, and the value in word 209 would be 4001h.

physical sector 0		physical sector 1	
(inaccessible)	logical sector 0	logical sector 1	logical sector 2

Example 3:
There are 4 logical sectors within one physical sector, and the first logical sector is in the second half. The proposed offset would be: 3, and the value in word 209 would be 4003h.

physical sector 0				physical sector 1			
(inaccessible)	(inaccessible)	(inaccessible)	logical 0	logical 1	logical 2	logical 3	logical 4

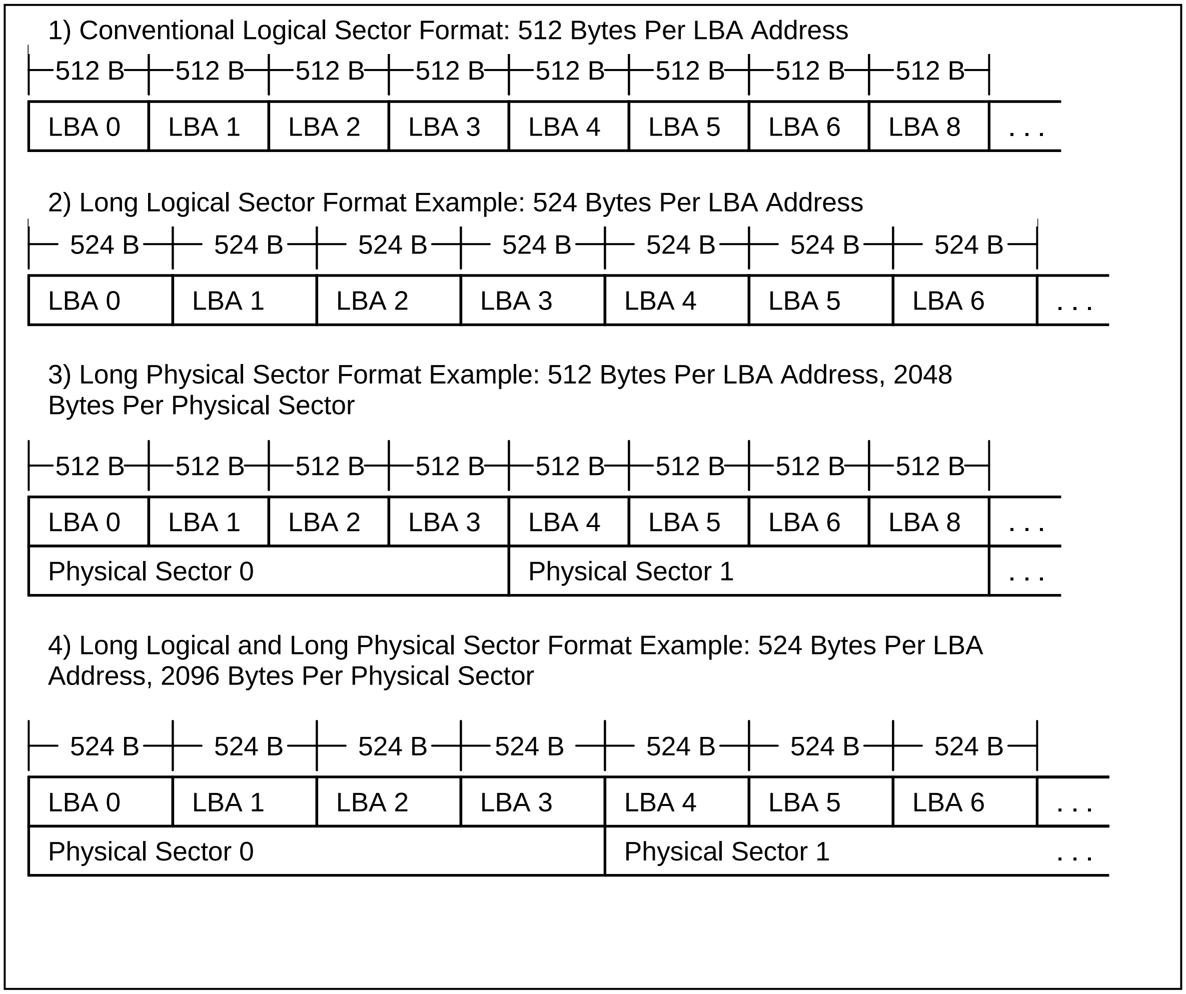


Figure 8 - Long Logical and long Physical Sector Example

4.22 Long Logical Sector Feature Set for Non-Packet Devices

The purpose of the long logical sector feature set is to allow additional data words per sector for server applications. Sectors with 520 or 528 bytes are typical. Devices with long logical sectors set IDENTIFY DEVICE data word 106 bit 13 to 1. The Long Logical Sector length is described by IDENTIFY DEVICE data words 117-118.

Devices that implement the Long Logical Sector Feature set are not backward compatible with applications that use 256 word logical sectors, e.g. desktop and laptop system.

Table 5 - Long Logical Sector Function

Command	Words Per Sector Transferred
CFA ERASE SECTORS	-
CFA REQUEST EXTENDED ERROR CODE	-
CFA TRANSLATE SECTOR	IDENTIFY DEVICE data words 117-118
CFA WRITE MULTIPLE WITHOUT ERASE	IDENTIFY DEVICE data words 117-118
CFA WRITE SECTORS WITHOUT ERASE	IDENTIFY DEVICE data words 117-118
CHECK MEDIA CARD TYPE	-
CHECK POWER MODE	-
CONFIGURE STREAM	-
DEVICE CONFIGURATION	-
DEVICE RESET	-
DOWNLOAD MICROCODE	256
EXECUTE DEVICE DIAGNOSTIC	-
FLUSH CACHE	-
FLUSH CACHE EXT	-
GET MEDIA STATUS	-
IDENTIFY DEVICE	256
IDENTIFY PACKET DEVICE	-
IDLE	-
IDLE IMMEDIATE	-
MEDIA EJECT	-
MEDIA LOCK	-
MEDIA UNLOCK	-
NOP	-
PACKET	-
READ BUFFER	256
READ DMA	IDENTIFY DEVICE data words 117-118
READ DMA EXT	IDENTIFY DEVICE data words 117-118
READ DMA QUEUED	IDENTIFY DEVICE data words 117-118
READ DMA QUEUED EXT	IDENTIFY DEVICE data words 117-118
READ LOG EXT	256
READ MULTIPLE	IDENTIFY DEVICE data words 117-118
READ MULTIPLE EXT	IDENTIFY DEVICE data words 117-118
READ NATIVE MAX ADDRESS	-
READ NATIVE MAX ADDRESS EXT	-
READ SECTOR(S)	IDENTIFY DEVICE data words 117-118
READ SECTOR(S) EXT	IDENTIFY DEVICE data words 117-118
READ STREAM DMA EXT	IDENTIFY DEVICE data words 117-118
READ STREAM EXT	IDENTIFY DEVICE data words 117-118
READ VERIFY SECTOR(S)	IDENTIFY DEVICE data words 117-118
READ VERIFY SECTOR(S) EXT	-
SECURITY DISABLE PASSWORD	256

(continued)

Table 5 - Long Logical Sector Function (continued)

Command	Words Per Sector Transferred
SECURITY ERASE PREPARE	-
SECURITY ERASE UNIT	256
SECURITY FREEZE LOCK	-
SECURITY SET PASSWORD	256
SECURITY UNLOCK	256
SEEK	-
SERVICE	-
SET FEATURES	-
SET MAX SET PASSWORD	256
SET MAX LOCK	-
SET MAX FREEZE LOCK	-
SET MAX UNLOCK	256
SET MAX ADDRESS	-
SET MAX ADDRESS EXT	-
SET MULTIPLE MODE	-
SLEEP	-
SMART DISABLE OPERATIONS	-
SMART ENABLE/DISABLE AUTOSAVE	-
SMART ENABLE OPERATIONS	-
SMART EXECUTE OFF-LINE IMMEDIATE	-
SMART READ DATA	256
SMART READ LOG	256
SMART RETURN STATUS	-
SMART WRITE LOG	256
STANDBY	-
STANDBY IMMEDIATE	-
WRITE BUFFER	256
WRITE DMA	IDENTIFY DEVICE data words 117-118
WRITE DMA EXT	IDENTIFY DEVICE data words 117-118
WRITE DMA FUA EXT	IDENTIFY DEVICE data words 117-118
WRITE DMA QUEUED	IDENTIFY DEVICE data words 117-118
WRITE DMA QUEUED EXT	IDENTIFY DEVICE data words 117-118
WRITE DMA QUEUED FUA EXT	IDENTIFY DEVICE data words 117-118
WRITE LOG EXT	256
WRITE MULTIPLE	IDENTIFY DEVICE data words 117-118
WRITE MULTIPLE EXT	IDENTIFY DEVICE data words 117-118
WRITE MULTIPLE FUA EXT	IDENTIFY DEVICE data words 117-118
WRITE SECTOR(S)	IDENTIFY DEVICE data words 117-118
WRITE SECTOR(S) EXT	IDENTIFY DEVICE data words 117-118
WRITE STREAM DMA EXT	IDENTIFY DEVICE data words 117-118
WRITE STREAM EXT	IDENTIFY DEVICE data words 117-118

(concluded)

Table 5 describes the command behavior of drives that have been manufactured with long logical sectors. Data transfer commands transfer either the long logical sector length or 256 words depending on the command. For example, Read and Write Extended commands transfer data in long logical sectors while READ LOG EXT and WRITE LOG EXT commands transfer 256 words per sector, regardless of the logical sector length. Figure 8 example 2 shows a diagram of a device formatted with long logical sectors.

4.23 Devices Implementing the Long Physical Sector Feature Set and the Long Logical Feature Sector Set

The long physical sector feature set and the long logical sector feature set are not exclusive. **Figure 8** example 4 illustrates a device implementing both the Long Physical Sector and Long Logical Sector feature sets.

4.24 Write-Read-Verify Feature Set

The optional Write Read Verify feature set allows a host to control Read After Write behavior in a device.

This feature set is available for all devices.

The device may report whether the feature set is supported and/or enabled via the IDENTIFY DEVICE command.

To enable or disable the feature of Write/Read/Verify, the host may execute a SET FEATURES command with one of two subcommand codes.

This feature set shall not be controllable via the DEVICE CONFIGURATION OVERLAY (DCO) command.

It is possible that the device may experience a performance degradation when the WriteReadVerify feature is enabled.

These commands are affected by this feature:

WRITE DMA
WRITE DMA EXT
WRITE DMA FUA EXT
WRITE DMA QUEUED
WRITE DMA QUEUED EXT
WRITE DMA QUEUED FUA EXT
WRITE MULTIPLE
WRITE MULITIPLE EXT
WRITE MULTIPLE FUA EXT
WRITE SECTOR(S)
WRITE SECTOR(S) EXT
See clause 7.51.10 for a description of device behavior when this feature set is supported and enabled.

The IDENTIFY DEVICE or IDENTIFY PACKET DEVICE command shall reflect the enabled or disabled state of the feature set.

If the Write Cache is enabled, the device may report status to the Host before writing the data to the media. When the device Write Cache is enabled, the device may report "good" status to the host even if the data is in the device Write Cache and not Written and Verified to the media. This is important to reduce the performance degradation when we use the Write Read Verify function.

Read Verify behavior is unaffected by whether Write Caching is enabled or disabled. If the WriteReadVerify feature is disabled, or if the device has already verified the maximum number of logical sectors configured for this feature set, then no further action shall be taken. After the device has written the sectors to the media, it shall attempt to read (Verify) those same sectors. A read from the media shall be performed before verification. The verification of sectors is defined as vendor specific.

If an unrecoverable error condition is encountered by the device during the write, read, or verify operation, the device shall set the DF. See clause 6.2.4 for details on the DF bit operation.

The Reset Behavior shall be defined as follows:

- Power on Reset, the Write Read Verify feature is disabled or set to default setting.
- Hard Reset, the Write Read Verify feature is disabled or set to default setting.
- Soft Reset the Write Read Verify feature is disabled or the current mode is remained depends on the "Enable/Disable reverting to power-on defaults" setting.

5 ATA Protocols

5.1 Overview

ATA Protocols are fully described in the transport documents ATA8-SATA and ATA8-PATA. The protocols listed here shall be implemented by all transports that use ATA8-ACS commands.

5.2 Power-On

[Editors Note: Provide Description]

5.3 Hardware Reset

[Editors Note: Provide Description]

5.4 Software Reset

[Editors Note: Provide Description]

5.5 Non-data Command Protocol

[Editors Note: Provide Description]

5.6 PIO data-in Command Protocol

Following an interface CRC error on a the data payload, if the device transmits a response that updates the Status Register it may set bit 7 (i.e. the ICRC bit) to one in the Error field

[Editors Note: Provide Description]

5.7 PIO data-out Command Protocol

Following an interface CRC error on a the data payload, if the device transmits a response that updates the Status Register it may set bit 7 (i.e. the ICRC bit) to one in the Error field

[Editors Note: Provide Description]

5.8 DMA Command Protocol

[Editors Note: Provide Description]

5.9 Packet Command Protocol

[Editors Note: Provide Description]

5.10 DMA Queued Command Protocol

[Editors Note: Provide Description]

5.11 Execute Device Diagnostic Command Protocol

[Editors Note: Provide Description]

5.12 Device Reset Command Protocol

[Editors Note: Provide Description]

5.13 Ultra DMA data-in Command Protocol

[Editors Note: Provide Description]

5.14 Ultra DMA Data-Out Command Protocol

[Editors Note: Provide Description]

6 Status and Error bits

6.1 Overview

There are several bits that are provided by both the Parallel and Serial transports. Blah, blah, blah

6.2 Status Bits

6.2.1 Busy (BSY)

Busy shall be cleared to zero. This bit is transport dependent. Refer to the appropriate transport standard for a definition of this bit.

6.2.2 Check Condition (CHK)

Check Condition shall be set to one if an Error register sense key or code bit is set. T

6.2.3 Error (ERR)

The Error bit in the status field shall be set to one if any bit in the Error field (see 6.3) is set to one

6.2.4 Device Fault (DF)

If the device enters a condition where continued operation could affect user data integrity, the device shall set the DF bit in the status register and no longer accept commands. This condition is only cleared by power cycling the drive. Once the DF bit has been cleared it may remain clear until a command that could affect user data integrity is received by the device. Examples of conditions that may cause the DF bit to be set by a device are: Failure to spin-up properly, and no spares remaining for reallocation.**]**

6.2.5 Device Ready (DRDY)

Device Ready shall be set to one. This bit is transport dependent. Refer to the appropriate transport standard for a definition of this bit.

6.2.6 Data Request (DRQ)

Device Request shall be cleared to zero. This bit is transport dependent. Refer to the appropriate transport standard for a definition of this bit.

6.2.7 Deferred Write Error (DWE)

DWE shall be set to one if an error was detected in a deferred write to the media for a previous WRITE STREAM DMA EXT or WRITE STREAM EXT command. This error is from a previously issued command. If DWE is set to one, the location of the deferred error is only reported in the Write Stream error log.

6.2.8 DMA Ready (DMRD)

[Editors Note: Need Definition]

6.2.9 Service (SERV)

shall be cleared to zero when no other queued command is ready for service. SERV shall be set to one when another queued command is ready for service. SERV shall be set to one when the device has prepared this command for service. If overlap is not supported, this bit is command specific.

6.2.10 Stream Error (SE)

SE is set to one if an error occurred during the processing of a command in the Streaming feature set and either Read Continuous (RC) is set to one in a READ STREAM command (see 7.38.3.4) or Write Continuous (WC) is set to one in a WRITE STREAM command (see 7.74.3.2). When SE is set to one, the value returned in the LBA bits (7:0) contains the address of the first sector in error, and the Count field contains the number of consecutive logical sectors that may contain errors. If RC is set to one in a READ STREAM command or WC is set to one a WRITE STREAM command, and ICRC, UNC, IDNF, ABRT, or CCTO is set to one (see 6.3), then the SE bit is set to one, the ERR bit is cleared to zero, and the error information (e.g., bits set in the Error register) are saved in the appropriate Read Stream or Write Stream Error log.

6.2.11 Transport Dependent (TD)

ATA/ATAPI-7 defines the status bits BSY,DRDY, and DRQ. This bits are fully documented in the transport standards. Although all of the commands in this standard use BSY=0, DRDY=1 and DRQ=0 to specify that the device is ready to accept a command and to specify that a command is complet, they are processed differently in the various transport standard.

6.3 Error Bits

6.3.1 Abort (ABRT)
Abort shall be set to one if the command is not supported. Abort may be set to one if the device is not able to complete the action requested by the command. Abort shall also be set to one if an address outside of the range of user-accessible addresses is requested if IDNF is not set to one.

6.3.2 Command Completion Time Out (CCTO)
CCTO shall be set to one if a Command Completion Time Limit Out error has occurred.

6.3.3 End of Media? (EOM)
The operation of this bit is specific to the SCSI command set implemented by the packet device.

6.3.4 ID Not Found (IDNF)
ID Not Found shall be set to one if a user-accessible address could not be found. ID Not Found shall be set to one if an address outside of the range of user-accessible addresses is requested when command aborted is not returned.

6.3.5 Illegal Legenth Indicator (ILI)
The operation of this bit is specific to the SCSI command set implemented by the packet device.

6.3.6 Interface CRC (ICRC)
Interface CRC shall be set to one if an interface CRC error has occurred during an Ultra DMA data transfer. The content of this bit may be applicable to Multiword DMA and PIO data transfers.

6.3.7 Media Change (MC)
Media Change shall be set to one if the media in a removable media device changed since the issuance of the last command. The device shall clear the device internal media change detected state.

6.3.8 Media Change Request (MCR)
Media Change Request shall be set to one if a media change request has been detected by a removable media device. This bit is only cleared by a GET MEDIA STATUS or a media access command.

6.3.9 Media Error (MED)
Media Error shall be set to one if a media error is detected.

6.3.10 No Media (NM)
No Media shall be set to one if no media is present in the device. This bit shall be set to one for each execution of GET MEDIA STATUS until media is inserted into the device.

6.3.11 Sense Key
The operation of this four bit field is specific to the SCSI command set implemented by the packet device.

6.3.12 Uncorrectable Error (UNC)
Uncorrectable Error shall be set to one if data is uncorrectable.

6.3.13 Write Protect (WP)
Write Protect shall be set to one for each execution of GET MEDIA STATUS while the media is write protected.

6.4 Interrupt Reason Bits

6.4.1 Command/Data (C/D)
Shall be set to one if the transfer is a command packet. Shall be set to zero if the transfer is data.

6.4.2 Input/Output (I/O)
Shall be cleared to zero if the transfer is to the device (O). Shall be set to one if the transfer is to the host (I).

6.4.3 Release (REL)
Shall be set to one if a command has been accepted but not completed and the device is ready to accept another command.

6.4.4 Tag
If the device supports command queuing and overlap is enabled, this field contains the command Tag for the command. A Tag value may be any value between 0 and 31 regardless of the queue depth supported. If the device does not support command queuing or overlap is disabled, this field is N/A.

7 Command Descriptions

7.1 Overview

[Editors Note: Need to state that this word ordering is mapped differently to different transports]

7.1.1 Introduction

In ATA/ATAPI-7, commands were described by indicating how Features, Sector Count, LBA Low, LBA Mid, LBA High, Device, and Command registers are initialized. The introduction of ATA8-ST has changed the way that ATA8-ACS needs to describe commands. In ATA8-ST, commands are initiated by setting up fields in a FIS and then sending the FIS to a device that implements ATA8-ST. Therefore, it is inconsistent to describe commands through register initialization sequences. ATA8-ST also makes the status bits Busy (BSY), Device Ready (DRDY), and Device Request (DRQ) transport specific.

The basic structure of an ATA8 command has Feature, Count, LBA, and Command fields. These fields all reside in the Command Structure. Fields length are fixed at either 8, 16, or 48 bits. When a command only uses 8 bits of a 16 bit field, or 28 bits of a 48 bit field, the unused bits are marked shall be set to zero. Since the sector address is now contained in a single field, the Device register described in ATA/ATAPI-7 is a transport specific register.

ATA8-ACS describes the ATA command set in a transport independent fashion. Each command is defined by the sections described in clauses x through y.

7.1.2 Command Name - Command Code [/featurecode], Command Protocol

The heading for each command starts with the name of the command. The name is follwed by “-“ and then the command code and protocol used to execute the command. A sample heading reads:

READ SECTOR(S) - 20h, PIO data-in

The name of the command is “READ SECTOR(S)”. The command code is 20h. The protocol used to transfer the data is PIO data-out.

The protocols are defined in detail in each transport. There is an overview of each protocol in clause 5.

7.1.3 Feature Set

The Feature Set clause for each command lists the feature sets (see clause 4) which list this command as optional or mandatory. A sample feature set section reads:

Feature Set

This command is mandatory for all devices implementing the General Feature Set.

7.1.4 Description

Each command starts with a description. This description contains information regarding the feature set, if the command is optional or mandatory, and any prerequisites that may be required before the command is executed. A sample descriptopn reads:

Description

This command reads from 1 to 256 logical sectors as specified in the Count field. A sector count of 0 requests 256 logical sectors. The transfer shall begin at the logical sector specified in the LBA field.

7.1.5 Inputs

7.1.5.1 Inputs for 28-bit Read/Write Commands

All commands require inputs. Inputs are specified in the Command Structure. A generic command structure for 28-bit commands is listed below. The description field shows how the fields mapped to ATA/ATAPI-7 registers.

Word	Name	Description
00h	Feature	In ATA/ATAPI-7 this was the Feature register. Each transport standard shows how the Feature field is mapped for proper functionality. The transport documents also show how 28-bit commands are mapped differently from 48-bit commands.
01h	Count	In ATA/ATAPI-7 this was the Sector Count register. Each transport standard shows how the Count field is mapped for proper functionality. The transport documents also show how 28-bit commands are mapped differently from 48-bit commands.
02h	LBA	MSB In ATA/ATAPI-7 this was the LBA Low, LBA Mid, and LBA High Registers. For many commands this is the address of first logical sector to be transferred. Bits 47:28 shall be cleared to zero for 28 bit commands.. Each transport shows how these 48-bits are mapped to the appropriate fields or registers. LSB
03h		
04h		
05h	Command	The command number goes here.

The Feature, Count, and Command fields are 16 bit fields where bits 15:8 shall be cleared to zero. The LBA field is 48 bits where bits 47:28 shall be cleared to zero. The command register shall always be represented as an 8-bit value.

7.1.5.2 Inputs for 48-bit Read/Write Commands

All commands require inputs. Inputs are specified in the Command Structure. A generic command structure for 48-bit commands is listed below. The description field shows how the fields mapped to ATA/ATAPI-7 registers.

Word	Name	Description
00h	Feature	In ATA/ATAPI-7 this was the Feature Current and Previous registers. Each transport standard shows how the Feature field is mapped for proper functionality.
01h	Count	In ATA/ATAPI-7 this was the Count Current and Previous registers. Each transport standard shows how the Count field is mapped for proper functionality.
02h	LBA	MSB In ATA/ATAPI-7, this are the LBA Low, LBA Mid, LBA High both Current and Previous registers. For many commands this is the address of first logical sector to be transferred . Each transport shows how these 48-bits are mapped to the appropriate fields or registers. LSB
03h		
04h		
05h	Command	The command number goes here.

The Feature, and Count, fields shall be 16 bit values; the LBA field shall be a 48-bit value. The command register shall always be represented as an 8-bit value.

7.1.6 Normal outputs

Many of the commands have a Normal Outputs description that lookes exactly like the one shown below. A command with normal outputs has no error, this field is reserved in every command. Count and LBA may be reserved. In some commands these fields have return parameters on successful command completion. The status register shows the Device Fault bit and the Error bit. As an aid to those using a PDF with hotlinks, many bits and fields are hotlinked to their descriptions. This allows the reader to click on the link and see the description of the bit. Bits 7,6, and 3 are marked Transport Dependent in all the Normal Outputs. These bits correspond to Busy, Device Ready, and Device Request in ATA/ATAPI-7 and are transport specific in their operation.

Word	Name	Description
00h	Error	Reserved
01h	Count	Reserved
02h-04h	LBA	Reserved
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2 N/A 1 N/A 0 Error - See clause 6.2.3

7.1.7 Error Outputs

The Error Outputs clause shows the Error, Count, LBA and Status fields. An Error Output occurs when a bit in the Status field indicates that an error has occurred. Examples of status bits that indicate and error has occurred include Error, Device Fault, Stream Error, etc. If the Error bit is set to one, the Error field shall indicate the type of Error that occurred.

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7 Interface CRC - See clause 6.3.6 6 Uncorrectable Error - See clause 6.3.12 5 Media Change - See clause 6.3.7 4 ID Not Found - See clause 6.3.4 3 Media Change Request - See clause 6.3.8 2 Abort - See clause 6.3.1 1 No Media - See clause 6.3.10 0 Obsolete
01h	Count	Reserved
02h	LBA	MSB Address of first unrecoverable error Bits 47:28 shall be cleared to zero LSB
03h		
04h		
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

7.1.8 Input Data Structure

Some commands, such as IDENTIFY DEVICE or DEVICE CONFIGURATION SET, return a data structure to the host. This data structure is referred to as an input data structure and is documented following the Error Outputs clause.

7.1.9 Output Data Structure

Some commands, such as DEVICE CONFIGURATION SET or SECURITY SET PASSWORD, accept a data structure from the host. This data structure is referred to as an Output Data Structure and is documented following the Error Outputs clase.

7.2 CFA ERASE SECTORS - C0h, non-data

7.2.1 Feature Set
This command is mandatory for devices implementing the CFA feature set. This command code is Vendor Specific for devices not implementing the CFA feature Set.

7.2.2 Description
This command pre-erases and conditions from 1 to 256 logical sectors as specified in the Count field. This command should be issued in advance of a CFA WRITE SECTORS WITHOUT ERASE or a CFA WRITE MULTIPLE WITHOUT ERASE command to increase the execution speed of the write operation.

7.2.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	number of logical sectors to be erased. A value of 00h specifies that 256 logical sectors are to be erased.
02h	LBA	MSB
03h		Address of first logical sector to be erased. Bits 47:28 shall be cleared to zero
04h		LSB
05h	Command	24h

7.2.4 Normal outputs
See Table 84

7.2.5 Error outputs
See Table 97

7.3 CFA REQUEST EXTENDED ERROR CODE - 03h, non-data

7.3.1 Feature Set

This command is mandatory for devices implementing the CFA featureset.

7.3.2 Description

This command provides an extended error code which identifies the cause of an error condition in more detail than is available with Status and Error register values. The CFA REQUEST EXTENDED ERROR CODE command shall return an extended error code if the previous command completed with an error or a no error detected extended error code if the previous command completed without error.

7.3.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	03h

7.3.4 Normal outputs

See Table 83

Table 6 - Extended error codes

Extended error code	Description
00h	No error detected / no additional information
01h	Self-test passed
03h	Write / Erase failed
05h	Self-test or diagnostic failed
09h	Miscellaneous error
0Bh	Vendor specific
0Ch	Corrupted media format
0D-0Fh	Vendor specific
10h	ID Not Found / ID Error
11h	Uncorrectable ECC error
14h	ID Not Found
18h	Corrected ECC error
1Dh, 1Eh	Vendor specific
1Fh	Data transfer error / command aborted
20h	Invalid command
21h	Invalid address
22-23h	Vendor specific
27h	Write protect violation
2Fh	Address overflow (address too large)
30-34h	Self-test or diagnostic failed
35h, 36h	Supply or generated voltage out of tolerance
37h, 3Eh	Self-test or diagnostic failed
38h	Corrupted media format
39h	Vendor specific
3Ah	Spare sectors exhausted
3Bh 3Ch, 3Fh	Corrupted media format
3Dh	Vendor specific
All other values	Reserved

7.3.5 Error outputs

See Table 99

7.4 CFA TRANSLATE SECTOR - 87h, PIO data-in

7.4.1 Feature Set

This command is mandatory for devices implementing the CFA feature set. This command code is Vendor Specific for devices not implementing the CFA feature Set.

7.4.2 Description

This command provides information related to a specific logical sector. The data indicates the erased or not erased status of the sector, and the number of erase and write cycles performed on that sector. Devices may return zero in fields that do not apply or that are not supported by the device.

7.4.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h	LBA	MSB Logical sector Address. Bits 47:28 shall be cleared to zero LSB
03h		
04h		
05h	Command	87h

7.4.4 Normal outputs

See Table Table 86 for the data structure layout. A 512 byte information table is transferred to the host, see Table 7.

Table 7 - CFA TRANSLATE SECTOR Information

Byte	Description
00h-03h	Obsolete
04h	LBA bits (23:16)
05h	LBA bits (15:8)
06h	LBA bits (7:0)
07h-12h	Reserved
13h	Sector erased flag (FFh = erased; 00h = not erased)
14h-17h	Reserved
18h	Sector write cycles count bits (23:16)
19h	Sector write cycles count bits (15:8)
1Ah	Sector write cycles count bits (7:0)
1Bh-FFh	Reserved

7.4.5 Error outputs

See Table 99

7.5 CFA WRITE MULTIPLE WITHOUT ERASE - CDh, PIO data-out

7.5.1 Feature Set

This command is mandatory for devices implementing the CFA feature set.

7.5.2 Description

This command is similar to the WRITE MULTIPLE command. Interrupts are not generated on every logical sector, but on the transfer of a block that contains the number of logical sectors defined by the SET MULTIPLE MODE.

Command execution is identical to the WRITE MULTIPLE operation except that the logical sectors are written without an implied erase operation. The logical sectors should be pre-erased by a preceding CFA ERASE SECTORS command.

if bit 8 of IDENTIFY DEVICE data word 59 is cleared to zero, a successful SET MULTIPLE MODE command shall precede a CFA WRITE MULTIPLE WITHOUT ERASE command.

7.5.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	Number of logical sectors to be transferred. A value of 00h specifies that 256 logical sectors are to be transferred.
02h	LBA	MSB Starting logical sector address to be written. Bits 47:28 shall be cleared to zero
03h		
04h		LSB
05h	Command	CDh

7.5.4 Normal outputs

See Table 86.

7.5.5 Error outputs

The device shall return command aborted if the command is not supported. An unrecoverable error encountered during execution of this command results in the termination of the command. The command block registers contain the address of the logical sector where the first unrecovered error occurred. The amount of data transferred is indeterminate. See Table 98.

7.6 CFA WRITE SECTORS WITHOUT ERASE - 38h, PIO data-out

7.6.1 Feature Set
This command is mandatory for device implementing the CFA feature set.

7.6.2 Description
This command is similar to the WRITE SECTORS command. Command execution is identical to the WRITE SECTORS operation except that the logical sectors are written without an implied erase operation. The logical sectors should be pre-erased by a preceding CFA ERASE SECTORS command.

7.6.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	Number of logical sectors to be transferred. A value of 00h specifies that 256 logical sectors are to be transferred.
02h	LBA	MSB Starting logical sector address to be written.
03h		Bits 47:28 shall be cleared to zero
04h		LSB
05h	Command	38h

7.6.4 Normal outputs
See Table 86.

7.6.5 Error outputs
The device shall return command aborted if the command is not supported. An unrecoverable error encountered during execution of this command results in the termination of the command. The command block registers contain the address of the logical sector where the first unrecovered error occurred. The amount of data transferred is indeterminate. See Table 98.

7.7 CHECK MEDIA CARD TYPE - D1h, Non-data

7.7.1 Feature Set
This command is mandatory for devices implementing the Media Card Pass Through Command feature set.

7.7.2 Description
The CHECK MEDIA CARD TYPE command allows the host to determine if the device supports the Media Card Pass Through Command feature set. If the Enable bit in the Feature field is set to one, IDENTIFY DEVICE data bit 3 word 87 shall be set to one upon successful command completion.

If the adapter supports the Media Card Pass Through Command feature set and the Enable bit of the Feature field is set to one, the adapter shall process any further Media Card Pass Through Command feature set commands. If the Enable bit is cleared to zero, the adapter shall not interpret the command codes D2 through D4 as the Media Card Pass Through Command feature set commands. If the adapter does not support the Media Card Pass Through Command feature set, or the host has disabled the Media Card Pass Through Command feature set mode by clearing the Enable bit to zero, the host shall not send any further Media Card Pass Through Command feature set commands to the adapter.

7.7.3 Inputs

Word	Name	Description
00h	Feature	**Bit** **Description** 15:1 Reserved 0 Enable - Shall be set to one to enable the Media Card Pass Through Command feature set. Enable shall be cleared to zero to disable the Media Card Pass Through Command feature set.
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	D1h
Note - Power-on, hardware, or software reset disables the Media Card Pass Through Command feature set		

7.7.4 Normal Outputs
See Table 87

7.7.5 Error Outputs
See Table 100

7.8 CHECK POWER MODE - E5h, Non-data

7.8.1 Feature Set

This command is mandatory for devices implementing the General feature set. This command is mandatory for devices implementing the PACKET Command feature set when power management is not implemented in the PACKET command set.

7.8.2 Description

The CHECK POWER MODE command allows the host to determine the current power mode of the device. The CHECK POWER MODE command shall not cause the device to change power or affect the operation of the Standby timer.

7.8.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	E5h

7.8.4 Normal outputs

See Table 88

7.8.5 Error outputs

The device shall return command aborted if the device does not support the Power Management feature set. See Table 100

7.9 CONFIGURE STREAM - 51h, Non-data

7.9.1 Feature Set

This command is Mandatory for devices that implement the Streaming feature set.

7.9.2 Description

7.9.3 The CONFIGURE STREAM command specifies the operating parameters for a stream. A CONFIGURE STREAM command may be issued for each stream that is to be added or removed from the current operating configuration.Inputs

7.9.3.1 Inputs overview

Word	Name	Description
00h	Feature	**Bit** **Description** 15 Add/Remove Stream (A/R) – See 7.9.3.2. 14 Obsolete 13:11 Reserved 10:8 Stream ID - The Stream ID shall be a value between 0 and 7. 7:0 Default Command Completion Time Limit (Default CCTL) – See 7.9.3.4.
01h	Count	Specifies the Allocation Unit (AU) size (see 3.1.6) in logical sectors.
02h-04h	LBA	Reserved
05h	Command	51h

7.9.3.2 Add/Remove Stream (A/R)

If A/R is set to one, then the device shall set the operating parameters for the stream as specified by this command. If A/R is cleared to zero, then the device shall clear the operating characteristics for the Stream ID specified by this command. If A/R is cleared to zero, then the other bits in Features are N/A.

If A/R is set to one, the Stream ID was specified by a previous CONFIGURE STREAM command, and the current CONFIGURE STREAM command completes without error, then the operating parameters specified by the current CONFIGURE STREAM command shall replace the operating parameters specified by the previous CONFIGURE STREAM command for the stream.

7.9.3.3 Stream Identifier (Stream ID)

Stream ID specifies the stream to which the operating parameters in the command apply. There are eight possible streams total. A host may use both READ STREAM and WRITE STREAM commands to access any stream.

7.9.3.4 Default Command Completion Time Limit (Default CCTL)

7.9.4 If CCTL is cleared to zero for a READ STREAM or WRITE STREAM command (see 7.38.3.2) with the Stream ID specified in this command, then the device shall report command completion within (Default CCTL ∗ (IDENTIFY DEVICE data words (99:98)) microseconds. The device shall measure the time before reporting command completion from command acceptance.Normal Outputs

See Table 89

7.9.5 Error Outputs

ABRT shall be set to one if any of the following are true:

a) The device does not support the requested stream configuration;
b) A/R is cleared to zero and the Feature field contains a Stream ID that has not been sent in a previous CONFIGURE STREAM command;
c) The device does not support the requested Default CCTL; or
d) The device does not support the Streaming feature set.

See Table 102 for the definition of other error outputs.:

7.10 DEVICE CONFIGURATION

Individual Device Configuration Overlay (DCO) feature set commands are identified by the value placed in the Feature field. Table 8 shows these Feature field values.

Table 8 - Device Configuration Overlay Feature field values

Value	Command
C0h	DEVICE CONFIGURATION RESTORE
C1h	DEVICE CONFIGURATION FREEZE LOCK
C2h	DEVICE CONFIGURATION IDENTIFY
C3h	DEVICE CONFIGURATION SET
00h-BFh, C4h-FFh	Reserved

7.10.1 DEVICE CONFIGURATION RESTORE - B1h/C0h, Non-data

7.10.1.1 Feature Set
This command is mandatory for devices implementing the Device Configuration Overlay feature set.

7.10.1.2 Description
The DEVICE CONFIGURATION RESTORE command disables any setting previously made by a DEVICE CONFIGURATION SET command and returns the content of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE command data to the original settings as indicated by the data returned from the execution of a DEVICE CONFIGURATION IDENTIFY command.

7.10.1.3 Inputs

Word	Name	Description
00h	Feature	C0h
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	B1h

7.10.1.4 Normal outputs
See Table 85

7.10.1.5 Error outputs
Abort shall be set to one if a Host Protected Area has been set by a SET MAX ADDRESS or SET MAX ADDRESS EXT command, or if DEVICE CONFIGURATION FREEZE LOCK is set. See Table 100

7.10.2 DEVICE CONFIGURATION FREEZE LOCK - B1h/C1h, Non-data

7.10.2.1 Feature Set

This command is mandatory for devices implementing the Device Configuration Overlay feature set.

7.10.2.2 Description

The DEVICE CONFIGURATION FREEZE LOCK command prevents accidental modification of the Device Configuration Overlay settings. After successful execution of a DEVICE CONFIGURATION FREEZE LOCK command, all DEVICE CONFIGURATION SET, DEVICE CONFIGURATION FREEZE LOCK, DEVICE CONFIGURATION IDENTIFY, and DEVICE CONFIGURATION RESTORE commands shall be aborted by the device. The DEVICE CONFIGURATION FREEZE LOCK condition shall be cleared by a power-down. The DEVICE CONFIGURATION FREEZE LOCK condition shall not be cleared by hardware or software reset. [Editors Note: Is hardware/software reset the right terminology?]

7.10.2.3 Inputs

Word	Name	Description
00h	Feature	C1h
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	B1h

7.10.2.4 Normal outputs

See Table 85

7.10.2.5 Error outputs

Abort shall be set to one if the device has executed a previous DEVICE CONFIGURATION FREEZE LOCK command since power-up. See Table 100.

7.10.3 DEVICE CONFIGURATION IDENTIFY - B1h/C2h, PIO Data-in

7.10.3.1 Feature Set
This command is mandatory for devices implementing the Device Configuration Overlay feature set.

7.10.3.2 Description
The DEVICE CONFIGURATION IDENTIFY command returns a 512 byte data structure. The content of this data structure indicates the selectable commands, modes, and feature sets that the device is capable of supporting. If a DEVICE CONFIGURATION SET command has been issued reducing the capabilities, the response to an IDENTIFY DEVICE or IDENTIFY PACKET DEVICE command will reflect the reduced set of capabilities, while the DEVICE CONFIGURATION IDENTIFY command will reflect the entire set of selectable capabilities.

The term 'is allowed' indicates that the device may report that a feature is supported and/or enabled.

If the device is not 'allowed' to report support, then the device shall not support and shall report that the selected feature is both 'not supported' and if appropriate 'not enabled.' [Editors Note: Does this mean shall abort?]

The format of the Device Configuration Overlay data structure is shown in Table 9.

7.10.3.3 Inputs

Word	Name	Description
00h	Feature	C2h
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	B1h

7.10.3.4 Normal outputs
See Table 85

7.10.3.5 Error outputs
Abort shall be set to one if the device has executed a previous DEVICE CONFIGURATION FREEZE LOCK command since power-up. See Table 100. The device may return error status if an Interface CRC error has occurred.

Note: There is no defined mechanism for a device to return an ICRC error status that may have occurred during the last data block of a PIO-in data transfer, there may be other mechanisms in which a host can verify that an Interface CRC error occurred in these cases.

7.10.3.6 Input Data

Table 9 - Device Configuration Identify data structure

Word	Content
0	Data structure revision
1	Multiword DMA modes supported 15:3 Reserved 2 1 = Reporting support for Multiword DMA mode 2 and below is allowed 1 1 = Reporting support for Multiword DMA mode 1 and below is allowed 0 1 = Reporting support for Multiword DMA mode 0 is allowed
2	Ultra DMA modes supported 15:7 Reserved 6 1 = Reporting support for Ultra DMA mode 6 and below is allowed 5 1 = Reporting support for Ultra DMA mode 5 and below is allowed 4 1 = Reporting support for Ultra DMA mode 4 and below is allowed 3 1 = Reporting support for Ultra DMA mode 3 and below is allowed 2 1 = Reporting support for Ultra DMA mode 2 and below is allowed 1 1 = Reporting support for Ultra DMA mode 1 and below is allowed 0 1 = Reporting support for Ultra DMA mode 0 is allowed
3-6	Maximum LBA
7	Command set/feature set supported part 1 15 Reserved 14 1 = Reporting support for Write Read Verify feature set is allowed 13 1 = Reporting support for SMART Conveyance self-test is allowed 12 1 = Reporting support for SMART Selective self-test is allowed 11 1 = Reporting support for Forced Unit Access is allowed 10 Reserved for ANSI/INCITS TR-37-2004 9 1 = Reporting support for Streaming feature set is allowed 8 1 = Reporting support for 48-bit Addressing feature set is allowed 7 1 = Reporting support for Host Protected Area feature set is allowed 6 1 = Reporting support for Automatic acoustic management is allowed 5 1 = Reporting support for READ/WRITE DMA QUEUED commands is allowed 4 1 = Reporting support for Power-up in Standby feature set is allowed 3 1 = Reporting support for Security feature set is allowed 2 1 = Reporting support for SMART error log is allowed 1 1 = Reporting support for SMART self-test is allowed 0 1 = Reporting support for SMART feature set is allowed
8-9	Reserved for serial ATA
10-20	Reserved
21	Command set/feature set supported part 2 15 Reserved for e05106 14 Reserved for e05106 13 1 = Reporting support for WRITE UNCORRECTABLE is allowed 12:0 Reserved
22	Command set/feature set supported part 3 15:0 Reserved
23-207	Reserved
208-254	Vendor Specific
255	Integrity word 15:8 Checksum 7:0 Signature

7.10.3.6.1 Word 0: Data structure revision

Word 0 shall contain the value 0002h.

7.10.3.6.2 Word 1: Multiword DMA modes supported

Word 1 bits (2:0) contain the same information as contained in word 63 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE command data (See 7.17.7.23). Bits (15:3) of word 1 are reserved.

7.10.3.6.3 Word 2: Ultra DMA modes supported

Word 2 bits (6:0) contain the same information as contained in word 88 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE command data (See 7.17.7.44). Bits (15:7) of word 2 are reserved.

7.10.3.6.4 Words (6:3): Maximum LBA

Words (6:3) define the maximum LBA. This is the highest address accepted by the device in the factory default condition. If no DEVICE CONFIGURATION SET command has been executed modifying the factory default condition, this is the same value as that returned by a READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT command.

7.10.3.6.5 Word 7: Command/features set supported part 1

Word 7 bit 0 if set to one indicates that the device is allowed to report support for the SMART feature set.

Word 7 bit 1 if set to one indicates that the device allowed to report support for SMART self-test including the self-test log.

Word 7 bit 2 if set to one indicates that the device is allowed to report support for SMART error logging.

Word 7 bit 3 if set to one indicates that the device is allowed to report support for the Security feature set.

Word 7 bit 4 if set to one indicates that the device is allowed to report support for the Power-up in Standby feature set.

Word 7 bit 5 if set to one indicates that the device is allowed to report support for the READ DMA QUEUED and WRITE DMA QUEUED commands.

Word 7 bit 6 if set to one indicates that the device is allowed to report support for the Automatic Acoustic Management feature set.

Word 7 bit 7 if set to one indicates that the device is allowed to report support for the Host Protected Area feature set.

Word 7 bit 8 if set to one indicates that the device is allowed to report support for the 48-bit Addressing feature set.

Word 7 bit 9 if set to one indicates that the device is allowed to report support for Streaming feature set.

Word 7 bit 10 is reserved for technical report **[Editors Note;: Which one?]**.

Word 7 bit 11if set to one indicates that the device is allowed to report support for Force Unit Access commands.

Word 7 bit 12 if set to one indicates that the device is allowed to report support for SMART Selective self-test.

Word 7 bit 13 if set to one indicates that the device is allowed to report support for SMART Conveyance self-test.

Word 7 bit 14 if set to one indicates that the device is allowed to report support for the Write Read Verify feature set.

7.10.3.6.6 Word 8-9: Reserved for serial ATA

These words are reserved for future serial ATA use.

7.10.3.6.7 Words (20:10) Reserved

7.10.3.6.8 Word 21: Command/features set supported part 2

Word 21 bits 15:14 Reserved for technical report.

Word 21 bit 13 if set to one indicates that the device is allowed to support the WRITE UNCORRECTABLE command.

Word 21 bits 12:0 are reserved.

7.10.3.6.9 Word 22: Command/features set supported part 3

Bits 15:0 are reserved.

7.10.3.6.10 Words (254:23): Reserved

7.10.3.6.11 Word 255: Integrity word

Bits (7:0) of this word shall contain the value A5h. Bits (15:8) of this word shall contain the data structure checksum. The data structure checksum shall be the two's complement of the sum of all byte in words (154:0) and the byte consisting of bits (7:0) of word 255. Each byte shall be added with unsigned arithmetic, and overflow shall be ignored. The sum of all bytes is zero when the checksum is correct.

This command is mandatory for devices implementing the Device Configuration Overlay feature set.

7.10.4 DEVICE CONFIGURATION SET - B1h/C3h, PIO Data Out

7.10.4.1 Feature Set

This command is mandatory for devices implementing the Device Configuration Overlay feature set.

7.10.4.2 Description

The DEVICE CONFIGURATION SET command allows a device manufacturer or a personal computer system manufacturer to reduce the set of optional commands, modes, or feature sets supported by a device as indicated by a DEVICE CONFIGURATION IDENTIFY command. The DEVICE CONFIGURATION SET command,may modify the data returned by IDENTIFY DEVICE and/or IDNETIFY PACKET DEVICE. When the IDENTIFY DEVICE data or IDENTIFY PACKET DEVICE data is changed, the device shall shall respond in a manner consistent with the new data. If a bit is set in the DCO data transmitted by the device that is not set in the DCO data received from a DEVICE CONFIGURATION IDENTIFY command, no action is taken for that bit. Modifying the maximum LBA of the device also modifies the address value returned by a READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT command.

The format of the DCO data transmitted by the device is described in 7.10.4.6. The restrictions on changing these bits are also described in clause 7.10.4.6. If any of the bit modification restrictions described are violated, the device shall return command aborted.

The term ‘is allowed’ indicates that the device may report that a feature is supported and/or enabled.

If the device is not ‘allowed’ to report support, then the device shall not support and shall report that the selected feature is both ‘not supported’ and if appropriate ‘not enabled.

7.10.4.3 Inputs

Word	Name	Description
00h	Feature	C3h
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	B1h

7.10.4.4 Normal outputs

See Table 85

7.10.4.5 Error outputs

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7:3 N/A 2 Abort - See clause 6.3.1. Abort shall be set to one if a DEVICE CONFIGURATION SET command has already modified the original settings as reported by a DEVICE CONFIGURATION IDENTIFY command, if DEVICE CONFIGURATION FREEZE LOCK is set, if any of the bit modification restrictions described in 7.10.4.1 are violated, or if a Host Protected Area has been established by the execution of a SET MAX ADDRESS or SET MAX ADDRESS EXT command, or if an attempt was made to modify a mode or feature that cannot be modified with the device in its current state. 1:0 N/A
01h	Count	Vendor Specific
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:16 Word location - If the command was aborted because an attempt was made to modify a bit that cannot be modified with the device in its current state, this register shall contain the offset of the first word encountered that cannot be changed. If an illegal maximum LBA is encountered, the offset of word 3 shall be entered. If a checksum error occurred, the value FFh shall be entered. A value of 00h indicates that the Data Structure Revision was invalid. 15:0 Bit Location - If the command was aborted because an attempt was made to modify a mode or feature that cannot be modified with the device in its current state, this register shall contain bits set in the bit positions that correspond to the bits in the device configuration overlay data structure words 1, 2, or 7 for each mode or feature that cannot be changed. If not, the value shall be 00h. **[Editors Note: This is really unclear]**
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

7.10.4.6 Output Data Structure

Table 10 - Device Configuration Overlay (DCO) data structure

Word	Content
0	Data structure revision
1	Multiword DMA modes supported 15:3 Reserved 2 1 = Reporting support for Multiword DMA mode 2 and below is allowed 1 1 = Reporting support for Multiword DMA mode 1 and below is allowed 0 1 = Reporting support for Multiword DMA mode 0 is allowed
2	Ultra DMA modes supported 15:7 Reserved 6 1 = Reporting support for Ultra DMA mode 6 and below is allowed 5 1 = Reporting support for Ultra DMA mode 5 and below is allowed 4 1 = Reporting support for Ultra DMA mode 4 and below is allowed 3 1 = Reporting support for Ultra DMA mode 3 and below is allowed 2 1 = Reporting support for Ultra DMA mode 2 and below is allowed 1 1 = Reporting support for Ultra DMA mode 1 and below is allowed 0 1 = Reporting support for Ultra DMA mode 0 is allowed
3-6	Maximum LBA
7	Command set/feature set supported part 1 15 Reserved 14 1 = Reporting support for Write Read Verify feature set is allowed 13 1 = Reporting support for SMART Conveyance self-test is allowed 12 1 = Reporting support for SMART Selective self-test is allowed 11 1 = Reporting support for Forced Unit Access is allowed 10 Reserved for ANSI/INCITS TR-37-2004 9 1 = Reporting support for Streaming feature set is allowed 8 1 = Reporting support for 48-bit Addressing feature set is allowed 7 1 = Reporting support for Host Protected Area feature set is allowed 6 1 = Reporting support for Automatic acoustic management is allowed 5 1 = Reporting support for READ/WRITE DMA QUEUED commands is allowed 4 1 = Reporting support for Power-up in Standby feature set is allowed 3 1 = Reporting support for Security feature set is allowed 2 1 = Reporting support for SMART error log is allowed 1 1 = Reporting support for SMART self-test is allowed 0 1 = Reporting support for SMART feature set is allowed
8-9	Reserved for serial ATA
10-20	Reserved
21	Command set/feature set supported part 2 15 Reserved for e05106 14 Reserved for e05106 13 1 = Reporting support for the WRITE UNCORRECTABLE command is allowed 12:0 Reserved
22	Command set/feature set supported part 3 15:0 Reserved
23-254	Reserved
255	Integrity word 15:8 Checksum 7:0 Signature

7.10.4.6.1 Word 0: Data structure revision

Word 0 shall contain the value 0002h.

7.10.4.6.2 Word 1: Multiword DMA modes supported
Word 1 bits (15:3) are reserved.

Word 1 bit 2 is cleared to disable support for Multiword DMA mode 2 and has the effect of clearing bit 2 in word 63 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response. This bit shall not be cleared to zero if Multiword DMA mode 2 is currently selected.

Word 1 bit 1 is cleared to disable support for Multiword DMA mode 1 and has the effect of clearing bit 1 to zero in word 63 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response. This bit shall not be cleared to zero if Multiword DMA mode 2 is supported or Multiword DMA mode 1 or 2 is selected.

Word 1 bit 0 shall not be cleared to zero.

7.10.4.6.3 Word 2: Ultra DMA modes supported
Word 2 bits (15:7) are reserved.

Word 2 bit 6 is cleared to zero to disable support for Ultra DMA mode 6 and has the effect of clearing bit 6 to zero in word 88 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response. This bit shall not be cleared to zero if Ultra DMA mode 6 is currently selected.

Word 2 bit 5 is cleared to zero to disable support for Ultra DMA mode 5 and has the effect of clearing bit 5 to zero in word 88 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response. This bit shall not be cleared to zero if Ultra DMA mode 5 is currently selected.

Word 2 bit 4 is cleared to zero to disable support for Ultra DMA mode 4 and has the effect of clearing bit 4 to zero in word 88 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response. This bit shall not be cleared to zero if Ultra DMA mode 5 is supported or if Ultra DMA mode 5 or 4 is selected.

Word 2 bit 3 is cleared to zero to disable support for Ultra DMA mode 3 and has the effect of clearing bit 3 to zero in word 88 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response. This bit shall not be cleared to zero if Ultra DMA mode 5 or 4 is supported or if Ultra DMA mode 5, 4, or 3 is selected.

Word 2 bit 2 is cleared to zero to disable support for Ultra DMA mode 2 and has the effect of clearing bit 2 to zero in word 88 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response. This bit shall not be cleared to zero if Ultra DMA mode 5, 4, or 3 is supported or if Ultra DMA mode 5, 4, 3, or 2 is selected.

Word 2 bit 1 is cleared to zero to disable support for Ultra DMA mode 1 and has the effect of clearing bit 1 to zero in word 88 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response. This bit shall not be cleared to zero if Ultra DMA mode 5, 4, 3, or 2 is supported or if Ultra DMA mode 5, 4, 3, 2, or 1 is selected.

Word 2 bit 0 is cleared to zero to disable support for Ultra DMA mode 0 and has the effect of clearing bit 0 to zero in word 88 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response. This bit shall not be cleared to zero if Ultra DMA mode 5, 4, 3, 2, or 1 is supported or if Ultra DMA mode 5, 4, 3, 2, 1, or 0 is selected.

7.10.4.6.4 Words (6:3): Maximum LBA
Words (6:3) define the maximum LBA. This shall be the highest address accepted by the device after execution of the command. When this value is changed, the content of IDENTIFY DEVICE data words (61:60) and (103:100) shall be changed as described in the SET MAX ADDRESS and SET MAX ADDRESS EXT command descriptions to reflect the maximum address set with this command. This value shall not be changed and command aborted shall be returned if a Host Protected Area has been established by the execution of a SET MAX ADDRESS or SET MAX ADDRESS EXT command with an address value less than that returned by a READ NATIVE MAX ADDRESS or READ NATIVE MAX ADDRESS EXT command. Any data contained in the Host Protected Area is not affected.

7.10.4.6.5 Word 7: Command/features set supported part 1
Word 7 bits (15:14) are reserved.

Word 7 bit 14 is cleared to zero to disable support for the Write Read Verify feature set and has the effect of clearing word 119 bit 1 and word 120 bit 1.

Word 7 bit 13 is cleared to zero to disable support for the SMART Conveyance self-test. Subsequent attempts to start this test via the SMART EXECUTE OFF-LINE IMMEDIATE command shall cause that command to abort. In addition, the SMART READ DATA command shall clear bit 5 to zero in the “Off-line data collection capabilities“ field. If this bit is supported by DEVICE CONFIGURATION SET, then this feature shall not be disabled by bit 1 of word 7.

Word 7 bit 12 is cleared to zero to disable support for the SMART Selective self-test. Subsequent attempts to start this test test via the SMART EXECUTE OFF-LINE IMMEDIATE command shall cause that command to abort. In addition, the SMART READ DATA command shall clear bit 6 to zero in the "Off-line data collection capabilities " field. If this bit is supported by DEVICE CONFIGURATION SET, then this feature shall not be disabled by bit 1 of word 7.

Word 7 bit 11 is cleared to zero to disable support for the Force Unit Access commands and has the effect of clearing bits 6 and 7 to zero in word 84 and word 87 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response.

Word 7 bit 10 is –Reserved **[Editors Note: What Technical Report?]**

Word 7 bit 9 is cleared to zero to disable support for the Streaming feature set and has the effect of clearing bits 4, 9 and 10 to zero in word 84 and word 87 and clearing the value in words (99:95) and word 104 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response.

Word 7 bit 8 is cleared to zero to disable support for the 48-bit Addressing feature set and has the effect of clearing bit 10 to zero in word 83 and word 86 and clearing the value in words (103:100) of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response.

Word 7 bit 7 is cleared to zero to disable support for the Host Protected Area feature set and has the effect of clearing bit 10 to zero in word 82 and word 85 and clearing bit 8 to zero in word 83 and word 86 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response. If a Host Protected Area has been established by use of the SET MAX ADDRESS or SET MAX ADDRESS EXT command, these bits shall not be cleared to zero and the device shall return command aborted.

Word 7 bit 6 is cleared to zero to disable for the Automatic Acoustic Management feature set and has the effect of clearing bit 9 to zero in word 83 and word 94 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response.

Word 7 bit 5 is cleared to zero to disable support for the READ DMA QUEUED and WRITE DMA QUEUED commands and has the effect of clearing bit 1 to zero in word 83 and word 86 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response.

Word 7 bit 4 is cleared to zero to disable support for the Power-up in Standby feature set and has the effect of clearing bits (6:5) to zero in word 83 and word 86 and clearing the value in word 94 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response. If Power-up in Standby has been enabled by a jumper, these bits shall not be cleared.

Word 7 bit 3 is cleared to zero to disable support for the Security feature set and has the effect of clearing bit 1 to zero in word 82 and word 85 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response. These bits shall not be cleared if the Security feature set has been enabled.

Word 7 bit 2 is cleared to zero to disable support for the SMART error logging and has the effect of clearing bit 0 to zero in word 84 and word 87 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response.

Word 7 bit 1 is cleared to zero to disable support for the SMART self-test and has the effect of clearing bit 1 to zero in word 84 and word 87 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response.

Word 7 bit 1 disables support for the offline, short , extended self-tests (off-line and captive modes).

If bit 12 or bit 13 of word 7 are not supported, Word 7 bit 1 may also disable support for conveyance self-test and selective self-test. **[Editors Note: This is unclear?]**

Word 7 bit 0 is cleared to zero to disable support for the SMART feature set and has the effect of clearing bit 0 to zero in word 82 and word 85 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE response. If bits (2:1) of word 7 are not cleared to zero or if the SMART feature set has been enabled by use of the SMART ENABLE OPERATIONS command, these bits shall not be cleared and the device shall return command aborted.

7.10.4.6.6 Words 8-9: Reserved for serial ATA

These words are reserved for future serial ATA use.

7.10.4.6.7 Words (20:10) Reserved

7.10.4.6.8 Word 21: Command/features set supported part 2
Word 21 bits 15:14 Reserved for technical report.

Word 21 bit 13 if set to one indicates that the device is allowed to support the WRITE UNCORRECTABLE command.

Word 21 bits 12:0 are reserved.

7.10.4.6.9 Word 22: Command/features set supported part 3
Bits 15:0 are reserved.

7.10.4.6.10 Words (254:23): Reserved

7.10.4.6.11 Word 255: Integrity word
Bits (7:0) of this word shall contain the value A5h. Bits (15:8) of this word shall contain the data structure checksum. The data structure checksum shall be the two's complement of the sum of all byte in words (254:0) and the byte consisting of bits (7:0) of word 255. Each byte shall be added with unsigned arithmetic, and overflow shall be ignored. The sum of all bytes is zero when the checksum is correct.

This command is mandatory for devices implementing the Device Configuration Overlay feature set.

7.11 DEVICE RESET - 08h, Device reset

7.11.1 Feature Set

This command is mandatory for devices implementing the PACKET Command feature set.

7.11.2 Description

The DEVICE RESET command enables the host to reset a device.

7.11.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	08h

7.11.4 Normal outputs

See Table 90

7.11.5 Error outputs

If DEVICE RESET is supported, it shall not end in an error condition. If DEVICE RESET is not supported and the device has the BSY bit or the DRQ bit set to one when the command is written, the results of this command are indeterminate. If this command is not supported and the device has the BSY bit and the DRQ bit cleared to zero when the command is written, the device shall respond with command aborted. **[Editors Note: Not sure what to do with this, Jim hatfield to wordsmith]**

7.12 DOWNLOAD MICROCODE - 92h, PIO Data-out

7.12.1 Feature Set

This command is optional for devices implementing the General feature set

7.12.2 Description

This command enables the host to alter the device's microcode. The data transferred using the DOWNLOAD MICROCODE command is vendor specific.

All transfers shall be an integer multiple of the logical sector size. The size of the data transfer is determined by the contents of the LBA and Count fields. The LBA field shall be used to extend the Count field to create a 16-bit logical sector count value. The low order 8 bits of the LBA field shall be the most significant eight bits and the Count field shall be the least significant eight bits. A value of zero in both field shall specify no data is to be transferred. This allows transfer sizes from 0 bytes to 33,553,920 bytes, in 512 byte increments.

The Feature field shall be used to determine the effect of the DOWNLOAD MICROCODE command as described in 7.12.3.

A Features register value of 03h indicates that the microcode will be transferred in two or more DOWNLOAD MICROCODE commands using the offset transfer method.

The download sector count value in the Sector Count and LBA Low registers will indicate how many sectors of the microcode file are being transferred in one segment.

The Buffer Offset value is defined by the value in the LBA Mid and LBA High registers (used as one 16-bit buffer offset value). The buffer offset value is the starting location in the microcode file that will be transferred. The buffer offset value will vary from 0 byte to 33,553,920 bytes, in 512 byte increments. The buffer offset value is the byte count divided by 512.

All microcode segments shall be sent to the device in sequence.

The device may abort the DOWNLOAD MICROCODE command and discard all previously downloaded micocode if the current buffer offset is not equal to the sum of the previous DOWNLOAD MICROCODE command buffer offset and the previous sector count. The first DOWNLOAD MICROCODE command shall have a buffer offset of zero.

The new firmware should become effective immediately after the transfer of the last data segment has completed.

When the device detects the last download microcode command for the firmware download the device shall perform any device required verification and save the complete set of downloaded microcode. Device feature configuration (e.g. SET FEATURES settings) may be affected by the download microcode command.

If the device receives a command other than download microcode prior to the receipt of the last segment the new command is executed and all previously downloaded microcode is discarded.

If a software or hardware Reset is issued to the device before all of the microcode segments have been transferred to the device the device shall abandon all of the microcode segments received and process the Reset.

7.12.3 Inputs

Word	Name	Description
00h	Feature	**Sub command** **Description** 00h Reserved 01h Obsolete 02h Reserved 03h Download Microcode with offsets for immediate and future use. 04h-06h Reserved 07h Save downloadedMicrocode for immediate and future use. 08-FFh Reserved
01h	Count	Sector Count (Low Order)
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 Buffer offset (only used for Feature = 03h) 7:0 Sector Count (High Order)
05h	Command	92h

7.12.4 Normal outputs

See Table 85

7.12.5 Error outputs

The device shall return command aborted if the device did not accept the microcode data. The device shall return command aborted if subcommand code is not a supported value. See Table 100.

7.13 EXECUTE DEVICE DIAGNOSTIC - 90h, Device diagnostic

7.13.1 Feature Set

This command is mandatory for all devices.

7.13.2 Description

This command shall cause the devices to perform the internal diagnostic tests. Both devices, if present, shall execute this command regardless of which device is selected.

If the host issues an EXECUTE DEVICE DIAGNOSTIC command while a device is in or going to a power management mode except Sleep, then the device shall execute the EXECUTE DEVICE DIAGNOSTIC sequence.

7.13.3 Inputs

Only the command code (90h). All other registers shall be ignored.

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	90h

7.13.4 Normal outputs

See Table 90. The diagnostic code written into the Error field is an 8-bit code. Table 11 defines these values.

Table 11 - Diagnostic codes

Code (See note 1)	**Description**
When this code is in the Device 0 Error register	
01h	Device 0 passed, Device 1 passed or not present
00h, 02h-7Fh	Device 0 failed, Device 1 passed or not present
81h	Device 0 passed, Device 1 failed
80h, 82h-FFh	Device 0 failed, Device 1 failed
When this code is in the Device 1 Error register	
01h	Device 1 passed (See note 2)
00h, 02h-7Fh	Device 1 failed (See note 2)
NOTE – 1 Codes other than 01h and 81h may indicate additional information about the failure(s). 2 If Device 1 is not present, the host may see the information from Device 0 even though Device 1 is selected.	

7.13.5 Error outputs

Table 11 shows the error information that is returned as a diagnostic code in the Error register.
[Editors Note: Is there supposed to be an error output table here? ATA-7 does not document the error case either]

7.14 FLUSH CACHE - E7h, Non-data

7.14.1 Feature Set
This command is mandatory for devices not implementing the PACKET Command feature set. This command is optional for devices implementing the PACKET Command feature set.

7.14.2 Description
This command is used by the host to request the device to flush the write cache. If there is data in the write cache, that data shall be written to the media. This command shall not indication completion until the data is flushed to the media or an error occurs.

NOTE – This command may take longer than 30 s to complete.

7.14.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	E7h

7.14.4 Normal outputs
See Table 85

7.14.5 Error outputs
An unrecoverable error encountered during execution of writing data results in the termination of the command and the Command Block registers contain the logical sector address of the sector where the first unrecoverable error occurred. Subsequent FLUSH CACHE commands continue the process of flushing the cache starting with the first logical sector after the sector in error. LBA bits 47:28 shall be cleared to zero. See Table 103

7.15 FLUSH CACHE EXT - EAh, Non-data

7.15.1 Feature Set
This command is mandatory for devices implementing the 48-bit Address feature set

7.15.2 Description
This command is used by the host to request the device to flush the write cache. If there is data in the write cache, that data shall be written to the media. This command shall not indication completion until the data is flushed to the media or an error occurs.

NOTE – This command may take longer than 30 s to complete.

7.15.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	Reserved
02h-04h	LBA	Reserved
05h	Command	EAh

7.15.4 Normal outputs
See Table 85

7.15.5 Error outputs
An unrecoverable error encountered while writing data results in the termination of the command and the Command Block registers contain the logical sector address of the logical sector where the first unrecoverable error occurred. Subsequent FLUSH CACHE EXT commands continue the process of flushing the cache starting with the first sector after the sector in error. See Table 103.

7.16 GET MEDIA STATUS - DAh, Non-data

7.16.1 Feature Set

This command is mandatory for devices implementing the Removable Media Status Notification feature set. This command is optional for devices implementing the Removable Media feature set. **[Editors Note: Should we obsolete this feature set? or sets?]**

7.16.2 Description

This command returns media status bits WP, MC, MCR, and NM, as defined in clause 6. When Media Status Notification is disabled this command returns zeros in the WP, MC, MCR, and NM bits.

7.16.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	Reserved
02h-04h	LBA	Reserved
05h	Command	DAhh

7.16.4 Normal outputs

Normal outputs are returned if Media Status Notification is disabled or if no bits are set to one in the Error register. See Table 85.

7.16.5 Error outputs

See Table 104

7.17 IDENTIFY DEVICE - ECh, PIO Data-in

7.17.1 Feature Set

This command is mandatory for all devices.

7.17.2 Description

The IDENTIFY DEVICE command enables the host to receive parameter information from the device. See clause 7.17.7 for a description of the return data.

Some devices may have to read the media in order to complete this command.

The parameter information contains data regarding optional feature or command support. If the host issues a command that is indicated as not supported, the drive may produce indeterminate results.

Some parameters are defined as a 16-bit value. A word that is defined as a 16-bit value transmits the most significant byte first (See 3.2.7). For serial implementation see 3.2.8.

Some parameters are defined as 32-bit values (e.g., words (61:60)). Such fields are transferred using two successive word transfers. The device shall first transmit the least significant word of the valuefollowed by, the most significant bytes (See 3.2.7).

Some parameters are defined as a string of ACSII characters. Such fields are transferred as defined in 3.2.7.

7.17.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	ECh

7.17.4 Normal outputs for devices that do not implement the Packet Command feature set

See Table 85

7.17.5 Normal Outputs for PACKET Command feature set devices

In response to this command, devices that implement the PACKET Command feature set shall post command aborted and place the PACKET Command feature set signature in the appropriate fields, see 7.11.4.

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7:3 N/A 2 Abort - See clause 6.3.1 1:0 N/A
01h	Count	Reserved
02h-04h	LBA	N/A
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5:4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

7.17.6 Error outputs

Devices not implementing the PACKET Command feature set shall not report an error. **[Editors Note: The change to integrate e05133r3 conflicts with the ICRC issue.]** The device may return error status if an Interface CRC error has occurred.

Note: There is no defined mechanism for a device to return an ICRC error status that may have occurred during the last data block of a PIO-in data transfer, there may be other mechanisms in which a host can verify that an Interface CRC error occurred in these cases.

7.17.7 Input Data

Table 12 - IDENTIFY DEVICE data

Word	O/M	S/P	F/V	Description
0	M	B		General configuration bit-significant information:
			F	15 0 = ATA device
			X	14:8 Retired
			F	7 1 = removable media device
			X	6 Obsolete
			X	5:3 Retired
			V	2 Response incomplete
			X	1 Retired
			F	0 Reserved
1			X	Obsolete
2	O	B	V	Specific configuration
3			X	Obsolete
4-5			X	Retired
6			X	Obsolete
7-8	O	N	V	Reserved for assignment by the CompactFlash™ Association
9			X	Retired
10-19	M	B	F	Serial number (20 ASCII characters)
20-21			X	Retired
22			X	Obsolete
23-26	M	B	F	Firmware revision (8 ASCII characters)
27-46	M	B	F	Model number (40 ASCII characters)
47	M		F	15:8 80h
			F	7:0 00h = Reserved
		P	F	01h-FFh = Maximum number of logical sectors that shall be transferred per DRQ data block on READ/WRITE MULTIPLE commands
48			F	Reserved
49	M			Capabilities
			F	15:14 Reserved for the IDENTIFY PACKET DEVICE command.
		B	F	13 1 = Standby timer values as specified in this standard are supported
				0 = Standby timer values shall be managed by the device
			F	12 Reserved for the IDENTIFY PACKET DEVICE command.
		P	F	11 1 = IORDY supported
		P		0 = IORDY may be supported
		P	F	10 1 = IORDY may be disabled
		B	F	9 1 = LBA supported
		P	F	8 1 = DMA supported.
			X	7:0 Retired
50	M			Capabilities
			F	15 Shall be cleared to zero.
			F	14 Shall be set to one.
			F	13:2 Reserved.
			X	1 Obsolete
		B	F	0 Shall be set to one to indicate a device specific Standby timer value minimum.
51-52			X	Obsolete
53	M		F	15:3 Reserved
		B	F	2 1 = the fields reported in word 88 are valid
		B		0 = the fields reported in word 88 are not valid
		B	F	1 1 = the fields reported in words (70:64) are valid
		P		0 = the fields reported in words (70:64) are not valid
			X	0 Obsolete
54-58			X	Obsolete
59	M		F	15:9 Reserved
		B	V	8 1 = Multiple sector setting is valid
		B	V	7:0 xxh = Current setting for number of logical sectors that shall be transferred per DRQ data block on READ/WRITE Multiple commands
60-61	M	B	F	Total number of user addressable logical sectors
62			X	Obsolete

Table 12 - IDENTIFY DEVICE data

Word	O/M	S/P	F/V	Description
63	M	P	F	15:11 Reserved
		P	V	10 1 = Multiword DMA mode 2 is selected
		P		0 = Multiword DMA mode 2 is not selected
		P	V	9 1 = Multiword DMA mode 1 is selected
		P		0 = Multiword DMA mode 1 is not selected
		P	V	8 1 = Multiword DMA mode 0 is selected
		P		0 = Multiword DMA mode 0 is not selected
			F	7:3 Reserved
		P	F	2 1 = Multiword DMA mode 2 and below are supported
		P	F	1 1 = Multiword DMA mode 1 and below are supported
		P	F	0 1 = Multiword DMA mode 0 is supported
64	M		F	15:8 Reserved
		P	F	7:0 PIO modes supported
65	M			Minimum Multiword DMA transfer cycle time per word
		P	F	15:0 Cycle time in nanoseconds
66	M			Manufacturer's recommended Multiword DMA transfer cycle time
		P	F	15:0 Cycle time in nanoseconds
67	M			Minimum PIO transfer cycle time without flow control
		P	F	15:0 Cycle time in nanoseconds
68	M			Minimum PIO transfer cycle time with IORDY flow control
		P	F	15:0 Cycle time in nanoseconds
69-70			F	Reserved (for future command overlap and queuing) [Editors Note: should this be just reserved]
71-74			F	Reserved for the IDENTIFY PACKET DEVICE command.
75	O			Queue depth
			F	15:5 Reserved
		B	F	4:0 Maximum queue depth - 1
76-79		S	F	Reserved for Serial ATA
80	M	B		Major version number
				0000h or FFFFh = device does not report version
			F	15 Reserved
			F	14 Reserved for ATA/ATAPI-14
			F	13 Reserved for ATA/ATAPI-13
			F	12 Reserved for ATA/ATAPI-12
			F	11 Reserved for ATA/ATAPI-11
			F	10 Reserved for ATA/ATAPI-10
			F	9 Reserved for ATA/ATAPI-9
		B	F	8 1 = supports ATA/ATAPI8-ACS
		B	F	7 1 = supports ATA/ATAPI-7
		B	F	6 1 = supports ATA/ATAPI-6
		B	F	5 1 = supports ATA/ATAPI-5
		B	F	4 1 = supports ATA/ATAPI-4
			F	3 Obsolete
			X	2 Obsolete
			X	1 Obsolete
			F	0 Reserved
81	M	B	F	Minor version number
				0000h or FFFFh = device does not report version
				0001h-FFFEh = See 7.17.7.41

Table 12 - IDENTIFY DEVICE data

Word	O/M	S/P	F/V	Description
82	M			Command set supported.
			X	15 Obsolete
		B	F	14 1 = NOP command supported
		B	F	13 1 = READ BUFFER command supported
		B	F	12 1 = WRITE BUFFER command supported
			X	11 Obsolete
		B	F	10 1 = Host Protected Area feature set supported
		N	F	9 1 = DEVICE RESET command supported [Editots Note: Shouldn't this just be in ATAPI IDENTIFY DEVICE?]
		B	F	8 1 = SERVICE interrupt supported
		B	F	7 1 = release interrupt supported
		B	F	6 1 = look-ahead supported
		B	F	5 1 = write cache supported
		B	F	4 Shall be cleared to zero to indicate that the PACKET Command feature set is not supported.
		B	F	3 1 = mandatory Power Management feature set supported
		B	F	2 1 = Removable Media feature set supported
		B	F	1 1 = Security Mode feature set supported
		B	F	0 1 = SMART feature set supported
83	M			Command sets supported.
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
		B	F	13 1 = FLUSH CACHE EXT command supported
		B	F	12 1 = mandatory FLUSH CACHE command supported
		B	F	11 1 = Device Configuration Overlay feature set supported
		B	F	10 1 = 48-bit Address feature set supported
		B	F	9 1 = Automatic Acoustic Management feature set supported
		B	F	8 1 = SET MAX security extension supported
		B	F	7 See Address Offset Reserved Area Boot, INCITS TR27:2001
		B	F	6 1 = SET FEATURES subcommand required to spinup after power-up
		B	F	5 1 = Power-Up In Standby feature set supported
		B	F	4 1 = Removable Media Status Notification feature set supported
		B	F	3 1 = Advanced Power Management feature set supported
		N	F	2 1 = CFA feature set supported
		B	F	1 1 = READ/WRITE DMA QUEUED supported
		B	F	0 1 = DOWNLOAD MICROCODE command supported
84	M			Command set/feature supported
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
		B	F	13 1 = IDLE IMMEDIATE with UNLOAD FEATURE supported
		B	F	12 Reserved for technical report INCITS TR-37-2004 (TLC)
		B	F	11 Reserved for technical report INCITS TR-37-2004 (TLC)
		B	F	10:9 1 = Obsolete
		B	F	8 1 = 64-bit World wide name supported
		B	F	7 1 = WRITE DMA QUEUED FUA EXT command supported
		B	F	6 1 = WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands supported
		B	F	5 1 = General Purpose Logging feature set supported
		B	F	4 1 = Streaming feature set supported
		N	F	3 1 = Media Card Pass Through Command feature set supported
		B	F	2 1 = Media serial number supported
		B	F	1 1 = SMART self-test supported
		B	F	0 1 = SMART error logging supported

Table 12 - IDENTIFY DEVICE data

Word	O/M	S/P	F/V	Description
85	M			Command set/feature enabled.
			X	15 Obsolete
		B	F	14 1 = NOP command enabled
		B	F	13 1 = READ BUFFER command enabled **[Editors note: I think this should say command supported]**
		B	F	12 1 = WRITE BUFFER command enabled
			X	11 Obsolete
		B	V	10 1 = Host Protected Area feature set enabled
		N	F	9 1 = DEVICE RESET command enabled
		B	V	8 1 = SERVICE interrupt enabled
		B	V	7 1 = release interrupt enabled
		B	V	6 1 = look-ahead enabled
		B	V	5 1 = write cache enabled
			F	4 Shall be cleared to zero to indicate that the PACKET Command feature set is not supported.
		B	F	3 1 = Power Management feature set enabled
		B	F	2 1 = Removable Media feature set enabled
		B	V	1 1 = Security Mode feature set enabled
		B	V	0 1 = SMART feature set enabled
86	M			Command set/feature enabled.
		B		15 Enable detection of words 120:119
			F	14 Reserved
		B	F	13 1 = FLUSH CACHE EXT command supported
		B	F	12 1 = FLUSH CACHE command supported
		B	F	11 1 = Device Configuration Overlay supported
		B	F	10 1 = 48-bit Address features set supported
		B	V	9 1 = Automatic Acoustic Management feature set enabled
		B	F	8 1 = SET MAX security extension enabled by SET MAX SET PASSWORD
		B	F	7 Reserved for Address Offset Reserved Area Boot, INCITS TR27:2001
		B	F	6 1 = SET FEATURES subcommand required to spin-up after power-up
		B	V	5 1 = Power-Up In Standby feature set enabled
		B	V	4 1 = Removable Media Status Notification feature set enabled
		B	V	3 1 = Advanced Power Management feature set enabled
		N	F	2 1 = CFA feature set enabled
		B	F	1 1 = READ/WRITE DMA QUEUED command supported
		B	F	0 1 = DOWNLOAD MICROCODE command supported
87	M			Command set/feature enabled.
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
		B	F	13 1 = IDLE IMMEDIATE with UNLOAD FEATURE supported
		B	V	12 Reserved for technical report- INCITS TR-37-2004 (TLC)
		B	V	11 Reserved for technical report- INCITS TR-37-2004 (TLC)
		B	F	10:9 1 = Obsolete
		B	F	8 1 = 64 bit World wide name supported
		B	F	7 1 = WRITE DMA QUEUED FUA EXT command supported
		B	F	6 1 = WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands supported
		B	F	5 1 = General Purpose Logging feature set supported
		B	V	4 1 = Obsolete
		N	V	3 1 = Media Card Pass Through Command feature set enabled
		B	V	2 1 = Media serial number is valid
		B	F	1 1 = SMART self-test supported
		B	F	0 1 = SMART error logging supported

Table 12 - IDENTIFY DEVICE data

Word	O/M	S/P	F/V	Description
88	O		F	15 Reserved
		P	V	14 1 = Ultra DMA mode 6 is selected
		P		0 = Ultra DMA mode 6 is not selected
		P	V	13 1 = Ultra DMA mode 5 is selected
		P		0 = Ultra DMA mode 5 is not selected
		P	V	12 1 = Ultra DMA mode 4 is selected
		P		0 = Ultra DMA mode 4 is not selected
		P	V	11 1 = Ultra DMA mode 3 is selected
		P		0 = Ultra DMA mode 3 is not selected
		P	V	10 1 = Ultra DMA mode 2 is selected
		P		0 = Ultra DMA mode 2 is not selected
		P	V	9 1 = Ultra DMA mode 1 is selected
		P		0 = Ultra DMA mode 1 is not selected
		P	V	8 1 = Ultra DMA mode 0 is selected
		P		0 = Ultra DMA mode 0 is not selected
		P	F	7 Reserved
		P	F	6 1 = Ultra DMA mode 6 and below are supported
		P	F	5 1 = Ultra DMA mode 5 and below are supported
		P	F	4 1 = Ultra DMA mode 4 and below are supported
		P	F	3 1 = Ultra DMA mode 3 and below are supported
		P	F	2 1 = Ultra DMA mode 2 and below are supported
		P	F	1 1 = Ultra DMA mode 1 and below are supported
		P	F	0 1 = Ultra DMA mode 0 is supported
89	O	B	F	Time required for security erase unit completion
90	O	B	F	Time required for Enhanced security erase completion
91	O	B	V	Current advanced power management value
92	O	B	V	Master Password Revision Code
93	*			Hardware reset result. The contents of bits (12:0) of this word shall change only during the execution of a hardware reset.
			F	15 Shall be cleared to zero.
			F	14 Shall be set to one.
		P	V	13 1 = device detected CBLID- above V_{iH}
		P		0 = device detected CBLID- below V_{iL}
		P		12:8 Device 1 hardware reset result. Device 0 shall clear these bits to zero. Device 1 shall set these bits as follows:
		P	F	12 Reserved.
		P	V	11 0 = Device 1 did not assert PDIAG-.
		P		1 = Device 1 asserted PDIAG-.
		P	V	10:9 These bits indicate how Device 1 determined the device number:
		P		00 = Reserved.
		P		01 = a jumper was used.
		P		10 = the CSEL signal was used.
		P		11 = some other method was used or the method is unknown.
				8 Shall be set to one.
		P		7:0 Device 0 hardware reset result. Device 1 shall clear these bits to zero. Device 0 shall set these bits as follows:
			F	7 Reserved.
		P	F	6 0 = Device 0 does not respond when Device 1 is selected.
		P		1 = Device 0 responds when Device 1 is selected.
		P	V	5 0 = Device 0 did not detect the assertion of DASP-.
		P		1 = Device 0 detected the assertion of DASP-.
		P	V	4 0 = Device 0 did not detect the assertion of PDIAG-.
		P		1 = Device 0 detected the assertion of PDIAG-.
		P	V	3 0 = Device 0 failed diagnostics.
		P		1 = Device 0 passed diagnostics.
		P	V	2:1 These bits indicate how Device 0 determined the device number:
		P		00 = Reserved.
		P		01 = a jumper was used.
		P		10 = the CSEL signal was used.
		P		11 = some other method was used or the method is unknown.
			F	0 Shall be set to one.
94	O	B	V	15:8 Vendor’s recommended acoustic management value.

Table 12 - IDENTIFY DEVICE data

Word	O/M	S/P	F/V	Description
		B	V	7:0 Current automatic acoustic management value.
95		B	F	Stream Minimum Request Size
96		B	V	Streaming Transfer Time - DMA
97		B	V	Streaming Access Latency - DMA and PIO
98-99		B	F	Streaming Performance Granularity
100-103	O	B	V	Maximum user LBA for 48-bit Address feature set.
104	O	B	V	Streaming Transfer Time - PIO
105			F	Reserved
106	O			Physical sector size / Logical Sector Size
		B	F	15 Shall be cleared to zero
		B	F	14 Shall be set to one
		B	F	13 1 = Device has multiple logical sectors per physical sector.
		B		12 1= Device Logical Sector Longer than 256 Words
			F	11:4 Reserved
		B	F	3:0 2^X logical sectors per physical sector
107	O	B	F	Inter-seek delay for ISO-7779 acoustic testing in microseconds
108	O	B	F	15:12 NAA (3:0) 11:0 IEEE OUI (23:12)
109	O	B	F	15:4 IEEE OUI (11:0) 3:0 Unique ID (35:32)
110	O	B	F	15:0 Unique ID (31:16)
111	O	B	F	15:0 Unique ID (15:0)
112-115	O		F	Reserved for world wide name extension to 128 bits
116	O	B	V	Reserved for TLC technical report- INCITS TR-37-2004
117-118	O	B	F	Words per Logical Sector
119	M			Supported Settings (Continued from words 84:82)
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
			F	13:4 Reserved
		B	F	3 READ and WRITE DMA EXT GPL optional commands are supported
		B	F	2 WRITE UNCORRECTABLE is supported
		B	F	1 1 = Write Read Verify feature set is supported
		P	F	0 reserved for DT2014
120	M			Enabled Settings (Continued from words 87:85)
			F	15 Shall be cleared to zero
			F	14 Shall be set to one
			F	13:4 Reserved
		B	F	3 READ and WRITE DMA EXT GPL optional commands are supported
		B	F	2 WRITE UNCORRECTABLE is supported [Editors Note: use of supported is on purpose]
		B	F	1 1 = Write Read Verify feature set is enabled
		P	F	0 Reserved for DT2014
121-126			F	Reserved for expanded supported and enabled settings
127	O			Removable Media Status Notification feature set support
		B	F	15:2 Reserved
		B	F	1:0 00 = Removable Media Status Notification feature set not supported 01 = Removable Media Status Notification feature supported 10 = Reserved 11 = Reserved
128	O			Security status
			F	15:9 Reserved
		B	V	8 Security level 0 = High, 1 = Maximum
			F	7:6 Reserved
		B	F	5 1 = Enhanced security erase supported
		B	V	4 1 = Security count expired
		B	V	3 1 = Security frozen
		B	V	2 1 = Security locked
		B	V	1 1 = Security enabled
		B	F	0 1 = Security supported
129-159			X	Vendor specific

Table 12 - IDENTIFY DEVICE data

Word	O/M	S/P	F/V	Description
160	O			CFA power mode 1
			F	15 Word 160 supported
			F	14 Reserved
		N	F	13 CFA power mode 1 is required for one or more commands implemented by the device
		N	V	12 CFA power mode 1 disabled
		N	F	11:0 Maximum current in ma
161-175			X	Reserved for assignment by the CompactFlash™ Association
176-205	O	B	V	Current media serial number (60 ASCII characters)
206	O	B		SCT Command Transport
				15:12 Vendor Specific
				11:6 Reserved
				5 SCT Command Transport Data Tables supported
				4 SCT Command Transport Features Control supported
				3 SCT Command Transport Error Recovery Control supported
				2 SCT Command Transport Write Same supported
				1 SCT Command Transport Long Sector Access supported
				0 SCT Command Transport supported
207-208			F	Reserved for CE-ATA.
209	O		F	Alignemtn of logical blocks within a larger physical block
				15 Shall be cleared to zero
				14 Shall be set to one
		B		13:0 'Logical sector' offset within the first physical sector where the first logical sector is placed.
210-211	O	B	V	Write Read Verify Sector Count Mode 3 Only
212-213	O	B	F	Verify Sector Count Mode 2 Only
214	O		F	Reserved for e05106
		B		15:12 NV Cache Command Version
		B		11:8 NV Cache Power Management Mode Version
				7:0 Reserved
215-221	O		F	Reserved for e05106
222	M		F	Transport major version number. 0000h or FFFFh = device does not report version
		B		15:12 Transport Type – 0 = Parallel, 1 = Serial, 2-16 = Reserved
				Parallel (Type = 0) / Serial (Type = 1)
		S		11:4 Reserved / Reserved
		S		3 Reserved / SATA Rev 2.5
		S		2 Reserved / SATA II: Extensions
		S		1 Reserved / SATA 1.0a
		P		0 ATA8-APT / ATA8-AST
223	M	B	F	Transport minor version number
				0000h Device does not report minor version
				0001h-FFFEh See Table 14
				FFFFh Device does not report minor version
224-233			F	Reserved for CE-ATA
234-254				Reserved
255	M		X	Integrity word
		B		15:8 Checksum
		B		7:0 Signature

Key:
O/M – Mandatory/optional requirement.
M – Support of the word is mandatory.
O – Support of the word is optional.
* = See 7.17.7.65.
F/V – Fixed/variable content
F – The content of the field is fixed and does not change. For removable media devices, these values may change when media is removed or changed. **[Editors note: Isn't this the definition of variable?]**
V – The contents of the field is variable and may change depending on the state of the device or

S/P – Content applies to Serial or Parallel transport
S – Serial Transport
P – Parallel Transport
B – Both Serial and Parallel Transports
N – Belongs to a transport other than Serial or Parallel

Table 12 - IDENTIFY DEVICE data

Word	O/M	S/P	F/V	Description
the commands executed by the device. X – The content of the field may be fixed or variable.				

7.17.7.1 Word 0: General configuration

Devices that conform to this standard shall clear bit 15 to zero.

If bit 7 is set to one, the device is a removable media device.

Bit 6 is obsolete.

If bit 2 is set to one it indicates that the content of the IDENTIFY DEVICE data is incomplete. This will occur if the device supports the Power-up in Standby feature set and required data is contained on the device media. In this case the content of at least word 0 and word 2 shall be valid.

Devices supporting the CFA feature set shall place the value 848Ah in word 0. In this case, the above definitions for the bits in word 0 are not valid.

7.17.7.2 Word 1: Obsolete

7.17.7.3 Word 2: Specific configuration.

Word 2 shall be set as follows:

Value	Description
37C8h	Device requires SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is incomplete (See 4.12).
738Ch	Device requires SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is complete (See 4.12).
8C73h	Device does not require SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is incomplete (See 4.12).
C837h	Device does not require SET FEATURES subcommand to spin-up after power-up and IDENTIFY DEVICE data is complete (See 4.12).
All other values	Reserved.

7.17.7.4 Word 3: Obsolete

7.17.7.5 Word (5:4): Retired.

7.17.7.6 Word 6: Obsolete

7.17.7.7 Words (8:7): Reserved for assignment by the CompactFlash™ Association

7.17.7.8 Word 9: Retired.

7.17.7.9 Words (19:10): Serial number

This field contains the serial number of the device. The contents of this field is an ASCII character string of twenty bytes. The device shall pad the character string with spaces (20h), if necessary, to ensure that the string is the proper length. The combination of Serial number (words (19:10)) and Model number (words (46:27)) shall be unique for a given manufacturer (See 3.2.7).

7.17.7.10 Word (21:20): Retired.

7.17.7.11 Word 22: Obsolete.

7.17.7.12 Word (26:23): Firmware revision
This field contains the firmware revision number of the device. The contents of this field is an ASCII character string of eight bytes. The device shall pad the character string with spaces (20h), if necessary, to ensure that the string is the proper length (See 3.2.7).

7.17.7.13 Words (46:27): Model number
This field contains the model number of the device. The contents of this field is an ASCII character string of forty bytes. The device shall pad the character string with spaces (20h), if necessary, to ensure that the string is the proper length. The combination of Serial number (words (19:10)) and Model number (words (46:27)) shall be unique for a given manufacturer (See 3.2.7).

7.17.7.14 Word 47: READ/WRITE MULTIPLE support.
Bits (7:0) of this word define the maximum number of logical sectors per DRQ data block that the device supports for READ/WRITE MULTIPLE commands. If the serial interface **[Editors Note: Should we just say SATA here?]** is implemented, this field shall be set to 16 or less.

7.17.7.15 Word 48: Reserved.

7.17.7.16 Word (50:49): Capabilities
Bits (15:14) of word 49 are reserved for use in the IDENTIFY PACKET DEVICE command data.

Bit 13 of word 49 is used to determine whether a device uses the Standby timer values as defined in this standard. Table 16 specifies the Standby timer values used by the device if bit 13 is set to one. If bit 13 is cleared to zero, the timer values shall be vendor specific.

Bit 12 of word 49 is reserved for use in the IDENTIFY PACKET DEVICE command data.

Bit 11 of word 49 indicates whether a device supports IORDY. If this bit is set to one, then the device supports IORDY operation. All devices except CFA and PCMCIA devices shall support PIO mode 3 or higher, shall support IORDY, and shall set this bit to one. If the serial interface is implemented, this bit shall be set to one.

Bit 10 of word 49 is used to indicate a device's ability to enable or disable the use of IORDY. If this bit is set to one, then the device supports the disabling of IORDY. Disabling and enabling of IORDY is accomplished using the SET FEATURES command. If the serial interface is implemented, this bit shall be set to one.

Bit 9 of word 49 shall be set to one to indicate that an LBA transition is supported.

Bits 8 of word 49 Shall be set to one to indicate that DMA is supported. For devices not implementing the CompactFlash feature set this bit shall be set to one.

Bits (7:0) of word 49 are retired.

Bit 15 of word 50 shall be cleared to zero to indicate that the contents of word 50 are valid.

Bit 14 of word 50 shall be set to one to indicate that the contents of word 50 are valid.

Bits (13:2) of word 50 are reserved.

Bit 1 of word 50 is obsolete.

Bit 0 of word 50 set to one indicates that the device has a minimum Standby timer value that is device specific.

7.17.7.17 Words (52:51): Obsolete

7.17.7.18 Word 53: Field validity
Bit 0 of word 53 is obsolete.

If bit 1 of word 53 is set to one, the values reported in words (70:64) are valid. If this bit is cleared to zero, the values reported in words (70:64) are not valid. All devices except CFA and PCMCIA devices shall support PIO mode 3 or above and shall set bit 1 of word 53 to one and support the fields contained in words (70:64). If the serial interface is implemented, this bit shall be set to one.

If the device supports Ultra DMA and the values reported in word 88 are valid, then bit 2 of word 53 shall be set to one. If the device does not support Ultra DMA and the values reported in word 88 are not valid, then this bit is cleared to zero. If the serial interface is implemented, this bit shall be set to one.

7.17.7.19 Word (58:54): Obsolete

7.17.7.20 Word 59: Multiple sector setting

If bit 8 is set to one, bits (7:0) reflect the number of logical sectors currently set to transfer on a READ/WRITE MULTIPLE command. This field may default to the preferred value for the device (See 7.54).

7.17.7.21 Word (61:60): Total number of user addressable sectors

This field contains a value that is one greater than the maximum user accessable logical block address (See 4.2). The maximum value that shall be placed in this field is 0FFFFFFFh.

7.17.7.22 Word 62: Obsolete

7.17.7.23 Word 63: Multiword DMA transfer

Word 63 identifies the Multiword DMA transfer modes supported by the device and indicates the mode that is currently selected. Only one DMA mode shall be selected at any given time. If an Ultra DMA mode is enabled, then no Multiword DMA mode shall be enabled. If a Multiword DMA mode is enabled then no Ultra DMA mode shall be enabled.

7.17.7.24 Reserved

Bits (15:11) of word 63 are reserved.

7.17.7.25 Multiword DMA mode 2 selected

If bit 10 of word 63 is set to one, then Multiword DMA mode 2 is selected. If this bit is cleared to zero, then Multiword DMA mode 2 is not selected. If bit 9 is set to one or if bit 8 is set to one, then this bit shall be cleared to zero.

7.17.7.26 Multiword DMA mode 1 selected

If bit 9 of word 63 is set to one, then Multiword DMA mode 1 is selected. If this bit is cleared to zero then Multiword DMA mode 1 is not selected. If bit 10 is set to one or if bit 8 is set to one, then this bit shall be cleared to zero.

7.17.7.27 Multiword DMA mode 0 selected

If bit 8 of word 63 is set to one, then Multiword DMA mode 0 is selected. If this bit is cleared to zero then Multiword DMA mode 0 is not selected. If bit 10 is set to one or if bit 9 is set to one, then this bit shall be cleared to zero.

7.17.7.28 Reserved

Bits (7:3) of word 63 are reserved.

7.17.7.29 Multiword DMA mode 2 supported

If bit 2 of word 63 is set to one, then Multiword DMA modes 2 and below are supported. If this bit is cleared to zero, then Multiword DMA mode 2 is not supported. If Multiword DMA mode 2 is supported, then Multiword DMA modes 1 and 0 shall also be supported. If this bit is set to one, bits (1:0) shall be set to one. If the serial interface is implemented, this bit shall be set to one.

7.17.7.30 Multiword DMA mode 1 supported

If bit 1 of word 63 is set to one, then Multiword DMA modes 1 and below are supported. If this bit is cleared to zero, then Multiword DMA mode 1 is not supported. If Multiword DMA mode 1 is supported, then Multiword DMA mode 0 shall also be supported. If this bit is set to one, bit 0 shall be set to one. If the serial interface is implemented, this bit shall be set to one.

7.17.7.31 Multiword DMA mode 0 supported

If bit 0 of word 63 is set to one, then Multiword DMA mode 0 is supported. If the serial interface is implemented, this bit shall be set to one.

7.17.7.32 Word 64: PIO transfer modes supported

Bits (7:0) of word 64 of the IDENTIFY DEVICE data is defined as the PIO data and register transfer supported field. If this field is supported, bit 1 of word 53 shall be set to one. This field is bit significant. Any number of bits may be set to one in this field by the device to indicate the PIO modes the device is capable of supporting.

Of these bits, bits (7:2) are Reserved for future PIO modes. Bit 0, if set to one, indicates that the device supports PIO mode 3. All devices except CFA and PCMCIA devices shall support PIO mode 3 and shall set bit 0 to one. Bit 1, if set to one, indicates that the device supports PIO mode 4. If the serial interface is implemented, bits (1:0) shall be set to one.

7.17.7.33 Word 65: Minimum Multiword DMA transfer cycle time per word

Word 65 of the parameter information of the IDENTIFY DEVICE command data is defined as the minimum Multiword DMA transfer cycle time per word. This field defines, in nanoseconds, the minimum cycle time that the device supports when performing Multiword DMA transfers on a per word basis. If the serial interface is implemented, this value shall be set to indicate 120 ns.

If this field is supported, bit 1 of word 53 shall be set to one. Any device that supports Multiword DMA mode 1 or above shall support this field, and the value in word 65 shall not be less than the minimum cycle time for the fastest DMA mode supported by the device.

If bit 1 of word 53 is set to one because a device supports a field in words (70:64) other than this field and the device does not support this field, the device shall return a value of zero in this field.

7.17.7.34 Word 66: Device recommended Multiword DMA cycle time

Word 66 of the parameter information of the IDENTIFY DEVICE command data is defined as the device recommended Multiword DMA transfer cycle time. This field defines, in nanoseconds, the minimum cycle time per word during a single logical sector host transfer while performing a multiple logical sector READ DMA or WRITE DMA command for any location on the media under nominal conditions. If a host runs at a faster cycle rate by operating at a cycle time of less than this value, the device may negate DMARQ for flow control. The rate at which DMARQ is negated could result in reduced throughput despite the faster cycle rate. Transfer at this rate does not ensure that flow control will not be used, but implies that higher performance may result. If the serial interface is implemented, this value shall be set to indicate 120 ns.

If this field is supported, bit 1 of word 53 shall be set to one. Any device that supports Multiword DMA mode 1 or above shall support this field, and the value in word 66 shall not be less than the value in word 65.

If bit 1 of word 53 is set to one because a device supports a field in words (70:64) other than this field and the device does not support this field, the device shall return a value of zero in this field.

7.17.7.35 Word 67: Minimum PIO transfer cycle time without IORDY flow control

Word 67 of the parameter information of the IDENTIFY DEVICE command data is defined as the minimum PIO transfer without IORDY flow control cycle time. This field defines, in nanoseconds, the minimum cycle time that, if used by the host, the device guarantees data integrity during the transfer without utilization of IORDY flow control. If the serial interface is implemented, this value shall be set to indicate 120 ns.

If this field is supported, Bit 1 of word 53 shall be set to one.

Any device that supports PIO mode 3 or above shall support this field, and the value in word 67 shall not be less than the value reported in word 68.

If bit 1 of word 53 is set to one because a device supports a field in words (70:64) other than this field and the device does not support this field, the device shall return a value of zero in this field.

7.17.7.36 Word 68: Minimum PIO transfer cycle time with IORDY flow control

Word 68 of the parameter information of the IDENTIFY DEVICE command data is defined as the minimum PIO transfer with IORDY flow control cycle time. This field defines, in nanoseconds, the minimum cycle time that the device supports while performing data transfers while utilizing IORDY flow control. If the serial interface is implemented, this value shall be set to indicate 120 ns.

If this field is supported, Bit 1 of word 53 shall be set to one.

All devices except CFA and PCMCIA devices shall support PIO mode 3 and shall support this field, and the value in word 68 shall be the fastest defined PIO mode supported by the device. The maximum value reported in this field shall be 180 to indicate support for PIO mode 3 or above.

If bit 1 of word 53 is set to one because a device supports a field in words (70:64) other than this field and the device does not support this field, the device shall return a value of zero in this field.

7.17.7.37 Words (74:69): Reserved

7.17.7.38 Word 75: Queue depth

Bits (4:0) of word 75 indicate the maximum queue depth supported by the device. The queue depth includes all commands for which command acceptance has occurred and command completion has not occurred. The value in this field equals (maximum queue depth - 1), e.g., a value of zero indicates a queue depth of one, a value of 31 indicates a queue depth of 32. If bit 1 of word 83 is cleared to zero indicating that the device does not support READ/WRITE DMA QUEUED commands, the value in this field shall be zero. A device may support READ/WRITE DMA QUEUED commands to provide overlap only (i.e., queuing not supported), in this case, bit 1 of word 83 shall be set to one and the queue depth shall be set to zero. Support of this word is mandatory if the Queuing feature set is supported.

7.17.7.39 Words (79:76): Reserved for Serial ATA

7.17.7.40 Word 80: Major version number

If not 0000h or FFFFh, the device claims compliance with the major version(s) as indicated by bits (6:3) being set to one. Values other than 0000h and FFFFh are bit significant. Since ATA standards maintain downward compatibility, a device may set more than one bit.

7.17.7.41 Word 81: Minor version number

If an implementor claims that the revision of the standard they used to guide their implementation does not need to be reported or if the implementation was based upon a standard prior to the ATA-3 standard, word 81 shall be 0000h or FFFFh.

Table 13 defines the value that may optionally be reported in word 81 to indicate the revision of the standard that guided the implementation.

Table 13 - Minor version number

Value	Minor revision
0001h	Obsolete
0002h	Obsolete
0003h	Obsolete
0004h	Obsolete
0005h	Obsolete
0006h	Obsolete
0007h	Obsolete
0008h	Obsolete
0009h	Obsolete
000Ah	Obsolete
000Bh	Obsolete
000Ch	Obsolete
000Dh	ATA/ATAPI-4 X3T13 1153D revision 6
000Eh	ATA/ATAPI-4 T13 1153D revision 13
000Fh	ATA/ATAPI-4 X3T13 1153D revision 7
0010h	ATA/ATAPI-4 T13 1153D revision 18
0011h	ATA/ATAPI-4 T13 1153D revision 15
0012h	ATA/ATAPI-4 published, ANSI INCITS 317-1998
0013h	ATA/ATAPI-5 T13 1321D revision 3
0014h	ATA/ATAPI-4 T13 1153D revision 14
0015h	ATA/ATAPI-5 T13 1321D revision 1
0016h	ATA/ATAPI-5 published, ANSI INCITS 340-2000
0017h	ATA/ATAPI-4 T13 1153D revision 17
0018h	ATA/ATAPI-6 T13 1410D revision 0
0019h	ATA/ATAPI-6 T13 1410D revision 3a
001Ah	ATA/ATAPI-7 T13 1532D revision 1
001Bh	ATA/ATAPI-6 T13 1410D revision 2
001Ch	ATA/ATAPI-6 T13 1410D revision 1
001Dh	ATA/ATAPI-7 published ANSI INCITS 397-2005.
001Eh	ATA/ATAPI-7 T13 1532D revision 0
001Fh	Reserved
0020h	Reserved
0021h	ATA/ATAPI-7 T13 1532D revision 4a
0022h	ATA/ATAPI-6 published, ANSI INCITS 361-2002
0023h-FFFFh	Reserved

7.17.7.42 Words (84:82): Features/command sets supported

Words 84:82 and 119 shall indicate features/command sets supported. If a defined bit is cleared to zero, the indicated features/command set is not supported. If bit 14 of word 83 is set to one and bit 15 of word 83 is cleared to zero, the contents of words (83:82) contain valid support information. If not, support information is not valid in these words. If bit 14 of word 84 is set to one and bit 15 of word 84 is cleared to zero, the contents of word 84 contains valid support information. If not, support information is not valid in this word. If bit 14 of word 119 is set to one and bit 15 of word 119 is cleared to zero, the contents of word 119 contains valid support information. If not, support information is not valid in this word.

If bit 0 of word 82 is set to one, the SMART feature set is supported.

If bit 1 of word 82 is set to one, the Security Mode feature set is supported.

If bit 2 of word 82 is set to one, the Removable Media feature set is supported.

Bit 3 of word 82 shall be set to one indicating the mandatory Power Management feature set is supported.

Bit 4 of word 82 shall be cleared to zero to indicate that the PACKET Command feature set is not supported.

If bit 5 of word 82 is set to one, write cache is supported.

If bit 6 of word 82 is set to one, look-ahead is supported.

If bit 7 of word 82 is set to one, release interrupt is supported.

If bit 8 of word 82 is set to one, SERVICE interrupt is supported.

If bit 9 of word 82 is set to one, the DEVICE RESET command is supported.

If bit 10 of word 82 is set to one, the Host Protected Area feature set is supported.

Bit 11 of word 82 is obsolete.

If bit 12 of word 82 is set to one, the device supports the WRITE BUFFER command.

If bit 13 of word 82 is set to one, the device supports the READ BUFFER command.

If bit 14 of word 82 is set to one, the device supports the NOP command.

Bit 15 of word 82 is obsolete.

If bit 0 of word 83 is set to one, the device supports the DOWNLOAD MICROCODE command.

If bit 1 of word 83 is set to one, the device supports the READ DMA QUEUED and WRITE DMA QUEUED commands.

If bit 2 of word 83 is set to one, the device supports the CFA feature set.

If bit 3 of word 83 is set to one, the device supports the Advanced Power Management feature set.

If bit 4 of word 83 is set to one, the device supports the Removable Media Status feature set.

If bit 5 of word 83 is set to one, the device supports the Power-Up In Standby feature set.

If bit 6 of word 83 is set to one, the device requires the SET FEATURES subcommand to spin-up after power-up if the Power-Up In Standby feature set is enabled (See 7.51.8).

Bit 7 is defined in Address Offset Reserved Area Boot, INCITS TR27:2001.

If bit 8 of word 83 is set to one, the device supports the SET MAX security extension.

If bit 9 of word 83 is set to one, the device supports the Automatic Acoustic Management feature set.

If bit 10 of word 83 is set to one, the 48-bit Address feature set is supported.

If bit 11 of word 83 is set to one, the device supports the Device Configuration Overlay feature set.

Bit 12 of word 83 shall be set to one indicating the device supports the mandatory FLUSH CACHE command.

If bit 13 of word 83 is set to one, the device supports the FLUSH CACHE EXT command.

If bit 0 of word 84 is set to one, the device supports SMART error logging.

If bit 1 of word 84 is set to one, the device supports SMART self-test.

If bit 2 of word 84 is set to one, the device supports the media serial number field words (205:176).

If bit 3 of word 84 is set to one, the device supports the Media Card Pass Through Command feature set.

If bit 4 of word 84 is set to one, the device supports the Streaming feature set.

If bit 5 of word 84 is set to one, the device supports the General Purpose Logging feature set.

If bit 6 of word 84 is set to one, the device supports the WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands.

If bit 7 of word 84 is set to one, the device supports the WRITE DMA QUEUED FUA EXT command.

If bit 8 of word 84 is set to one, the device supports a world wide name.

Bit 11 of word 84 is reserved for technical report-

Bit 12 of word 84 is reserved for technical report-

If bit 13 of word 84 is set to one, the device supports IDLE IMMEDIATE with UNLOAD FEATURE.

Bit 0 of word 119 is reserved for technical report.

If bit 1 of word 119 is set to one, the device supports the Write-Read-Verify feature set

If bit 2 of word 119 is set to one, the device supports the WRITE UNCORRECTAB LE command

If bit 3 of word 119 is set to one, READ and WRITE DMA EXT GPL optional commands are supported

7.17.7.43 Words (87:85): Features/command sets enabled

Words 87:85 and 120 shall indicate features/command sets enabled. If a defined bit is cleared to zero, the indicated features/command set is not enabled. If a supported features/command set is supported and cannot be disabled, it is defined as supported and the bit shall be set to one. If bit 14 of word 87 is set to one and bit 15 of word 87 is cleared to zero, the contents of words (87:85) contain valid information. If bit 14 of word 120 is set to one and bit 15 of word 120 is cleared to zero, the contents of word 120 contain valid information. If not, information is not valid in these words.

If bit 0 of word 85 is set to one, the SMART feature set has been enabled via the SMART ENABLE OPERATIONS command. If bit 0 of word 85 is cleared to zero, the SMART feature set has been disabled via the SMART DISABLE OPERATIONS command.

If bit 1 of word 85 is set to one, the Security Mode feature set has been enabled via the SECURITY SET PASSWORD command. If bit 1 of word 85 is cleared to zero, the Security Mode feature set has been disabled via the SECURITY DISABLE PASSWORD command.

If bit 2 of word 85 is set to one, the Removable Media feature set is supported.

Bit 3 of word 85 shall be set to one indicating the mandatory Power Management feature set is supported.

Bit 4 of word 85 shall be cleared to zero to indicate that the PACKET Command feature set is not supported.

If bit 5 of word 85 is set to one, write cache has been enabled via the SET FEATURES command (See 7.51.4). If bit 5 of word 85 is cleared to zero, write cache has been disabled via the SET FEATURES command.

If bit 6 of word 85 is set to one, look-ahead has been enabled via the SET FEATURES command (See 7.51.14). If bit 6 of word 85 is cleared to zero, look-ahead has been disabled via the SET FEATURES command.

If bit 7 of word 85 is set to one, release interrupt has been enabled via the SET FEATURES command (See 7.51.15). If bit 7 of word 85 is cleared to zero, release interrupt has been disabled via the SET FEATURES command.

If bit 8 of word 85 is set to one, SERVICE interrupt has been enabled via the SET FEATURES command (See 7.51.16). If bit 8 of word 85 is cleared to zero, SERVICE interrupt has been disabled via the SET FEATURES command.

If bit 9 of word 85 is set to one, the DEVICE RESET command is supported.

If bit 10 of word 85 is set to one, the Host Protected Area feature set is supported. [Editors Note: Should we say when SETMAX is issued to resize the drive, this shall be set to one. If the device is indicating its full size as defined by read native max then this bt shall be set to zero.]

Bit 11 of word 85 is obsolete.

If bit 12 of word 85 is set to one, the device supports the WRITE BUFFER command.

If bit 13 of word 85 is set to one, the device supports the READ BUFFER command.

If bit 14 of word 85 is set to one, the device supports the NOP command.

Bit 15 of word 85 is obsolete.

If bit 0 of word 86 is set to one, the device supports the DOWNLOAD MICROCODE command.

If bit 1 of word 86 is set to one, the device supports the READ DMA QUEUED and WRITE DMA QUEUED commands.

If bit 2 of word 86 is set to one, the device supports the CFA feature set.

If bit 3 of word 86 is set to one, the Advanced Power Management feature set has been enabled via the SET FEATURES command. If bit 3 of word 86 is cleared to zero, the Advanced Power Management feature set has been disabled via the SET FEATURES command.

If bit 4 of word 86 is set to one, the Removable Media Status feature set has been enabled via the SET FEATURES command. If bit 4 of word 86 is cleared to zero, the Removable Media Status feature set has been disabled via the SET FEATURES command.

If bit 5 of word 86 is set to one, the Power-Up In Standby feature set has been enabled via the SET FEATURES command (See 7.51.7). If bit 5 of word 86 is cleared to zero, the Power-Up In Standby feature set has been disabled via the SET FEATURES command

If bit 6 of word 86 is set to one, the device requires the SET FEATURES subcommand to spin-up after power-up (See 7.51.8).

Bit 7 of word 86 is defined in Address Offset Reserved Area Boot, INCITS TR27:2001.

If bit 8 of word 86 is set to one, the device has had the SET MAX security extension enabled via a SET MAX SET PASSWORD command.

If bit 9 of word 86 is set to one, the device has had the Automatic Acoustic Management feature set enabled via a SET FEATURES command and the value in word 94 is valid.

If bit 10 of word 86 is set to one, the 48-bit Address feature set is supported.

If bit 11 of word 86 is set to one, the device supports the Device Configuration Overlay feature set.

Bit 12 of word 86 shall be set to oneindicating the device supports the mandatory FLUSH CACHE command. [Editors Note: This command is mandatory, the is no disable for Flush Cache. IF this bit is 1, the bit 12 of 83 shall be set to one. Also change words 83 bit 12. Also add verbage to all bits that supported]

If bit 13 of word 86 is set to one, the device supports the FLUSH CACHE EXT command.

If bit 0 of word 87 is set to one, the device supports SMART error logging.

If bit 1 of word 87 is set to one, the device supports SMART self-test.

If bit 2 of word 87 is set to one, the media serial number field in words (205:176) is valid. This bit shall be cleared to zero if the media does not contain a valid serial number or if no media is present.

If bit 3 of word 87 is set to one, the Media Card Pass Through feature set has been enabled.

If bit 5 of word 87 is set to one, the device supports the General Purpose Logging feature set.

If bit 6 of word 87 is set to one, the device supports the WRITE DMA FUA EXT and WRITE MULTIPLE FUA EXT commands.

If bit 7 of word 87 is set to one, the device supports the WRITE DMA QUEUED FUA EXT command.

If bit 8 of word 87 is set to one, the device supports a world wide name.

Bit 11 of word 87 is reserved for technical report.

Bit 12 of word 87 is reserved for technical report.

If bit 13 of word 87 is set to one, the device supports IDLE IMMEDIATE with UNLOAD FEATURE.

Bit 0 of word 120 is reserved for technical report

If bit 1 of word 120 is set to one then the Write-Read-Verify feature set is enabled

If bit 2 of word 120 is set to one then the WRITE UNCORRECTABLE command is supported

If bit 3 of word 120 is set to one, READ and WRITE DMA EXT GPL optional commands are supported

7.17.7.44 Word 88: Ultra DMA modes

Word 88 identifies the Ultra DMA transfer modes supported by the device and indicates the mode that is currently selected. Only one DMA mode shall be selected at any given time. If an Ultra DMA mode is selected, then no Multiword DMA mode shall be selected. If a Multiword DMA mode is selected, then no Ultra DMA mode shall be selected. Support of this word is mandatory if Ultra DMA is supported.

7.17.7.45 Reserved
Bit (15) of word 88 is reserved.

7.17.7.46 Ultra DMA mode 6 selected
If bit 14 of word 88 is set to one, then Ultra DMA mode 6 is selected. If this bit is cleared to zero, then Ultra DMA mode 6 is not selected. If bit 13 or bit 12 or bit 11 or bit 10 or bit 9 or bit 8 is set to one, then this bit shall be cleared to zero.

7.17.7.47 Ultra DMA mode 5 selected
If bit 13 of word 88 is set to one, then Ultra DMA mode 5 is selected. If this bit is cleared to zero, then Ultra DMA mode 5 is not selected. If bit 12 or bit 11 or bit 10 or bit 9 or bit 8 is set to one, then this bit shall be cleared to zero.

7.17.7.48 Ultra DMA mode 4 selected
If bit 12 of word 88 is set to one, then Ultra DMA mode 4 is selected. If this bit is cleared to zero, then Ultra DMA mode 4 is not selected. If bit 13 or 11 or bit 10 or bit 9 or bit 8 is set to one, then this bit shall be cleared to zero.

7.17.7.49 Ultra DMA mode 3 selected
If bit 11 of word 88 is set to one, then Ultra DMA mode 3 is selected. If this bit is cleared to zero, then Ultra DMA mode 3 is not selected. If bit 13 or 12 or bit 10 or bit 9 or bit 8 is set to one, then this bit shall be cleared to zero.

7.17.7.50 Ultra DMA mode 2 selected
If bit 10 of word 88 is set to one, then Ultra DMA mode 2 is selected. If this bit is cleared to zero, then Ultra DMA mode 2 is not selected. If bit 13 or 12 or bit 11 or bit 9 or bit 8 is set to one, then this bit shall be cleared to zero.

7.17.7.51 Ultra DMA mode 1 selected
If bit 9 of word 88 is set to one, then Ultra DMA mode 1 is selected. If this bit is cleared to zero then Ultra DMA mode 1 is not selected. If bit 13 or 12 or bit 11 or bit 10 or bit 8 is set to one, then this bit shall be cleared to zero.

7.17.7.52 Ultra DMA mode 0 selected
If bit 8 of word 88 is set to one, then Ultra DMA mode 0 is selected. If this bit is cleared to zero then Ultra DMA mode 0 is not selected. If bit 13 or 12 or bit 11 or bit 10 or bit 9 is set to one, then this bit shall be cleared to zero.

7.17.7.53 Reserved
Bit (7) of word 88 are reserved.

7.17.7.54 Ultra DMA mode 6 supported
If bit 6 of word 88 is set to one, then Ultra DMA modes 6 and below are supported. If this bit is cleared to zero, then Ultra DMA mode 6 is not supported. If Ultra DMA mode 6 is supported, then Ultra DMA modes 5, 4, 3, 2, 1 and 0 shall also be supported. If this bit is set to one, then bits (5:0) shall be set to one. If the serial interface is implemented, this bit shall be set to one.

7.17.7.55 Ultra DMA mode 5 supported
If bit 5 of word 88 is set to one, then Ultra DMA modes 5 and below are supported. If this bit is cleared to zero, then Ultra DMA mode 5 is not supported. If Ultra DMA mode 5 is supported, then Ultra DMA modes 4, 3, 2, 1 and 0 shall also be supported. If this bit is set to one, then bits (4:0) shall be set to one. If the serial interface is implemented, this bit shall be set to one.

7.17.7.56 Ultra DMA mode 4 supported
If bit 4 of word 88 is set to one, then Ultra DMA modes 4 and below are supported. If this bit is cleared to zero, then Ultra DMA mode 4 is not supported. If Ultra DMA mode 4 is supported, then Ultra DMA modes 3, 2, 1 and 0 shall also be supported. If this bit is set to one, then bits (3:0) shall be set to one. If the serial interface is implemented, this bit shall be set to one.

7.17.7.57 Ultra DMA mode 3 supported
If bit 3 of word 88 is set to one, then Ultra DMA modes 3 and below are supported. If this bit is cleared to zero, then Ultra DMA mode 3 is not supported. If Ultra DMA mode 3 is supported, then Ultra DMA modes 2, 1 and 0 shall also be supported. If this bit is set to one, then bits (2:0) shall be set to one. If the serial interface is implemented, this bit shall be set to one.

7.17.7.58 Ultra DMA mode 2 supported

If bit 2 of word 88 is set to one, then Ultra DMA modes 2 and below are supported. If this bit is cleared to zero, then Ultra DMA mode 2 is not supported. If Ultra DMA mode 2 is supported, then Ultra DMA modes 1 and 0 shall also be supported. If this bit is set to one, bits (1:0) shall be set to one. If the serial interface is implemented, this bit shall be set to one.

7.17.7.59 Ultra DMA mode 1 supported

If bit 1 of word 88 is set to one, then Ultra DMA modes 1 and below are supported. If this bit is cleared to zero, then Ultra DMA mode 1 is not supported. If Ultra DMA mode 1 is supported, then Ultra DMA mode 0 shall also be supported. If this bit is set to one, bit 0 shall be set to one. If the serial interface is implemented, this bit shall be set to one.

7.17.7.60 Ultra DMA mode 0 supported

If bit 0 of word 88 is set to one, then Ultra DMA mode 0 is supported. If this bit is cleared to zero, then Ultra DMA is not supported. If the serial interface is implemented, this bit shall be set to one.

7.17.7.61 Word 89: Time required for Security erase unit completion

Word 89 specifies the time required for the SECURITY ERASE UNIT command to complete. Support of this word is mandatory if the Security feature set is supported.

Value	Time
0	Value not specified
1-254	(Value∗2) minutes
255	>508 minutes

7.17.7.62 Word 90: Time required for Enhanced security erase unit completion

Word 90 specifies the time required for the ENHANCED SECURITY ERASE UNIT command to complete. Support of this word is mandatory if support of the Enhanced Security feature set is supported.

Value	Time
0	Value not specified
1-254	(Value∗2) minutes
255	>508 minutes

7.17.7.63 Word 91: Advanced power management level value

Bits (7:0) of word 91 contain the current Advanced Power Management level setting. Support of this word is mandatory if advanced power management is supported.

7.17.7.64 Word 92: Master Password Revision Code

Word 92 contains the value of the Master Password Revision Code set when the Master Password was last changed. Valid values are 0001h through FFFEh. A value of 0000h or FFFFh indicates that the Master Password Revision is not supported. Support of this word is mandatory if the Security feature set is supported.

7.17.7.65 Word 93: Hardware configuration test results

If bit 14 of word 93 is set to one and bit 15 of word 93 is cleared to zero, the content of word 93 contains valid information. During hardware reset execution, Device 0 shall clear bits (12:8) of this word to zero and shall set bits (7:0) of the word as indicated to show the result of the hardware reset execution. During hardware reset execution, Device 1 shall clear bits (7:0) of this word to zero and shall set bits (12:8) as indicated to show the result of the hardware reset execution. Support of bits (15:13) are mandatory. Support of bits (12:0) is optional.

Bit 13 shall be set or cleared by the selected device to indicate whether the device detected CBLID- above V_{IH} or below V_{IL} at any time during execution of each IDENTIFY DEVICE routine after receiving the command from the host but before returning data to the host. This test may be repeated as desired by the device during command execution (See Volume 2, annex A).

If the serial interface is implemented, word 93 shall be set to the value 0000h.

7.17.7.66 Word 94: Current automatic acoustic management value

Bits (15:8) contain the device vendor's recommended acoustic management level (See Table 38 for an enumeration of all of the possible acoustic management levels). If the host desires the drive to perform with highest performance, it should set the automatic acoustic management level to Feh. If the OEM host desires the vendor's recommended acoustic management level as defined by the device's vendor, the host should set the automatic acoustic management level to the value returned to the host in these 8 bits of the IDENTIFY DEVICE data. The use of this setting may not provide the lowest acoustics, or the best tradeoff of acoustics and performance, in all configurations. Support of this word is mandatory if the Acoustic Management feature set is supported.

Bits (7:0) contain the current automatic acoustic management level. If the Automatic Acoustic Management feature set is supported by the device, but the level has not been set by the host, this byte shall contain the drive's default setting. If the Automatic Acoustic Management feature set is not supported by the device, the value of this byte shall be zero.

7.17.7.67 Word 95: Stream Minimum Request Size

Number of logical sectors that provides optimum performance in a streaming environment. This number shall be a power of two, with a minimum of eight logical sectors (4096 bytes). The starting LBA value for each streaming command should be evenly divisible by this request size.

7.17.7.68 Word 96: Streaming Transfer Time -- DMA

Word 96 defines the Streaming Transfer Time for DMA mode. The worst-case sustainable transfer time per logical sector for the device is calculated as follows:

$$\text{Streaming Transfer Time} = (\text{word } 96) * (\text{words } (99:98) / 65536)$$

The content of IDENTIFY DEVICE data word 96 may be affected by the host issuing a SET FEATURES subcommand 43h (Typical Host Interface Sector Time for DMA mode). Because of this effect, an IDENTIFY DEVICE command shall be issued after a SET FEATURES command that may affect these words. If the Streaming Feature Set is not supported by the device, the content of word 96 shall be zero.

7.17.7.69 Word 97: Streaming Access Latency - DMA and PIO

Word 97 defines the Streaming Access Latency for DMA and PIO mode. The worst-case access latency of the device for a streaming command is calculated as follows:

$$\text{Access Latency} = (\text{word } 97) * (\text{words } (99:98) / 256)$$

The content of IDENTIFY DEVICE data word 97 may be affected by the host issuing a SET FEATURES subcommand 42h or C2h (Automatic Acoustic Management). Because of this effect, an IDENTIFY DEVICE command shall be issued after a SET FEATURES command that may affect these words. If the Streaming Feature Set is not supported by the device, the content of word 97 shall be zero.

7.17.7.70 Words (99:98): Streaming Performance Granularity

These words define the fixed unit of time that is used in IDENTIFY DEVICE data words (97:96) and (104), and SET FEATURES subcommand 43h, and in the Streaming Performance Parameters log, which is accessed by use of the READ LOG EXT command, and in the Command Completion Time Limit that is passed in streaming commands. The unit of time for this parameter shall be in microseconds, e.g., a value of 10000 indicates 10 milliseconds. If yy was returned by the drive for this parameter, then

- the Command Completion Time Limit in the Feature field for a streaming command shall be yy microseconds.
- the Streaming Transfer Time shall be ((word 96) ∗ (yy/65536)) microseconds, ((word 104) ∗ (yy/65536)) microseconds, or ((a Sector Time array entriy in the Streaming Performance Parameters log) ∗ (yy/65536)) microseconds.
- The Streaming Access Latency shall be ((word 97) ∗ (yy/256)) microseconds, or ((an Access Time array entries in the Streaming Performance Parameters log) ∗ (yy/256)) microseconds.
- taking these units into account, the host may calculate the estimated time for a streaming command of size S logical sectors as ((word 96 ∗ S / 65536) + (word 97 / 256)) ∗ yy microseconds for DMA mode.
- taking these units into account, the host may calculate the estimated time for a streaming command of size S logical sectors as ((word 104 ∗ S / 65536) + (word 97 / 256)) ∗ yy microseconds for PIO mode.

The value of the Streaming Performance Granularity is vendor specific and fixed for a device.

7.17.7.71 Words (103:100): Maximum user LBA for 48-bit Address feature set

Words (103:100) contain a value that is one greater than the maximum LBA in user accessable space when the 48-bit Addressing feature set is supported. The maximum value that shall be placed in this field is 0000FFFFFFFFFFFFh. Support of these words is mandatory if the 48-bit Address feature set is supported.

7.17.7.72 Word 104: Streaming Transfer Time - PIO

Word 104 defines the Streaming Transfer Time for PIO mode. The worst-case sustainable transfer time per logical sector for the device is calculated as follows:

$$\text{Streaming Transfer Time} = (\text{word } 104) * (\text{words } (99{:}98) / 65536)$$

The content of IDENTIFY DEVICE data word 104 may be affected by the host issuing a SET FEATURES subcommand 43h (Typical Host Interface Sector Time for PIO mode). Because of this effect, an IDENTIFY DEVICE command shall be issued after a SET FEATURES command that may affect these words. If the Streaming Feature Set is not supported by the device, the content of word 104 shall be zero.

7.17.7.73 Word 106: Physical sector size / Logical Sector Size

If bit 14 of word 106 is set to one and bit 15 of word 106 is cleared to zero, the contents of word 106 contain valid information. If not, information is not valid in this word.

Bit 13 of word 106 shall be set to one to indicate that the device has more than one logical sector per physical sector.

Bit 12 of word 106 shall be set to 1 to indicate that the device has been formatted with a logical sector size larger than 256 words. Bit 12 of word 106 shall be cleared to 0 to indicate that words 117-118 are invalid and that the logical sector size is 256 words.

Bits (11:4) of word 106 are reserved.

Bits (3:0) of word 106 indicate the size of the device physical sectors in power of two logical sectors.

Examples:

Bits (3:0): 0 = 2^0 = 1 logical sector per physical sector
Bits (3:0): 1 = 2^1 = 2 logical sector per physical sector
Bits (3:0): 2 = 2^2 = 4 logical sector per physical sector
Bits (3:0): 3 = 2^3 = 8 logical sector per physical sector

7.17.7.74 Word 107: Inter-seek delay for ISO 7779 standard acoustic testing

Word 107 is defined as the manufacturer's recommended time delay between seeks during ISO-7779 standard acoustic testing in microseconds (ISO 7779 value t_D. See ISO 7779:1999 (E) Clause C.9 Equipment Category: Disk units and storage subsystems.

7.17.7.75 Words (111:108): World wide name

Words 111-108 shall contain the optional value of the world wide name (WWN) for the device.

Word 108 bits 15-12 shall contain 5h, indicating that the naming authority is IEEE. All other values are reserved.

Words 108 bits 11-0 and word 109 bits 15-4 shall contain the Organization Unique Identifier (OUI) for the device manufacturer. The OUI shall be assigned by the IEEE/RAC as specified by ISO/IEC 13213:1994 (See 3.1.80).

The identifier may be obtained from:

Institute of Electrical and Electronic Engineers, Inc.
Registration Authority Committee
445 Hoes Lane
Piscataway, NJ 08855-1331

Word 109 bits 3-0, word 110, and word 111 shall contain a value assigned by the vendor that is unique for the OUI domain.

7.17.7.76 Words (115:112): Reserved for a 128-bit world wide name

7.17.7.77 Word 116: Reserved for TLC technical report.
This field is described in Time-Limited Commands (TLC) INCITS TR-37-2004

7.17.7.78 Words 117-118: Logical Sector Size
Words 117,118 indicate the size of device logical sectors in words. The value of words 117,118 shall be equal to or greater than 256. The value in words 117,118 shall be valid when word 106 bit 12 is set to 1. All logical sectors on a device shall be 117,118 words long.

7.17.7.79 Words (126:119): Reserved

7.17.7.80 Word 127: Removable Media Status Notification feature set support
If bit 0 of word 127 is set to one and bit 1 of word 127 is cleared to zero, the device supports the Removable Media Status Notification feature set. Bits (15:2) shall be cleared to zero. Support of this word is mandatory if the Removable Media Status Notification feature set is supported.

7.17.7.81 Word 128: Security status
Support of this word is mandatory if the Security feature set is supported.

Bit 8 of word 128 indicates the security level. If security mode is enabled and the security level is high, bit 8 shall be cleared to zero. If security mode is enabled and the security level is maximum, bit 8 shall be set to one. When security mode is disabled, bit 8 shall be cleared to zero.

Bit 5 of word 128 indicates the Enhanced security erase unit feature is supported. If bit 5 is set to one, the Enhanced security erase unit feature set is supported.

Bit 4 of word 128 indicates that the security count has expired. If bit 4 is set to one, the security count is expired and SECURITY UNLOCK and SECURITY ERASE UNIT are command aborted until a power-on reset or hardware reset.

Bit 3 of word 128 indicates security frozen. If bit 3 is set to one, the security is frozen.

Bit 2 of word 128 indicates security locked. If bit 2 is set to one, the security is locked.

Bit 1 of word 128 indicates security enabled. If bit 1 is set to one, the security is enabled.

Bit 0 of word 128 indicates the Security Mode feature set supported. If bit 0 is set to one, security is supported.

7.17.7.82 Words (159:129): Vendor specific.

7.17.7.83 Word 160: CFA power mode
Word 160 indicates the presence and status of a CFA feature set device that supports CFA Power Mode 1. Support of this word is mandatory if CFA Power Mode 1 is supported.

If bit 13 of word 160 is set to one then the device shall be in CFA Power Mode 1 to perform one or more commands implemented by the device.

If bit 12 of word 160 is set to one the device is in CFA Power Mode 0 (See 7.51.9).

Bits (11:0) indicate the maximum average RMS current in Milliamperes required during 3.3V or 5V device operation in CFA Power Mode 1.

7.17.7.84 Words (175:161): Reserved for assignment by the CompactFlash™ Association

7.17.7.85 Words (205:176): Current media serial number
Words (205:176) contain the current media serial number. Serial numbers shall consist of 60 bytes. The first 40 bytes shall indicate the media serial number and the remaining 20 bytes shall indicate the media manufacturer.

For removable ATA devices (e.g., flash media with native ATA interfaces) that do not support removable media, the first 20 words of this field shall be the same as words (46:27) of the IDENTIFY DEVICE data and the next ten words shall be the same as words (19:10) of the IDENTIFY DEVICE response.

7.17.7.86 Word (206): SCT Command Transport
Word 206 bit 0 indicates that the device supports the SCT Command Transport. Bits 11:1 indicate which SCT action codes are supported by the device. Bits 15:12 indicate support for vendor specific action codes

If bit 5 of word 206 is set to one the device supports SCT Data Tables (See 8.3.5)

If bit 4 of word 206 is set to one the device supports SCT Features Control (See 8.3.4)

If bit 3 of word 206 is set to one the device supports SCT Error Recovery Contro (See 8.3.3)

If bit 2 of word 206 is set to one the device supports SCT Write Same (See **Error! Reference source not found.**)

If bit 1 of word 206 is set to one the device supports SCT Long Sector Access (See 8.3.1)

7.17.7.87 Word (209): Alignment of logical blocks within a physical block
Word 209 shall report the location of LBA0 within the first physical sector of the media.

7.17.7.88 Words (211:210): Write Read Verify Sector Count Mode 3 Only
Words 210-211 shall indicate the number of logical sectors to be verified after spinup, as set by the SET FEATURES command for the Enable Write Read Verify feature set. Write Read Verify sector count only applies to mode 3.

7.17.7.89 Words (213:212): Verify Sector Count Mode 2 Only
Words 212-213 shall indicate the number of logical sectors to be verified after spinup for the Enable Write Read Verify feature set. Verify sector count only applies to mode 2.

7.17.7.90 Word 222: Transport major version number
If not FFFFh, the device claims compliance with the Transport Standard major version(s) as indicated by bits (6:3) being set to one. Values other than 0000h and FFFFh are bit significant. Since ATA standards maintain downward compatibility, a device may set more than one bit.

7.17.7.91 Word 223: Transport minor mersion mumber
If an implementer claims that the revision of the standard they used to guide their transport implementation does not need to be reported or if the implementation was based upon a standard prior to the ATA-3 standard, word 223 shall be 0000h or FFFFh.

Table 14 defines the value that may optionally be reported in word TBD to indicate the revision of the standard that guided the implementation. [editors note: This says optionally, but the table says mandatory, this does not seem consistent]

Table 14 – Transport minor version number

Value	Minor Version
00h-20h	Reserved
21h	ATA8-AST T13 Project D1697 Revision 0b
22h-FFh	Reserved

7.17.7.92 Words (254:213): Reserved.

7.17.7.93 Word 255: Integrity word
The use of this word is optional. If bits (7:0) of this word contain the signature A5h, bits (15:8) contain the data structure checksum. The data structure checksum is the two's complement of the sum of all bytes in words (254:0) and the byte consisting of bits (7:0) in word 255. Each byte shall be added with unsigned arithmetic, and overflow shall be ignored. The sum of all 512 bytes is zero when the checksum is correct.

7.18 IDENTIFY PACKET DEVICE - A1h, PIO Data-in

7.18.1 Feature Set
This command is mandatory for devices implementing the PACKET Command feature set.

7.18.2 Description
The IDENTIFY PACKET DEVICE command enables the host to receive parameter information from a device that implements the PACKET Command feature set. . See clause 7.18.6 for a description of the return data.

Some devices may have to read the media in order to complete this command.

Some parameters are defined as a 16-bit value. A word that is defined as a 16-bit value transmits the most significant byte of the value the first and the least significant byte second (See 3.2.7).

Some parameters are defined as 32-bit values (e.g., words (61:60)). Such values are transferred using two word transfers. The device shall first transfer the least significant word followed by the most significant value (See 3.2.7).

Some parameters are defined as a string of ASCII characters (See 3.2.7).

7.18.3 Inputs

Word	Name	**Description**
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	A1h

7.18.4 Normal outputs
See Table 85

7.18.5 Error outputs
The device shall return command aborted if the device does not implement this command, otherwise, the device shall not report an error. See Table 100. The device may return error status if an Interface CRC error has occurred.

Note: There is no defined mechanism for a device to return an ICRC error status that may have occurred during the last data block of a PIO-in data transfer, there may be other mechanisms in which a host can verify that an Interface CRC error occurred in these cases.

7.18.6 Input Data [Editors note: add column indicating transport]
7.18.6.1 Overview

Table 15 - IDENTIFY PACKET DEVICE data

Word	O/M	F/V	Description
0	M		General configuration bit-significant information:
		F	15:14 10 = ATAPI device
		F	11 = Reserved
		F	13 Reserved
		F	12:8 Field indicates command packet set used by device
		F	7 1 = removable media device
		F	6:5 00 = Device shall set DRQ to one within 3 ms of receiving PACKET command.
			01 = Obsolete.
			10 = Device shall set DRQ to one within 50 μs of receiving PACKET command.
			11 = Reserved
		F	4:3 Reserved
		V	2 Incomplete response
		F	1:0 00 = 12 byte command packet
			01 = 16 byte command packet
			1x = Reserved
1		F	Reserved
2		V	Unique configuration
3-9		F	Reserved
10-19	M	F	Serial number (20 ASCII characters)
20-22		F	Reserved
23-26	M	F	Firmware revision (8 ASCII characters)
27-46	M	F	Model number (40 ASCII characters)
47-48		F	Reserved
49	M		Capabilities
		F	15 Obsolete
		F	14 Obsolete
		F	13 Obsolete
		F	12 1 = ATA software reset required (Obsolete)
		F	11 1 = IORDY supported
		F	10 1 = IORDY may be disabled
		F	9 Shall be set to one.
		F	8 1 = DMA supported
			Devices which require the DMADIR bit in the Packet command shall clear this bit to 0
		X	7:0 Vendor specific
50	O		Capabilities
		F	15 Shall be cleared to zero.
		F	14 Shall be set to one.
		F	13:2 Reserved
		X	1 Obsolete
		F	0 Shall be set to one to indicate a device specific Standby timer value minimum.
51-52		X	Obsolete
53	M	F	15:3 Reserved
		F	2 1 = the fields reported in word 88 are valid
			0 = the fields reported in word 88 are not valid
		F	1 1 = the fields reported in words (70:64) are valid
			0 = the fields reported in words (70:64) are not valid
		X	0 Obsolete
54-61		F	Reserved

(continued)

Table 15 - IDENTIFY PACKET DEVICE data *(continued)*

Word	O/M	F/V	Description	
62	M	F	15	1 = DMADIR bit in the Packet command is required for DMA transfers 0 = DMADIR bit in Packet command is not required for DMA transfers.
		F	14:11	Reserved
		F	10	1 = DMA is supported
		F	9	1 = Multiword DMA mode 2 is supported
		F	8	1 = Multiword DMA mode 1 is supported
		F	7	1 = Multiword DMA mode 0 is supported
		F	6	1 = Ultra DMA mode 6 and below are supported
		F	5	1 = Ultra DMA mode 5 and below are supported
		F	4	1 = Ultra DMA mode 4 and below are supported
		F	3	1 = Ultra DMA mode 3 and below are supported
		F	2	1 = Ultra DMA mode 2 and below are supported
		F	1	1 = Ultra DMA mode 1 and below are supported
		F	0	1 = Ultra DMA mode 0 is supported
63	M	F	15:11	Reserved
		V	10	1 = Multiword DMA mode 2 is selected 0 = Multiword DMA mode 2 is not selected
		V	9	1 = Multiword DMA mode 1 is selected 0 = Multiword DMA mode 1 is not selected
		V	8	1 = Multiword DMA mode 0 is selected 0 = Multiword DMA mode 0 is not selected
		F	7:3	Reserved
		F	2	1 = Multiword DMA mode 2 and below are supported Devices which require the DMADIR bit in the Packet command shall clear this bit to 0.
		F	1	1 = Multiword DMA mode 1 and below are supported Devices which require the DMADIR bit in the Packet command shall clear this bit to 0.
		F	0	1 = Multiword DMA mode 0 is supported Multiword DMA mode selected Devices which require the DMADIR bit in the Packet command shall clear this bit to 0.
64	M	F	15:8	Reserved
		F	7:0	PIO transfer modes supported
65	M		Minimum Multiword DMA transfer cycle time per word	
		F	15:0	Cycle time in nanoseconds
66	M		Manufacturer's recommended Multiword DMA transfer cycle time	
		F	15:0	Cycle time in nanoseconds
67	M		Minimum PIO transfer cycle time without flow control	
		F	15:0	Cycle time in nanoseconds
68	M		Minimum PIO transfer cycle time with IORDY flow control	
		F	15:0	Cycle time in nanoseconds
69-70		F	Reserved (for future command overlap and queuing)	
71-72	O	F	Obsolete	
73-74		F	Reserved	
75	O		Queue depth	
		F	15:5 [Editors Note: Something is missing here]	
		F	4:0	Reserved
76-79		R	Reserved for Serial ATA	Maximum queue depth supported - 1

(continued)

Table 15 - IDENTIFY PACKET DEVICE data *(continued)*

Word	O/M	F/V	Description
80	M		Major version number
			0000h or FFFFh = device does not report version
		F	15 Reserved
		F	14 Reserved for ATA/ATAPI-14
		F	13 Reserved for ATA/ATAPI-13
		F	12 Reserved for ATA/ATAPI-12
		F	11 Reserved for ATA/ATAPI-11
		F	10 Reserved for ATA/ATAPI-10
		F	9 Reserved for ATA/ATAPI-9
		F	8 Reserved for ATA/ATAPI-8
		F	7 1 = Supports ATA/ATAPI-7
		F	6 1 = supports ATA/ATAPI-6
		F	5 1 = supports ATA/ATAPI-5
		F	4 1 = supports ATA/ATAPI-4
		F	3 Obsolete
		X	2 Obsolete
		X	1 Obsolete
		F	0 Reserved
81	M		Minor version number
			0000h or FFFFh=device does not report version
			0001h-FFFEh=See 7.17.7.41
82	M		Command set supported. If words (83:82) = 0000h or FFFFh command set notification not supported.
		X	15 Obsolete
		F	14 1 = NOP command supported
		F	13 1 = READ BUFFER command supported
		F	12 1 = WRITE BUFFER command supported
		X	11 Obsolete
		F	10 1 = Host Protected Area feature set supported
		F	9 1 = DEVICE RESET command supported
		F	8 1 = SERVICE interrupt supported
		F	7 1 = release interrupt supported
		F	6 1 = look-ahead supported
		F	5 1 = write cache supported
		F	4 Shall be set to one indicating the PACKET Command feature set is supported.
		F	3 1 = Power Management feature set supported
		F	2 1 = Removable Media feature set supported
		F	1 1 = Security Mode feature set supported
		F	0 1 = SMART feature set supported
83	M		Command sets supported. If words (83:82) = 0000h or FFFFh command set notification not supported.
		F	15 Shall be cleared to zero
		F	14 Shall be set to one
		F	13 Reserved
		F	12 1 = FLUSH CACHE command supported
		F	11 1 = Device Configuration Overlay feature set supported
		F	10 Reserved
		F	9 1 = AUTOMATIC Acoustic Management feature set supported
		F	8 1 = SET MAX security extension supported
		F	7 See Address Offset Reserved Area Boot, INCITS TR27:2001
		F	6 1 = SET FEATURES subcommand required to spinup after power-up
		F	5 1 = Power-Up In Standby feature set supported
		F	4 1 = Removable Media Status Notification feature set supported
		F	3:1 Reserved
		F	0 1 = DOWNLOAD MICROCODE command supported **[Editors Note: DM is not supported on ATAPI devices]**

(continued)

Table 15 - IDENTIFY PACKET DEVICE data *(continued)*

Word	O/M	F/V	Description
84	M		Command set/feature supported extension. If words 82, 83, and 84 = 0000h or FFFFh command set notification extension is not supported.
		F	15 Shall be cleared to zero
		F	14 Shall be set to one
			13:6 Reserved
			5 General Purpose Logging Featureset
		F	4:0 Reserved
85	M		Command set/feature enabled. If words 85, 86, and 87 = 0000h or FFFFh command set enabled notification is not supported.
		X	15 Obsolete
		F	14 1 = NOP command enabled
		F	13 1 = READ BUFFER command enabled
		F	12 1 = WRITE BUFFER command enabled
		X	11 Obsolete
		V	10 1 = Host Protected Area feature set enabled
		F	9 1 = DEVICE RESET command enabled
		V	8 1 = SERVICE interrupt enabled
		V	7 1 = release interrupt enabled
		V	6 1 = look-ahead enabled
		V	5 1 = write cache enabled
		F	4 Shall be set to one indicating the PACKET Command feature set is supported.
		F	3 1 = Power Management feature set enabled
		V	2 1 = Removable Media feature set enabled
		V	1 1 = Security Mode feature set enabled
		V	0 1 = SMART feature set enabled
86	M		Command set/feature enabled. If words 85, 86, and 87 = 0000h or FFFFh command set enabled notification is not supported.
		F	15:13 Reserved
		V	12 1 = FLUSH CACHE command supported
		F	11 1 = Device Configuration Overlay feature set supported
		F	10 Reserved
		V	9 1 = Automatic Acoustic Management feature set enabled
		V	8 1 = SET MAX security extension enabled by a SET MAX SET PASSWORD
		V	7 See Address Offset Reserved Area Boot, INCITS TR27:2001
		F	6 1 = SET FEATURES subcommand required to spinup after power-up
		V	5 1 = Power-Up In Standby feature set enabled
		V	4 1 = Removable Media Status Notification feature set enabled via the SET FEATURES command.
		F	3:1 Reserved
		F	0 1 = DOWNLOAD MICROCODE command enabled **[Editors Note: DM is not implemented on ATAPI devices.]**
87	M		Command set/feature default. If words 85, 86, and 87 = 0000h or FFFFh command set default notification is not supported.
		F	15 Shall be cleared to zero
		F	14 Shall be set to one
			13:6 Reserved
			5 General Purpose Logging Featureset
		F	4:0 Reserved

(continued)

Table 15 - IDENTIFY PACKET DEVICE data *(continued)*

Word	O/M	F/V	Description	
88	M	F	15	Reserved
			14	1 = Ultra DMA mode 6 is selected 0 = Ultra DMA mode 6 is not selected
		V	13	1 = Ultra DMA mode 5 is selected 0 = Ultra DMA mode 5 is not selected
		V	12	1 = Ultra DMA mode 4 is selected 0 = Ultra DMA mode 4 is not selected
		V	11	1 = Ultra DMA mode 3 is selected 0 = Ultra DMA mode 3 is not selected
		V	10	1 = Ultra DMA mode 2 is selected 0 = Ultra DMA mode 2 is not selected
		V	9	1 = Ultra DMA mode 1 is selected 0 = Ultra DMA mode 1 is not selected
		V	8	1 = Ultra DMA mode 0 is selected 0 = Ultra DMA mode 0 is not selected
		F	7	Reserved
		F	6	1 = Ultra DMA mode 6 and below are supported Devices which require the DMADIR bit in the Packet command shall clear this bit to 0.
		F	5	1 = Ultra DMA mode 5 and below are supported Devices which require the DMADIR bit in the Packet command shall clear this bit to 0.
		F	4	1 = Ultra DMA mode 4 and below are supported Devices which require the DMADIR bit in the Packet command shall clear this bit to 0.
		F	3	1 = Ultra DMA mode 3 and below are supported Devices which require the DMADIR bit in the Packet command shall clear this bit to 0.
		F	2	1 = Ultra DMA mode 2 and below are supported Devices which require the DMADIR bit in the Packet command shall clear this bit to 0.
		F	1	1 = Ultra DMA mode 1 and below are supported Devices which require the DMADIR bit in the Packet command shall clear this bit to 0.
		F	0	1 = Ultra DMA mode 0 is supported Devices which require the DMADIR bit in the Packet command shall clear this bit to 0.
89-92		F	Reserved	

(continued)

Table 15 - IDENTIFY PACKET DEVICE data *(continued)*

Word	O/M	F/V	Description
93	*		Hardware reset result. The contents of bits (12:0) of this word shall change only during the execution of a hardware reset.
		F	15 Shall be cleared to zero.
		F	14 Shall be set to one.
		V	13 1 = device detected CBLID- above V_{iH} 0 = device detected CBLID- below V_{iL}
			12:8 Device 1 hardware reset result. Device 0 shall clear these bits to zero. Device 1 shall set these bits as follows:
		F	12 Reserved.
		V	11 0 = Device 1 did not assert PDIAG-. 1 = Device 1 asserted PDIAG-.
		V	10:9 These bits indicate how Device 1 determined the device number: 00 = Reserved. 01 = a jumper was used. 10 = the CSEL signal was used. 11 = some other method was used or the method is unknown.
		F	8 Shall be set to one.
			7:0 Device 0 hardware reset result. Device 1 shall clear these bits to zero. Device 0 shall set these bits as follows:
		F	7 Reserved.
		F	6 0 = Device 0 does not respond when Device 1 is selected. 1 = Device 0 responds when Device 1 is selected.
		V	5 0 = Device 0 did not detect the assertion of DASP-. 1 = Device 0 detected the assertion of DASP-.
		V	4 0 = Device 0 did not detect the assertion of PDIAG-. 1 = Device 0 detected the assertion of PDIAG-.
		V	3 0 = Device 0 failed diagnostics. 1 = Device 0 passed diagnostics.
			2:1 These bits indicate how Device 0 determined the device number:
		F	00 = Reserved.
		V	01 = a jumper was used.
		V	10 = the CSEL signal was used.
		V	11 = some other method was used or the method is unknown.
		F	0 Shall be set to one.
94	O	V	15:8 Vendor’s recommended acoustic management value.
		V	7:0 Current automatic acoustic mamagement value.
95-124		F	Reserved
125	M	F	ATAPI byte count = 0 behavior
126		X	Obsolete
127	O		Removable Media Status Notification feature set support
		F	15:2 Reserved
		F	1:0 00 = Removable Media Status Notification feature set not supported 01 = Removable Media Status Notification feature set supported 10 = Reserved 11 = Reserved

(continued)

Table 15 - IDENTIFY PACKET DEVICE data *(continued)*

Word	O/M	F/V	Description
128	O		Security status
		F	15:9 Reserved
		V	8 Security level 0 = High, 1 = Maximum
		F	7:6 Reserved
		F	5 1 = Enhanced security erase supported
		V	4 1 = Security count expired
		V	3 1 = Security frozen
		V	2 1 = Security locked
		V	1 1 = Security enabled
		F	0 1 = Security supported
129-159		X	Vendor specific
160-175		F	Reserved for assignment by the CompactFlash™ Association
176-254		F	Reserved
255	O	X	Integrity word 15:8 Checksum 7:0 Signature

Key:
O/M = Mandatory/optional requirement.
M = Support of the word is mandatory.
O = Support of the word is optional.
* = See 7.17.7.65.
F/V = Fixed/variable content.
F = the content of the word is fixed and does not change. For removable media devices, these values may change when media is removed or changed.
V = the contents of the word is variable and may change depending on the state of the device or the commands executed by the device.
X = the content of the word may be fixed or variable.

(Concluded)

7.18.6.2 Word 0: General configuration

Bits (15:14) of word 0 indicate the type of device. Bit 15 shall be set to one and bit 14 shall be cleared to zeroto indicate the device implements the PACKET Command feature set.

Bits (12:8) of word 0 indicate the command packet set implemented by the device. This value follows the peripheral device type value as defined in SCSI Primary Commands, ANSI INCITS 301:1997.

Value	Description
00h	Direct-access device
01h	Sequential-access device
02h	Printer device
03h	Processor device
04h	Write-once device
05h	CD-ROM device
06h	Scanner device
07h	Optical memory device
08h	Medium changer device
09h	Communications device
0A-0Bh	Reserved for ACS IT8 (Graphic arts pre-press devices)
0Ch	Array controller device
0Dh	Enclosure services device
0Eh	Reduced block command devices
0Fh	Optical card reader/writer device
10-1Eh	Reserved
1Fh	Unknown or no device type

Bit 7 if set to one indicates that the device has removable media.

Bits (6:5) of word 0 indicate the DRQ response time when a PACKET command is received. A value of 00b indicates a maximum time of 3 ms from receipt of PACKET to the setting of DRQ to one. A value of 10b indicates a maximum time of 50 μs from the receipt of PACKET to the setting of DRQ to one. The value 11b is reserved.

If bit 2 is set to one it indicates that the content of the IDENTIFY DEVICE data is incomplete. This will occur if the device supports the Power-up in Standby feature set and required data is contained on the device media. In this case the content of at least word 0 and word 2 shall be valid.

Bits (1:0) of word 0 indicate the packet size the device supports. A value of 00b indicates that a 12-byte packet is supported; a value of 01b indicates a 16 byte packet. The values 10b and 11b are reserved.

7.18.6.3 Word 1: Reserved

7.18.6.4 Word 2: Specific configuration

Word 2 shall have the same content described for word 2 of the IDENTIFY DEVICE command.

7.18.6.5 Words (9:3): Reserved

7.18.6.6 Words (19:10): Serial number

The use of these words is optional. If not implemented, the content shall be zeros. If implemented, the content shall be as described in words (19:10) of the IDENTIFY DEVICE command (See 7.17).

7.18.6.7 Words (22:20): Reserved

7.18.6.8 Words (26:23): Firmware revision

Words (26:23) shall have the content described for words (26:23) of the IDENTIFY DEVICE command.

7.18.6.9 Words (46:27): Model number

Words (46:27) shall have the content described for words (46:27) of the IDENTIFY DEVICE command.

7.18.6.10 Words (48:47): Reserved

7.18.6.11 Word 49: Capabilities

Bit 15:12 of word 49 are obsolete.

Bit 11 of word 49 is used to determine whether a device supports IORDY. If this bit is set to one, then the device supports IORDY operation. If this bit is zero, the device may support IORDY. This ensures backward compatibility. If a device supports PIO mode 3 or higher, then this bit shall be set to one. If the serial interface is implemented, this bit shall be set to one.

Bit 10 of word 49 is used to indicate a device's ability to enable or disable the use of IORDY. If this bit is set to one, then the device supports the disabling of IORDY. Disabling and enabling of IORDY is accomplished using the SET FEATURES command. If the serial interface is implemented, this bit shall be set to one.

Bit 9 of word 49 shall be set to one.

Bit 8 of word 49 indicates that DMA is supported. Devices which require the DMADIR bit in the Packet command shall clear this bit to 0

7.18.6.12 Word 50: Capabilities

Word 50 shall have the content described for word 50 of the IDENTIFY DEVICE command. Support of this word is mandatory if the STANDBY command is supported.

7.18.6.13 Word 51: Obsolete

7.18.6.14 Word 52: Reserved

7.18.6.15 Word 53: Field validity

Word 53 shall have the content described for word 53 of the IDENTIFY DEVICE command.

7.18.6.16 Words (61:54): Reserved

7.18.6.17 Word 62: DMADIR

ATAPI devices that use a serial ATA bridge chip for connection to a serial ATA host may require use of the DMADIR bit to indicate transfer direction for Packet DMA commands. Word 62 is used to indicate if such support is required.

If bit 15 of word 62 is set to one, then DMADIR bit in the Packet Command is required by the device for Packet DMA and Bits 2:0 of word 63, bits 15 and 8 in word 49, and bits 6:0 of word 88 shall be cleared to 0,.

If bit 15 of word 62 is cleared to 0, DMADIR bit in the PACKET command is not required. If bit 15 of word 62 is cleared to zero, then all bits of word 62 shall be cleared to zero.

Bits (14:11) are reserved.

Bits (10:1) indicate DMA mode support. Since the DMADIR bit is only used for a Serial ATAPI device, all of these bits are set to 1.

7.18.6.18 Word 63: Multiword DMA transfer

Word 63 identifies the Multiword DMA transfer modes supported by the device and indicates the mode that is currently selected. Only one DMA mode shall be selected at any given time. If an Ultra DMA mode is enabled, then no Multiword DMA mode shall be enabled. If a Multiword DMA mode is enabled then no Ultra DMA mode shall be enabled.

Bit (15:11) are Reserved.

Bits 10:8 shall have the content described for word 63 of the IDENTIFY DEVICE command.

Bits (7:3) are Reserved

If bit 2 of Word 63 is set to one, then Multiword DMA modes 2 and below are supported. If this bit is cleared to zero, then Multiword DMA mode 2 is not supported. If Multiword DMA mode 2 is supported, then Multiword DMA modes 1 and 0 shall also be supported.

If bit 2 of Word 63 is set to one, bits (1:0) shall be set to one. If the serial interface is implemented, this bit shall be set to one except this bit shall be cleared 0 for Serial ATAPI devices requiring the DMADIR bit in the PACKET command.

If bit 1 of Word 63 is set to one, then Multiword DMA modes 1 and below are supported. If this bit is cleared to zero, then Multiword DMA mode 1 is not supported. If Multiword DMA mode 1 is supported, then Multiword DMA mode 0 shall also be supported.

If bit 1 of Word 63 is set to one, bit 0 shall be set to one. If the serial interface is implemented, this bit shall be set to one except this bit shall be cleared to 0 for Serial ATAPI devices which require the DMADIR bit in the PACKET command.

If bit 0 of word 63 is set to one, then Multiword DMA mode 0 is supported. If the serial interface is implemented, this bit shall be set to one except this bit shall be cleared to 0 for Serial ATAPI devices which require the DMADIR bit in the PACKET command.

7.18.6.19 Word 64: PIO transfer mode supported
Word 64 shall have the content described for word 64 of the IDENTIFY DEVICE command.

7.18.6.20 Word 65: Minimum multiword DMA transfer cycle time per word
Word 65 shall have the content described for word 65 of the IDENTIFY DEVICE command.

7.18.6.21 Word 66: Device recommended multiword DMA cycle time
Word 66 shall have the content described for word 66 of the IDENTIFY DEVICE command.

7.18.6.22 Word 67: Minimum PIO transfer cycle time without flow control
Word 67 shall have the content described for word 67 of the IDENTIFY DEVICE command.

7.18.6.23 Word 68: Minimum PIO transfer cycle time with IORDY
Word 68 shall have the content described for word 68 of the IDENTIFY DEVICE command.

7.18.6.24 Word (70:69): Reserved

7.18.6.25 Word (74:73): Reserved

7.18.6.26 Word 75: Queue depth
Bits (4:0) of word 75 shall have the content described for word 75 of the IDENTIFY DEVICE command. Support of this word is mandatory if the Queuing feature set is supported.

7.18.6.27 Words (79:76): Reserved for Serial ATA

7.18.6.28 Word 80: Major revision number
Word 80 shall have the content described for word 80 of the IDENTIFY DEVICE command.

7.18.6.29 Word 81: Minor revision number
Word 81 shall have the content described for word 81 of the IDENTIFY DEVICE command.

7.18.6.30 Words (84:82): Features/command sets supported
Words (84:82) shall have the content described for words (84:82) of the IDENTIFY DEVICE command except that bit 4 of word 82 shall be set to one to indicate that the PACKET Command feature set is supported.

7.18.6.31 Words (87:85): Features/command sets enabled
Words (87:85) shall have the content described for words (87:85) of the IDENTIFY DEVICE command except that bit 4 of word 85 shall be set to one to indicate that the PACKET Command feature set is supported.

7.18.6.32 Word 88:Ultra DMA modes
Word 88 shall have the content described for word 88 of the IDENTIFY DEVICE command, except bits 6:0 shall be cleared to 0 for Serial ATAPI devices which require the DMADIR bit in the Packet command.

7.18.6.33 Word 89: Time required for Security erase unit completion
Word 89 shall have the content described for word 89 of the IDENTIFY DEVICE command.

7.18.6.34 Word 90: Time required for Enhanced security erase unit completion
Word 90 shall have the content described for word 90 of the IDENTIFY DEVICE command.

7.18.6.35 Word (92:91): Reserved

7.18.6.36 Word 93: Hardware reset results

Word 93 shall have the content described for word 93 of the IDENTIFY DEVICE command. Support of bits (13:15) is mandatory. Support of bits (12:0) is optional.

7.18.6.37 Word 94: Current automatic acoustic management value

Word 94 shall have the content described for word 94 of the IDENTIFY DEVICE command.

7.18.6.38 Word (124:95): Reserved

7.18.6.39 Word 125 ATAPI byte count=0 behavior.

If the contents of word 125 are 0000h and the value of the byte count limit is zero, the device shall return command aborted.

If the contents of word 125 are non-zero and the value of the byte count limit is zero, the device shall use the contents of word 125 as the actual byte count limit for the current command and shall not abort.

The device may be reconfigured to report a new value. However, after the device is reconfigured, the content of word 125 reported shall not change until after the next hardware reset or power-on reset event.

7.18.6.40 Word 126: Obsolete

7.18.6.41 Word 127: Removable Media Status Notification feature set support

Word 127 shall have the content described for word 127 of the IDENTIFY DEVICE command. Support of this word is mandatory if the Removable Media Status Notification feature set is supported.

7.18.6.42 Word 128: Security status

Word 128 shall have the content described for word 128 of the IDENTIFY DEVICE command. Support of this word is mandatory if the Security feature set is supported.

7.18.6.43 Words (160:129): Reserved

7.18.6.44 Words (175:161): Reserved for assignment by the CompactFlash™ Association

7.18.6.45 Words (254:176): Reserved

7.18.6.46 Word 255: Integrity Word

Word 255 shall have the content described for word 255 of the IDENTIFY DEVICE command. Word 255 should be implemented.

7.19 IDLE - E3h, Non-data

7.19.1 Feature Set

This command is mandatory for devices implementing the Power Management feature set. The Power Management feature set is mandatory for devices not implementing the PACKET Command set This command is mandatory when power management is not implemented by the PACKET Command set implemented by the device.

7.19.2 Description

The IDLE command allows the host to place the device in the Idle mode and also set the Standby timer.I

If the Count field is non-zero then the Standby timer shall be enabled. The value in the Count field shall be used to determine the time programmed into the Standby timer (See 4.5). If the Count field is zero then the Standby timer is disabled.

7.19.3 Inputs

Values other than zero in the Count field when the IDLE command is issued shall determine the time period programmed into the Standby timer. Table 16 defines these values.

Word	Name	Description
00h	Feature	Reserved
01h	Count	Timer period value (TPV) -The TPV shall determine the time period programmed into the Standby timer. Table 16 defines these values.
02h-04h	LBA	Reserved
05h	Command	E3h

Table 16 - Automatic Standby timer periods

Count field contents		Corresponding timeout period
0	(00h)	Timeout disabled
1-240	(01h-F0h)	(value ∗ 5) seconds
241-251	(F1h-FBh)	((value - 240) ∗30) minutes
252	(FCh)	21 minutes
253	(FDh)	Period between 8 hours and 12 hours
254	(Feh)	Reserved
255	(FFh)	21 min 15 seconds
NOTE – Times are approximate.		

7.19.4 Normal outputs

See Table 85

7.19.5 Error outputs

See Table 100

7.20 IDLE IMMEDIATE - E1h, Non-data

7.20.1 Feature Set

This command is mandatory for devices implementing the Power Management feature set. However, the Unload Feature of the command is optional. The Power Management feature set is mandatory for devices not implementing the PACKET Command set This command is mandatory when power management is not implemented by the PACKET Command set implemented by the device.

7.20.2 Description

7.20.2.1 Default Function

The IDLE IMMEDIATE command allows the host to immediately place the device in the Idle mode. Command completion may occur even though the device has not fully transitioned into the Idle mode.

7.20.2.2 Unload Feature

The UNLOAD FEATURE of the IDLE IMMEDIATE command allows the host to immediately unload/park the heads. The device shall stop read look-ahead if it is in process. If the device is performing a write operation, the device shall suspend writing cached data onto the media as soon as possible, and keep unwritten sectors stored in the buffer until receiving a new command.

A device that supports load/unload technology shall retract the head(s) onto the ramp position as soon as receiving this command. The time to complete the unload operation is vendor specific, this typically would be within 500 milliseconds of receiving the command. The unload controlling method by the Unload Feature of the Idle Immediate command shall be the same as that by Power mode transition, and shall not effect the specification of normal load/unload times per device life.

A device that supports contact start/stop technology shall seek to the landing zone. The device shall not indicate command completion until it has completed the seek operation. The time to complete the seek operation is vendor specific, this typically would be within 300 milliseconds of receiving this command.

The device shall stay at Low Power Idle mode, shall not go into Standby mode and shall not load the head(s) onto the media until receiving a new command. Power consumption of the device is not an issue for this case. If a device receives this command while the head(s) is(are) currently on ramp/parked no physical action is needed.

The device shall retain data in the write cache and resume writing the cached data onto the media after receiving a Software Reset, a Hardware Reset, or any new command except IDLE IMMEDIATE with UNLOAD FEATURE. **[Editors Note: This creates a requirement that cache be preserved across COMRESET and Pin 1 reset. Is this normal?]**

7.20.3 Inputs (Default Fuction)

Word	Name	Description
00h	Feature	N/A except when the unload feature is requested, see 7.20.4
01h	Count	N/A except when the unload feature is requested, see 7.20.4
02h-04h	LBA	N/A except when the unload feature is requested, see 7.20.4
05h	Command	E1h

7.20.4 Inputs (Unload Feature)

Word	Name	Description
00h	Feature	0044h
01h	Count	0044h
02h-04h	LBA	000000554E4Ch
05h	Command	E1h

7.20.5 Normal outputs (Default Fuction)

See Table 85

7.20.6 Normal outputs (Unload Feature)

See Table 91

7.20.7 Error outputs

See Table 100

7.21 MEDIA EJECT - EDh, Non-data

7.21.1 Feature Set
This command is mandatory for devices implementing the Removable Media Status Notification feature set or the Removable Media feature set.

7.21.2 Description
This command causes any pending operations to complete, spins down the device if needed, unlocks the media if locked, and ejects the media. The device keeps track of only one level of media lock.

7.21.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	EDh

7.21.4 Normal outputs
See Table 85

7.21.5 Error outputs
See Table 105.

7.22 MEDIA LOCK - DEh, Non-data

7.22.1 Feature Set

This command is optional for devices implementing the Removable Media Status Notification feature set. This command is mandatory for devices implementing the Removable Media feature set.

7.22.2 Description

This command shall be used to lock the media, if Media Status Notification is disabled. If Media Status Notification is enabled, this command shall return good status (no Error bit in the Status field) and perform no action.

If the media is unlocked and media is present, the media shall be set to the LOCKED state and no Error register bit shall be set to one. The device keeps track of only one level of media lock. Subsequent MEDIA LOCK commands, while the media is in the LOCKED state, do not set additional levels of media locks.

If the media is locked, the status returned shall indicate whether a media change request has been detected by the device. If a media change request has been detected, the MCR bit in the Error register and the ERR bit in the Status register shall be set to one.

When media is in the LOCKED state, the device shall respond to the media change request button, by setting the MCR bit in the Error register and the ERR bit in the Status register to one, until the media LOCKED condition is cleared.

7.22.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	DEh

7.22.4 Normal outputs

See Table 85

7.22.5 Error outputs

See Table 106

7.23 MEDIA UNLOCK - DFh, Non-data

7.23.1 Feature Set

This command is optional for devices implementing the Removable Media Status Notification feature set. This command is mandatory for devices implementing the Removable Media feature set.

7.23.2 Description

This command can be used to unlock the device, if Media Status Notification is disabled. If Media Status Notification is enabled, this command will return good status (no Error bit in the Status field) and perform no action.

If the media is present, the media shall be set to the UNLOCKED state and no Error register bit shall be set to one. The device keeps track of only one level of media lock. A single MEDIA UNLOCK command unlocks the media.

If a media change request has been detected by the device prior to the issuance of this command, the media shall be ejected at MEDIA UNLOCK command completion.

7.23.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	DFh

7.23.4 Normal outputs

See Table 85

7.23.5 Error outputs

See Table 105.

7.24 NOP - 00h, Non-data

7.24.1 Feature Set
This command is mandatory for devices implementing the PACKET Command feature set. This command is mandatory for devices implementing the Overlapped feature set.

7.24.2 Description
The device shall respond with command aborted. For devices implementing the Overlapped feature set, subcommand code 00h in the Feature field shall abort any outstanding queue. Subcommand codes 01h through FFh in the Feature field shall not affect the status of any outstanding queue.

7.24.3 Inputs

Word	Name	Description
00h	Feature	Subcommand Code (See Table 17)
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	00h

Table 17 - NOP Subcommand Code

Subcommand code	Description	Action
00h	NOP	Return command aborted and abort any outstanding queued commands.
01h	NOP Auto Poll	Return command aborted and do not abort any outstanding queued commands.
02h-FFh	Reserved	Return command aborted and do not abort any outstanding queued commands.

7.24.4 Normal outputs
This command always fails with an error.

7.24.5 Error outputs

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7:3 N/A 2 Abort - See clause 6.3.1. 1:0 Obsolete
01h	Count	Initial Value
02h-04h	LBA	Initial Value
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

The Command Block registers, other than the Error and Status registers, are not changed by this command. This command always fails with the device returning command aborted.

7.25 NV CACHE – B6h, TBD

Reserved for e05106

7.26 PACKET - A0h, Packet

7.26.1 Feature Set

This command is mandatory for devices implementing the PACKET Command feature set.

7.26.2 Description

The PACKET command is used to transfer a device command via a command packet. If the native form of the encapsulated command is shorter than the packet size reported in bits (1:0) of word 0 of the IDENTIFY PACKET DEVICE response, the encapsulated command shall begin at byte 0 of the packet. Packet bytes beyond the end of the encapsulated command are reserved.

7.26.3 Inputs

Word	Name	Description
00h	Feature	**Bit** **Description** 7:3 Reserved 2 DMADIR - See clause 7.26.4 1 Obsolete. 0 DMA - This bit is set to one to inform the device that the data transfer (not the command packet transfer) associated with this command is via Multiword DMA or Ultra DMA mode.
01h	Count	**Bit** **Description** 7:3 Tag - If the device supports command queuing, this field contains the command Tag for the command being delivered. A Tag may have any value between 0 and 31 regardless of the queue depth supported. If queuing is not supported, this field is not applicable. 2:0 N/A
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 Byte Count - See clause 7.26.5 7:0 Reserved
05h	Command	A0h

7.26.4 DMADIR

This bit indicates Packet DMA direction and is used only for devices that implement the Packet Command feature set with a Serial ATA bridge that require direction indication from the host. Support for this bit is determined by reading bit 15 of word 62 in the IDENTIFY PACKET DEVICE data. If bit 15 of word 62 is set to 1, the device requires the use of the DMADIR bit for Packet DMA commands.

If the device requires the DMADIR bit to be set for Packet DMA operations and the current operations is DMA (i.e. bit 0, the DMA bit, is set), this bit indicates the direction of data transfer (0 = transfer to the device; 1 = transfer to the host). If the device requires the DMADIR bit to be set for Packet DMA operations but the current operations is PIO (i.e. bit 0, the DMA bit, is cleared), this bit is ignored.

Since the data transfer direction will be set by the host as the command is constructed, the DMADIR bit should not conflict with the data transfer direction of the command. If a conflict between the command transfer direction and the DMADIR bit occurs, the device should return with an ABORTED command, and the sense key set to ILLEGAL REQUEST.

If the device does not require the DMADIR bit for Packet DMA operations, this bit should be cleared to 0.

A device that does not support the DMADIR feature may abort a command if the DMADIR bit is set to 1.

7.26.5 Byte Count

This is the maximum byte count that is to be transferred in any single DRQ assertion for PIO transfers. The byte count does not apply to the command packet transfer. If the PACKET command does not transfer data, the byte count is ignored.

If the PACKET command results in a data transfer:

1. the host should not set the byte count limit to zero. If the host sets the byte count limit to zero, the contents of IDENTIFY PACKET DEVICE data word 125 determines the expected behavior;
2. the value set into the byte count limit shall be even if the total requested data transfer length is greater than the byte count limit;
3. the value set into the byte count limit may be odd if the total requested data transfer length is equal to or less than the byte count limit;

The value FFFFh is interpreted by the device as though the value were FFFEh.

7.26.6 Normal outputs

7.26.6.1 Awaiting command

When the device is ready to accept the command packet from the host the return structure shall be set according to Table 92. Input/Output shall be cleared to zero, and Command/Data shall be set to one. Byte Count shall reflect the value set by the host when the command was issued

7.26.6.2 Data transmission

Data transfer shall occur after the receipt of the command packet. See Table 92 for the return structure when the device is ready to transfer data requested by a data transfer command. Input/Output is ignored, and Command/Data shall be set to zero. See clause 7.26.6.3 for a desciption of how Byte Count operates during data transmission.

7.26.6.3 Byte Count

If the transfer is to be in PIO mode, the byte count of the data to be transferred for this DRQ assertion shall be presented.

Valid byte count values are as follows:

1. the byte count shall be less than or equal to the byte count limit value from the host;
2. the byte count shall not be zero;
3. the byte count shall be less than or equal to FFFEh;
4. the byte count shall be even except for the last transfer of a command;
5. if the byte count is odd, the last valid byte transferred is on DD(7:0) and the data on DD(15:8) is a pad byte of undefined value;

if the last transfer of a command has a pad byte, the byte count shall be odd.

7.26.6.4 Successful command completion

When the device has command completion without error, the device returns the data structure found in Table 92. Input/Output shall be set to one, Command/Data shall be set to one. Byte Count is reserved at command completion.

7.26.7 Error outputs

The device shall not terminate the PACKET command with an error before the last byte of the command packet has been written (See Clause 5.9).

Word	Name	Description
00h	Error	**Bit** **Description** 7:4 Sense Key - See clause 6.3.11 3 N/A 2 Abort - See clause 6.3.1 1 End of Media - See clause 6.3.3 0 Illegal Length Indicator - See clause 6.3.5
01h	Interrupt Reason	**Bit** **Description** 7:3 Tag - See clause 6.4.4 2 Release - See clause 6.4.1. Shall be cleared to zero 1 Input/Output - See clause 6.4.2. Shall be set to one 0 Command/Data - See clause 6.4.1. Shall be set to one
02h-04h	LBA	N/A
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 N/A 4 Service - See clause 6.2.9. 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Check Condition - See clause 6.2.2.

7.27 READ BUFFER - E4, PIO data-in

7.27.1 Feature Set
This command is optional for devices not implementing the PACKET Command feature set.

7.27.2 Description
The READ BUFFER command enables the host to read the current contents of the device's sector buffer.

The READ BUFFER and WRITE BUFFER commands shall be synchronized such that sequential WRITE BUFFER and READ BUFFER commands access the samebytes within the buffer.

The command prior to a READ BUFFER command shall be a WRITE BUFFER command.

7.27.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	E4h

7.27.4 Normal outputs
See Table 85

7.27.5 Error outputs
The device may return error status if an Interface CRC error has occurred. See Table 100.

Note: There is no defined mechanism for a device to return an ICRC error status that may have occurred during the last data block of a PIO-in data transfer, there may be other mechanisms in which a host can verify that an Interface CRC error occurred in these cases.

7.28 READ DMA - C8h, DMA

7.28.1 Feature Set
This command is mandatory for devices not implementing the PACKET Command feature set.

7.28.2 Description
The READ DMA command allows the host to read data using the DMA data transfer protocol.

7.28.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred. Bits 15:8 shall be cleared to zero
02h	LBA	MSB Address of first logical sector to be transferred. Bits 47:28 shall be cleared to zero LSB
03h		
04h		
05h	Command	C8h

7.28.4 Normal outputs
See Table 85

7.28.5 Error outputs
An unrecoverable error encountered during the execution of this command results in the termination of the command. The LBA field contains the address of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. LBA bits 47:28 shall be cleared to zero. See Table 107.

7.29 READ DMA EXT - 25h, DMA

7.29.1 Feature Set
This command is mandatory for devices implementing the 48-bit Address feature set.

7.29.2 Description
The READ DMA EXT command allows the host to read data using the DMA data transfer protocol.

7.29.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65536 logical sectors are to be transferred.
02h	LBA	MSB Address of first logical sector to be transferred. LSB
03h		
04h		
05h	Command	C8h

7.29.4 Normal outputs
See Table 85

7.29.5 Error outputs
An unrecoverable error encountered during the execution of this command results in the termination of the command. The Command Block registers contain the address of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. See Table 107.

7.30 READ DMA QUEUED - C7h, DMA Queued

7.30.1 Feature Set

This command is mandatory for devices implementing the Overlapped feature set **[Editors Note: This seems strange since we have a Queued command set as well]**.

7.30.2 Description

This command executes in a similar manner to a READ DMA command. The device may perform a release or may execute the data transfer without performing a release if the data is ready to transfer.

7.30.3 Inputs

Word	Name	Description
00h	Feature	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred. Bits 15:8 shall be cleared to zero
01h	Count	**Bit** **Description** 15:8 Reserved 7:3 Tag - See clause 6.4.4 2:0 N/A
02h	LBA	MSB Address of first logical sector to be transferred. Bits 47:28 shall be cleared to zero LSB
03h		
04h		
05h	Command	C7h

7.30.4 Normal outputs

7.30.4.1 Data transmission

Data transfer may occur after receipt of the command or may occur after the receipt of a SERVICE command. When the device is ready to transfer data requested by a data transfer command, the device returns the data structure described in Table 93. Release shall be cleared to zero, Input/Output shall be set to one, and Command/Data shall be cleared to zero.

7.30.4.2 Release

If the device performs a release before transferring data for this command, the device returns the data structure described in Table 93. Release shall be set to one, Input/Output shall be cleared to zero, and Command/Data shall be cleared to zero.

7.30.4.3 Service request

When the device is ready to transfer data or complete a command after the command has performed a release, the device shall set the SERV bit and not change the state of any other status bit. When the SERVICE command is received, the device shall set outputs as described in data transfer, command completion, or error outputs depending on the service the device requires.

7.30.4.4 Command completion

When the transfer of all requested data has occurred without error, the device returns the data structure described in Table 93. Release shall be cleared to zero, Input/Output shall be set to one, and Command/Data shall be set to one.

7.30.5 Error outputs

The Count field contains the Tag for this command if the device supports command queuing. The device shall return command aborted if the command is not supported or if the device has not had overlapped interrupt enabled. The device shall return command aborted if the device supports command queuing and the Tag is invalid. An unrecoverable error encountered during the execution of this command results in the termination of the command and the Command Block registers contain the logical sector where the first unrecoverable error occurred. If write cache is enabled unrecoverable errors may not be reliably reported as they may occur after the completion of the command. If a queue existed, the unrecoverable error shall cause the queue to abort.

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7 Interface CRC - See clause 6.3.6 6 Uncorrectable Error - See clause 6.3.12 5 Media Change - See clause 6.3.7 4 ID Not Found - See clause 6.3.4 3 Media Change Request - See clause 6.3.8 2 Abort - See clause 6.3.1 1 No Media - See clause 6.3.10 0 Obsolete
01h	Interrupt Reasont	**Bit** **Description** 7:3 Tag - See clause 6.4.4. If the device supports command queuing, this field shall contain the Tag of the command being released. 2 Release - See clause 6.4.1. Shall be cleared to zero 1 Input/Output - See clause 6.4.2. Shall be set to one 0 Command/Data - See clause 6.4.1. Shall be set to one
02h	LBA	MSB Address of first unrecoverable error Bits 47:28 shall be cleared to zero LSB
03h		
04h		
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 Service - See clause 6.2.9 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

7.31 READ DMA QUEUED EXT- 26h, DMA Queued

7.31.1 Feature Set
This command is mandatory for devices implementing both the Overlapped and 48-bit feature sets

7.31.2 Description
This command executes in a similar manner to a READ DMA command. The device may perform a release or may execute the data transfer without performing a release if the data is ready to transfer.

7.31.3 Inputs

Word	Name	Description
00h	Feature	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred. Bits 15:8 shall be cleared to zero
01h	Count	**Bit** **Description** 15:8 Reserved 7:3 Tag - See clause 6.4.4 2:0 N/A
02h	LBA	MSB
03h		Address of first logical sector to be transferred.
04h		LSB
05h	Command	26h

7.31.4 Normal outputs
See clause 7.30.4

7.31.5 Error outputs

The Count field contains the Tag for this command if the device supports command queuing. The device shall return command aborted if the command is not supported or if the device has not had overlapped interrupt enabled. The device shall return command aborted if the device supports command queuing and the Tag is invalid. An unrecoverable error encountered during the execution of this command results in the termination of the command and the Command Block registers contain the logical sector where the first unrecoverable error occurred. If write cache is enabled unrecoverable errors may not be reliably reported as they may occur after the completion of the command. If a queue existed, the unrecoverable error shall cause the queue to abort.

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7 Interface CRC - See clause 6.3.6 6 Uncorrectable Error - See clause 6.3.12 5 Media Change - See clause 6.3.7 4 ID Not Found - See clause 6.3.4 3 Media Change Request - See clause 6.3.8 2 Abort - See clause 6.3.1 1 No Media - See clause 6.3.10 0 Obsolete
01h	Interrupt Reasont	**Bit** **Description** 7:3 Tag - See clause 6.4.4. If the device supports command queuing, this field shall contain the Tag of the command being released. 2 Release - See clause 6.4.1. Shall be cleared to zero 1 Input/Output - See clause 6.4.2. Shall be set to one 0 Command/Data - See clause 6.4.1. Shall be set to one
02h	LBA	MSB
03h		Address of first unrecoverable error
04h		LSB
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 Service - See clause 6.2.9 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

7.32 READ LOG EXT - 2Fh, PIO data-in

7.32.1 Feature Set
This command is mandatory for devices implementing the General Purpose Logging feature set

7.32.2 Description
This command returns the specified log to the host.

7.32.2.1 General Purpose Log Directory
Table 18 defines the 512 bytes that make up the General Purpose Log Directory.

Table 18 - General Purpose Log Directory

Byte	Descriptions
0-1	General Purpose Logging Version
2	Number of logical sectors in the log at log address 01h (7:0)
3	Number of logical sectors in the log at log address 01h (15:8)
4	Number of logical sectors in the log at log address 02h (7:0)
5	Number of logical sectors in the log at log address 02h (15:8)
…	
256	10h logical sectors in the log at log address 80h
257	00h logical sectors in the log at log address 80h
…	
510-511	Number of logical sectors in the log at log address FFh

The value of the General Purpose Logging Version word shall be 0001h. A value of 0000h indicates that no General Purpose log Directory exists.

The logs at log addresses 80-9Fh shall each be defined as 16 logical sectors long.

7.32.2.2 Extended Comprehensive SMART Error log
Table 19 defines the format of each of the logical sectors that comprise the Extended Comprehensive SMART error log. The maximum size of the Extended Comprehensive SMART error log is 65,536 logical sectors. Devices may support fewer than 65,535 logical sectors. All multi-byte fields shown in this structure follow the byte ordering described in clause 3.2.7. Error log data structures shall include Uncorrectable errors (see clause 6.3.12), ID Not Found errors (see clause 6.3.4) for which the address requested was valid, servo errors, write fault errors, etc. Error log data structures shall not include errors attributed to the receipt of faulty commands such as command codes not implemented by the device or requests with invalid parameters or invalid addresses.

All 28-bit entries contained in the Comprehensive SMART log, defined under section 7.56.7.2.5, shall also be included in the Extended Comprehensive SMART error log with the 48-bit entries.

Table 19 - Extended Comprehensive SMART error log

Byte	First sector	Subsequent sectors
0	SMART error log version	Reserved
1	Reserved	Reserved
2	Error log index (7:0)	Reserved
3	Error log index (15:8)	Reserved
4-127	First error log data structure	Data structure 4n+1
128-251	Second error log data structure	Data structure 4n+2
252-375	Third error log data structure	Data structure 4n+3
376-499	Fourth error log data structure	Data structure 4n+4
500-501	Device error count	Reserved
502-510	Reserved	Reserved
511	Data structure checksum	Data structure checksum
n is the logical sector number within the log. The first logical sector is sector zero		

7.32.2.2.1 Error log version
The value of the SMART error log version byte shall be 01h.

7.32.2.2.2 Error log index
The error log index indicates the error log data structure representing the most recent error. If there have been no error log entries, the error log index is cleared to zero. Valid values for the error log index are zero to 65,536.

7.32.2.2.3 Extended Error log data structure
The error log is viewed as a circular buffer. When the last supported error log sector has been filled, the next error shall create an error log data structure that replaces the first error log data structure in logical sector zero. The next error after that shall create an error log data structure that replaces the second error log data structure in logical sector zero. The fifth error after the log has filled shall replace the first error log data structure in logical sector one, and so on.

The error log index indicates the most recent error log data structure. Unused error log data structures shall be filled with zeros.

The content of the error log data structure entries is defined in Table 20.

Table 20 - Extended Error log data structure

Byte	Descriptions
n thru n+17	First command data structure
n+18 thru n+35	Second command data structure
n+36 thru n+53	Third command data structure
n+54 thru n+71	Fourth command data structure
n+72 thru n+89	Fifth command data structure
n+90 thru n+123	Error data structure

7.32.2.2.3.1 Command data structure
The fifth command data structure shall contain the command or reset for which the error is being reported. The fourth command data structure should contain the command or reset that preceded the command or reset for which the error is being reported, the third command data structure should contain the command or reset preceding the one in the fourth command data structure, etc. If fewer than four commands and resets preceded the command or reset for which the error is being reported, the unused command data structures shall be zero filled, for example, if only three commands and resets preceded the command or reset for which the error is being reported, the first command data structure shall be zero filled. In some devices, the hardware implementation may preclude the device from reporting the commands that preceded the command for which the error is being reported or that preceded a reset. In this case, the command data structures are zero filled.

If the command data structure represents a command or software reset, the content of the command data structure shall be as shown in Table 21. If the command data structure represents a hardware reset, the content of byte n shall be FFh, the content of bytes n+1 through n+13 are vendor specific, and the content of bytes n+14 through n+17 shall contain the timestamp.

Table 21 - Command data structure

Byte	Descriptions
n	Content of the Device Control register when the Command register was written.
n+1	Content of the Feature field (7:0) when the Command was initiated. (See note)
n+2	Content of the Feature field (15:8) when the Command was initiated.
n+3	Content of the Count field (7:0) when the Command was initiated.
n+4	Content of the Count field (15:8) when the Command was initiated.
n+5	Content of the LBA field (7:0) when the Command was initiated.
n+6	Content of the LBA field (15:8) when the Command was initiated.
n+7	Content of the LBA field (23:16) when the Command was initiated.
n+8	Content of the LBA field (31:24) when the Command was initiated.
n+9	Content of the LBA field (39:32) when the Command was initiated.
n+10	Content of the LBA field (47:40) when the Command was initiated.
n+11	Transport specific (refer to the appropriate transport standard for a description of this field, reference Device/Head register) when the Command was initiated.
n+12	Content written to the Command field when the command was initiated
n+13	Reserved
n+14	Timestamp (least significant byte)
n+15	Timestamp (next least significant byte)
n+16	Timestamp (next most significant byte)
n+17	Timestamp (most significant byte)

Timestamp shall be the time since power-on in milliseconds when command acceptance occurred. This timestamp may wrap around.

7.32.2.2.3.2 Error data structure

The error data structure shall contain the error description of the command for which an error was reported as described in Table 22. If the error was logged for a hardware reset, the content of bytes n+1 through n+11 shall be vendor specific and the remaining bytes shall be as defined in Table 22.

Table 22 - Error data structure

Byte	Descriptions
n	Reserved
n+1	Content of the Error field (7:0) after command completion occurred.
n+2	Content of the Count field (7:0) after command completion occurred. (see note)
n+3	Content of the Count field (15:8) after command completion occurred. (see note)
n+4	Content of the LBA field (7:0) after command completion occurred.
n+5	Content of the LBA field (15:8) after command completion occurred.
n+6	Content of the LBA field (23:16) after command completion occurred.
n+7	Content of the LBA field (31:24) after command completion occurred.
n+8	Content of the LBA field (39:32) after command completion occurred.
n+9	Content of the LBA field (47:40) after command completion occurred.
n+10	Transport specific (refer to the appropriate transport standard for a description of this field, reference Device/Head register) after command completion occurred..
n+11	Content written to the Status field after command completion occurred.
n+12 through n+30	Extended error information
n+31	State
n+32	Life timestamp (least significant byte)
n+33	Life timestamp (most significant byte)

Extended error information shall be vendor specific.

State shall contain a value indicating the state of the device when the command was written to the Command register or the reset occurred as described in Table 23.

Table 23 - State field values

Value	State
x0h	Unknown
x1h	Sleep
x2h	Standby
x3h	Active/Idle
x4h	Executing SMART off-line or self-test
x5h-xAh	Reserved
xBh-xFh	Vendor unique
The value of x is vendor specific and may be different for each state.	

Sleep indicates the reset for which the error is being reported was received when the device was in the Sleep mode.

Standby indicates the command or reset for which the error is being reported was received when the device was in the Standby mode.

Active/Idle indicates the command or reset for which the error is being reported was received when the device was in the Active or Idle mode. **[Editors Note: was "and BSY=0" I do not know if removing the BSY statement changes the report. I do not see a BSY=1 entry]**

Executing SMART off-line or self-test indicates the command or reset for which the error is being reported was received when the device was in the process of executing a SMART off-line or self-test.

Life timestamp shall contain the power-on lifetime of the device in hours when command completion occurred.

7.32.2.2.4 Device error count

The device error count field shall contain the total number of errors attributable to the device that have been reported by the device during the life of the device. These errors shall include Uncorrectable errors (see clause 6.3.12), ID Note Found errors (see clause 6.3.4) for which the address requested was valid, servo errors, write fault errors, etc. This count shall not include errors attributed to the receipt of faulty commands such as commands codes not implemented by the device or requests with invalid parameters or invalid addresses. If the maximum value for this field is reached, the count shall remain at the maximum value when additional errors are encountered and logged.

7.32.2.2.5 Data structure checksum

The data structure checksum is the two's complement of the sum of the first 511 bytes in the data structure. Each byte shall be added with unsigned arithmetic, and overflow shall be ignored. The sum of all 512 bytes will be zero when the checksum is correct. The checksum is placed in byte 511.

7.32.2.3 Extended Self-test log sector

Table 24 defines the format of each of the logical sectors that comprise the Extended SMART Self-test log. The maximum size of the self-test log is 65,535 logical sectors. Devices may support fewer than 65,536 logical sectors. All multi-byte fields shown in this structure follow the byte ordering described in Volume 1, Clause 3.

The Extended SMART self-test log logical sector shall support 48-bit and 28-bit addressing. All 28-bit entries contained in the SMART self-test log, defined under section 7.56.7.2.6 shall also be included in the Extended SMART self-test log with all 48-bit entries.

Table 24 - Extended Self-test log data structure

Byte	First sector	Subsequent sectors
0	Self-test log data structure revision number	Reserved
1	Reserved	Reserved
2	Self-test descriptor index (7:0)	Reserved
3	Self-test descriptor index (15:8)	Reserved
4-29	Descriptor entry 1	Descriptor entry 18n+1
30-55	Descriptor entry 2	Descriptor entry 18n+2
….	....	....
472-497	Descriptor entry 18	Descriptor entry 18n+18
498-499	Vendor specific	Vendor specific
500-510	Reserved	Reserved
511	Data structure checksum	Data structure checksum
n is the logical sector number within the log. The first logical sector is zero		

This log is viewed as a circular buffer. When the last supported Self-test log sector has been filled, the next self-test shall create a descriptor that replaces descriptor entry 1 in logical sector 0. The next self-test after that shall create a descriptor that replaces descriptor entry 2 in logical sector 0, and so on. All unused self-test descriptors shall be filled with zeros.

7.32.2.3.1 Self-test descriptor index

The Self-test descriptor index indicates the most recent self-test descriptor. If there have been no self-tests, the Self-test descriptor index is set to zero. Valid values for the Self-test descriptor index are zero to 65,535.

7.32.2.3.2 Self-test log data structure revision number

The value of the self-test log data structure revision number shall be 01h.

7.32.2.3.3 Extended Self-test log descriptor entry

The content of the self-test descriptor entry is shown in Table 25.

Table 25 - Extended Self-test log descriptor entry

Byte	Descriptions
n	Content of the LBA field (7:0)
n+1	Content of the self-test execution status byte.
n+2	Life timestamp (least significant byte).
n+3	Life timestamp (most significant byte).
n+4	Content of the self-test failure checkpoint byte.
n+5	Failing LBA (7:0).
n+6	Failing LBA (15:8).
n+7	Failing LBA (23:16).
n+8	Failing LBA (31:24).
n+9	Failing LBA (39:32).
n+10	Failing LBA (47:40).
n+1 - n+23	Vendor specific.

Content of the LBA field (7:0) shall be the content of the LBA field (7:0) when the nth self-test subcommand was issued (See 7.56.5.1).

Content of the self-test execution status byte shall be the content of the self-test execution status byte when the nth self-test was completed (See 7.56.6.4).

Life timestamp shall contain the power-on lifetime of the device in hours when the nth self-test subcommand was completed.

Content of the self-test failure checkpoint byte may contain additional information about the self-test that failed.

The failing LBA shall be the LBA of the logical sector that caused the test to fail. If the device encountered more than one failed logical sector during the test, this field shall indicate the LBA of the first failed logical sector encountered. If the test passed or the test failed for some reason other than a failed logical sector, the value of this field is undefined.

7.32.2.3.4 Data structure checksum

The data structure checksum is the two's complement of the sum of the first 511 bytes in the data structure. Each byte shall be added with unsigned arithmetic, and overflow shall be ignored. The sum of all 512 bytes is zero when the checksum is correct. The checksum is placed in byte 511.

7.32.2.4 Read Stream Error Log

Table 26 defines the format of the Read Stream Error log. Entries are placed into the Read Stream Error log only when the SE bit is set to one in the Status register. The 512 bytes returned shall contain a maximum of 31 error entries. The Read Stream Error Count shall contain the total number of Read Stream Errors detected since the last successful completion of the READ LOG EXT command with LBA field (7:0) set to 22h. This error count may be greater than 31, but only the most recent 31 errors are represented by entries in the log. If the Read Stream Error Count reaches the maximum value that can be represented, after the next error is detected the Read Stream Error Count shall remain at the maximum value. After successful completion of a READ LOG EXT command with the LBA field (7:0) set to 22h, the Read Stream Error Log shall be reset to a power-on or hardware reset condition, with the Error Log Index and Read Stream Error Count cleared to zero. The Read Stream Error Log is not preserved across power cycles and hardware reset.

Table 26 - Read Stream Error Log

Byte	Content
0	Structure Version
1	Error Log Index
2-3	Read Stream Error Log Count
4-15	Reserved
16-31	Read Stream Error Log Entry #1
32-47	Read Stream Error Log Entry #2
48-63	Read Stream Error Log Entry #3
64-511	Read Stream Error Log Entries #4 through #31

The Data Structure Version field shall contain a value of 02h indicating the second revision of the structure format.

The Read Stream Error Log Count field shall contain the number of uncorrected sector entries currently reportable to the host. This value may exceed 31.

The Error Log Index indicates the error log data structure representing the most recent error. Only values (31:1) are valid.

Table 27 defines the format of each entry in the Read Stream Error Log.

Table 27 - Error Log Entry

Byte	7	6	5	4	3	2	1	0
0	Feature Register Contents Value (current)							
1	Feature Register Contents Value (previous)							
2	Status Register Contents Value							
3	Error Register Contents Value							
4	LBA (7:0)							
5	LBA (15:8)							
6	LBA (23:16)							
7	LBA (31:24)							
8	LBA (39:32)							
9	LBA (47:40)							
10-11	Reserved							
12	Sector Count (LSB)							
13	Sector Count (MSB)							
14	Reserved							
15	Reserved							

Byte (1:0) (Feature Register Contents Value) contains the contents of the Feature Register when the error occurred. This value shall be set to 0FFFFh for a deferred write error.

Byte 2 (Status Register Contents Value) contains the contents of the Status Register when the error occurred.

Byte 3 (Error Register Contents Value) contains the contents of the Error Register when the error occurred.

Bytes (9:4) (LBA) indicate the starting LBA of the error.

Bytes (13:12) (Sector Count) indicate the length of the error. Therefore, each entry may describe a range of logical sectors starting at the given address and spanning the specified number of logical sectors.

7.32.2.5 Write Stream Error Log

Table 28 defines the format of the Write Stream Error log. Entries are placed into the Write Stream Error log only when the SE bit is set to one in the Status register. The 512 bytes returned shall contain a maximum of 31 error entries. The Write Stream Error Count shall contain the total number of Write Stream Errors detected since the last successful completion of the READ LOG EXT command with LBA register field (7:0) set to 21h. This error count may be greater than 31, but only the most recent 31 errors are represented by entries in the log. If the Write Stream Error Count reaches the maximum value that can be represented, after the next error is detected the Write Stream Error Count shall remain at the maximum value. After successful completion of a READ LOG EXT command with the LBA field (7:0) set to 21h, the Write Stream Error Log shall be reset to a power-on or hardware reset condition, with the Error Log Index and Write Stream Error Count cleared to zero. The Write Stream Error Log is not preserved across power cycles and hardware reset.

Table 28 - Write Stream Error Log

Byte	Content
0	Structure Version
1	Error Log Index
2-3	Write Stream Error Log Count
4-15	Reserved
5-7	Reserved
16-31	Write Stream Error Log Entry #1
32-47	Write Stream Error Log Entry #2
48-63	Write Stream Error Log Entry #3
64-511	Write Stream Error Log Entries #4 through #31

The Data Structure Version field shall contain a value of 02h indicating the second revision of the structure format.

The Write Stream Error Log Count field shall contain the number of WRITE STREAM command entries since the last power on, since this log was last read, or since a hardware reset was executed.

The Error Log Index indicates the error log data structure representing the most recent error. Only values (31:0) are valid.

Table 27 defines the format of each entry in the Error Log.

7.32.3 Inputs

All Log Addresses in this standard reserve the Feature field.

Word	Name	Description
00h	Feature	Log Address Specific
01h	Count	Sector Count - Specifies the number of logical sectors to be read from the specified log. The log transferred by the drive shall start at the logical sector in the specified log at the specified offset, regardless of the logical sector count requested
02h-04h	LBA	**Bit** **Description** 47:32 Reserved 31:16 Sector Offset - Specifies the first logical sector of the log to be read. 15:8 Reserved 7:0 Log Address - Specifies the log to be returned as described in Table 29. A device may support a subset of the available logs. Support for individual logs is determined by support for the associated feature set. Support of the associated log(s) is mandatory for devices implementing the associated feature set. The host vendor specific logs may be used by the host to store any data desired. If a host vendor specific log has never been written by the host, when read the content of the log shall be zeros. Device vendor specific logs may be used by the device vendor to store any data and need only be implemented if used.
05h	Command	2Fh

Table 29 - Log address definition

Log address	Content	Feature set	R/W	Access
00h	Log directory	na	RO	GPL,SL
01h	Summary SMART error log	SMART	RO	SL
02h	Comprehensive SMART error log	SMART error logging	RO	SL
03h	Extended Comprehensive SMART error log	SMART error logging	RO	GPL
04h-05h	Reserved	na	Reserved	GPL
06h	SMART self-test log	SMART self-test	RO	SL
07h	Extended SMART self-test log	SMART self-test	RO	GPL
08h	Reserved	na	Reserved	
09h	Selective Self-test log	SMART Self-test	R/W	SL
0Ah-0Fh	Reserved	na	Reserved	
10h-17h	Reserved for Serial ATA	na	Reserved	
18h-1Fh	Reserved	na	Reserved	
20h	Obsolete			
21h	Write stream error log	Streaming	RO	GPL
22h	Read stream error log	Streaming	RO	GPL
23h	Obsolete			
24h-7Fh	Reserved	na	Reserved	
80h-9Fh	Host vendor specific	SMART	R/W	GPL,SL
A0h-BFh	Device vendor specific	SMART	VS	GPL,SL
C0h-EFh	Reserved	na	Reserved	
E0h-E1h	Reserved for SCT ***[Editors Note: Need to fill in project number]***	na	Reserved	
E2h-FFh	Reserved	na		

Key –

RO - Log is only read by the host.
R/W - Log is read or written by the host.
VS - Log is vendor specific thus read/write ability is vendor specific.
GPL - General Purpose Logging
SL - SMART Logging

NOTE – Command Abort shall be returned if a GPL command is used to access a log page that is marked with SL only. Command Abort shall be returned if an SL command is used to access a log page that is marked with GPL only.

The Comprehensive SMART error log and the SMART self-test log are defined in 7.56.7 and 7.56.9. If log address 02h or log address 06h are accessed using the READ LOG EXT or WRITE LOG EXT commands, command abort shall be returned.

All 28-bit entries contained in the Comprehensive SMART log shall also be included in the Extended Comprehensive SMART error log with the 48-bit entries.

The Extended SMART self-test log sector shall support 48-bit and 28-bit addressing. All 28-bit entries contained in the SMART self-test log sector shall also be included in the Comprehensive SMART self-test log sector with the 48-bit entries.

7.32.4 Normal outputs

See Table 85

7.32.5 Error outputs

If the device does not support this command, if the feature set associated with the log specified in the LBA LBA field (7:0) is not supported or enabled, or if the values in the Features, Count, or LBA (47:8) fields are invalid, the device shall return command aborted. Abort shall be set to one if the feature associated with the log specified in the LBA bits 7:0 is not supported, or if other field values are invalid. Abort may be set to one if the device is not able to complete the action requested by the command. Abort shall be set to one if the

Sector Count is larger than the log size reported in the Log Directory. Abort shall be set to one if the host issues a READ LOG EXT or WRITE LOG EXT command with a value of zero as Sector Count. The device may return error status if an Interface CRC error has occurred. See Table 108.

Note: There is no defined mechanism for a device to return an ICRC error status that may have occurred during the last data block of a PIO-in data transfer, there may be other mechanisms in which a host can verify that an Interface CRC error occurred in these cases.

7.33 READ LOG DMA EXT - 47h, DMA

7.33.1 Feature Set
This command is optional for devices implementing the General Purpose Logging feature set

7.33.2 Description
See clause 7.32.2

7.33.3 Inputs
See clause 7.32.3

7.33.4 Normal Outputs
See clause 7.32.4

7.33.5 Error Outputs
See clause 7.32.5

7.34 READ MULTIPLE - C4h, PIO data-in

7.34.1 Feature Set

This command is mandatory for devices implementing the General Feature Set.

7.34.2 Description

This command reads the number of logical sectors specified in the Count field.

The number of logical sectors per DRQ data block is defined by the content of word 59 in the IDENTIFY DEVICE data. The device shall interrupt for each DRQ data block transferred.

When the READ MULTIPLE command is issued, the Count field contains the number of logical sectors (not the number of blocks) requested.

If the number of requested logical sectors is not evenly divisible by the DRQ data block count, as many full DRQ data blocks as possible are transferred, followed by a final, partial DRQ data block transfer. The partial DRQ data block transfer shall be for n logical sectors, where n = remainder (sector count/ DRQ data block count).

If the READ MULTIPLE command is received when read multiple commands are disabled, the READ MULTIPLE operation shall be rejected with command aborted.

Device errors encountered during READ MULTIPLE commands are posted at the beginning of the block or partial block transfer The contents of the Command Structure following the transfer of a data block that had a logical sector in error are undefined. The host should retry the transfer as individual requests to obtain valid error information.

Subsequent DRQ datra blocks or partial DRQ data blocks are transferred only if the error was a correctable data error. All other errors cause the command to stop after transfer of the DRQ data block that contained the error.

If bit 8 of IDENTIFY DEVICE data word 59 is cleared to zero, a successful SET MULTIPLE MODE command shall precede a READ MULTIPLE command.

7.34.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred. Bits 15:8 shall be cleared to zero
02h	LBA	MSB Address of first logical sector to be transferred. Bits 47:28 shall be cleared to zero
03h		
04h		LSB
05h	Command	C4h

7.34.4 Normal outputs

See Table 85

7.34.5 Error outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The LBA field contains the address of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. LBA bits 47:28 shall be cleared to zero. The device may return error status if an Interface CRC error has occurred. See Table 109.

Note: There is no defined mechanism for a device to return an ICRC error status that may have occurred during the last data block of a PIO-in data transfer, there may be other mechanisms in which a host can verify that an Interface CRC error occurred in these cases.

7.35 READ MULTIPLE EXT - 29h, PIO data-in

7.35.1 Feature Set

This command is mandatory for all devices implementing the 48-bit Address feature set.

7.35.2 Description

This command reads the number of logical sectors specified in the Count field.

The number of logical sectors per DRQ data block is defined by the content of word 59 in the IDENTIFY DEVICE data. The device shall interrupt for each DRQ data block transferred.

When the READ MULTIPLE EXT command is issued, the Count field contains the number of logical sectors (not the number of blocks) requested.

If the number of requested logical sectors is not evenly divisible by the DRQ data block count, as many full DRQ data blocks as possible are transferred, followed by a final, partial DRQ data block transfer. The partial DRQ data block transfer shall be for n logical sectors, where n = remainder (sector count/ DRQ data block count).

If the READ MULTIPLE EXT command is received when read multiple commands are disabled, the READ MULTIPLE EXT operation shall be rejected with command aborted.

Device errors encountered during READ MULTIPLE EXT commands are posted at the beginning of the block or partial block transfer The contents of the Command Structure following the transfer of a data block that had a logical sector in error are undefined. The host should retry the transfer as individual requests to obtain valid error information.

Subsequent DRQ datra blocks or partial DRQ data blocks are transferred only if the error was a correctable data error. All other errors cause the command to stop after transfer of the DRQ data block that contained the error.

If bit 8 of IDENTIFY DEVICE data word 59 is cleared to zero, a successful SET MULTIPLE MODE command shall precede a READ MULTIPLE EXT command.

7.35.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred. Bits 15:8 shall be cleared to zero
02h	LBA	MSB
03h		Address of first logical sector to be transferred.
04h		LSB
05h	Command	29h

7.35.4 Normal outputs

See Table 85

7.35.5 Error outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The LBA field contains the address of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. The device may return error status if an Interface CRC error has occurred. See Table 109.

Note: There is no defined mechanism for a device to return an ICRC error status that may have occurred during the last data block of a PIO-in data transfer, there may be other mechanisms in which a host can verify that an Interface CRC error occurred in these cases.

7.36 READ NATIVE MAX ADDRESS - F8h, Non-data

7.36.1 Feature Set

This command is mandatory for devices implementing the Host Protected Area feature set. Use of this command is prohibited for devices implementing the Removable feature set.

7.36.2 Description

This command returns the native maximum address. The native maximum address is the highest address accepted by the device in the factory default condition. The native maximum address is the maximum address that is valid when using the SET MAX ADDRESS command.

If the 48-bit Address feature set is supported and the 48-bit native max address is greater than 268,435,455, the READ NATIVE MAX ADDRESS command shall return a maximum value of 268,435,454.

7.36.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	F8h

7.36.4 Normal outputs

See Table 94. LBA contains the Native Max Address. Bits 47:28 of LBA shall be cleared to zero.

7.36.5 Error outputs

See Table 101

7.37 READ NATIVE MAX ADDRESS EXT - 27h, Non-data

7.37.1 Feature Set

This command is mandatory for devices implementing both the Host Protected Area feature set and the 48-bit Address feature set. Use of this command is prohibited for devices implementing the Removable feature set.

7.37.2 Description

This command returns the native maximum address. The native maximum address is the highest address accepted by the device in the factory default condition. The native maximum address is the maximum address that is valid when using the SET MAX ADDRESS EXT command.

7.37.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	27h

7.37.4 Normal outputs

See Table 94. LBA contains the Native Max Address.

7.37.5 Error outputs

See Table 101.

7.38 READ SECTOR(S) - 20h, PIO data-in

7.38.1 Feature Set
This command is mandatory for all devices implementing the General Feature Set.

7.38.2 Description
This command reads from 1 to 256 logical sectors as specified in the Count field. A sector count of 0 requests 256 logical sectors. The transfer shall begin at the logical sector specified in the LBA field.

7.38.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred. Bits 15:8 shall be cleared to zero
02h	LBA	MSB Address of first logical sector to be transferred. Bits 47:28 shall be cleared to zero. LSB
03h		
04h		
05h	Command	20h

7.38.4 Outputs
7.38.4.1 Normal outputs
See Table 85

7.38.4.2 Outputs for PACKET Command feature set devices

In response to this command, devices that implement the PACKET Command feature set shall post command aborted and place the PACKET Command feature set signature in the LBA field (23:8) (See 7.11 for a list of the possible signatures).

7.38.5 Error outputs
LBA bits 47:28 shall be cleared to zero. The device may return error status if an Interface CRC error has occurred. See Table 109.

Note: There is no defined mechanism for a device to return an ICRC error status that may have occurred during the last data block of a PIO-in data transfer, there may be other mechanisms in which a host can verify that an Interface CRC error occurred in these cases.

7.39 READ SECTOR(S) EXT - 24h, PIO data-in

7.39.1 Feature Set
This command is mandatory for devices implementing the 48-bit Address feature set

7.39.2 Description
This command reads from 1 to 65,536 logical sectors as specified in the Count field. A sector count of 0000h requests 65,536 logical sectors. The transfer shall begin at the logical sector specified in the LBA field..

7.39.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred. Bits 15:8 shall be cleared to zero
02h	LBA	MSB
03h		Address of first logical sector to be transferred.
04h		LSB
05h	Command	24h

7.39.4 Normal outputs
See Table 85

7.39.5 Error outputs
The device may return error status if an Interface CRC error has occurred. See Table 109.

Note: There is no defined mechanism for a device to return an ICRC error status that may have occurred during the last data block of a PIO-in data transfer, there may be other mechanisms in which a host can verify that an Interface CRC error occurred in these cases.

7.40 READ STREAM DMA EXT - 2Ah, DMA

7.40.1 Feature Set

This command is mandatory for devices that implement the Streaming feature set.

7.40.2 Description

The READ STREAM DMA EXT command provides a method for a host to read data within an allotted time using the DMA data transfer protocol. This command allows the host to specify that additional actions are to be performed by the device prior to the completion of the command.

7.40.3 Inputs

7.40.3.1 Inputs Overview

The following table shows the inputs for the command.

Word	Name	Description
00h	Feature	**Bit** **Description** 15:8 Command Completion Time Limit (CCTL)- See clause 7.40.3.2. 7 Obsolete 6 Read Continuous (RC) - See clause7.40.3.3 5 Not Sequential (NS) – See 7.40.3.4 4 Obsolete 3 Reserved 2:0 Stream ID – See 7.40.3.5
01h	Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65536 logical sectors are to be transferred.
02h	LBA	MSB
03h		Address of first logical sector to be transferred.
04h		LSB
05h	Command	2Ah

7.40.3.2 Command Completion Time Limit (CCTL)

CCTL specifies the time allowed for the device to process the command before reporting command completion.

If CCTL is not cleared to zero, then the device shall report command completion within (CCTL ∗ (IDENTIFY DEVICE data words (99:98)) microseconds. The device shall measure the time before reporting command completion from command acceptance.

If CCTL is cleared to zero, and Default CCTL was not cleared to zero in the most recent CONFIGURE STREAM command (see 7.9) for the Stream ID, then the device shall report command completion within the time specified by Default CCTL (see 7.9.3.4).

If CCTL is cleared to zero, and Default CCTL was cleared to zero in the most recent CONFIGURE STREAM command (see 7.9) for the Stream ID, or CCTL is cleared to zero and no previous CONFIGURE STREAM command was used to specify a Default CCTL for this Stream ID, then the result is vendor specific.

After reporting command completion, a device may continue to write data for the command from device cache to the media.

7.40.3.3 Read Continuous

If RC is set to one, then:

a) the device shall not stop processing the command due to errors;
b) if an error occurs during data transfer or while reading data from the media before command completion or before the amount of time allowed for command completion based on the setting of CCTL (see 7.38.3.2) or Default CCTL (see 7.9.3) is reached, then the device:
    1) shall continue to transfer the amount of data requested;
    2) may continue reading data from the media;

3) shall report command completion after all data for the command has been transferred; and
4) shall save the error information in the Read Streaming Error log;

or

c) if the amount of time allowed for command completion based on the setting of CCTL (see 7.38.3.2) or Default CCTL (see 7.9.3) is reached, then the device:
   1) shall stop processing the command;
   2) shall report command completion; and
   3) shall set CCTO in the Read Streaming Error log to one.

If RC is cleared to zero and an error occurs, then the device:

a) may continue transferring data; and
b) shall report command completion after the data transfer has been completed.

7.40.3.4 Not Sequential (NS)

If NS is set to one, then the next READ STREAM command with the same Stream ID may not be sequential in the LBA space. Any read of the device media or internal device buffer management as a result of the state of the NS bit is vendor specific.

7.40.3.5 Stream ID

Stream ID specifies the stream to be read. The device shall operate according to the parameters specified by the most recent successful CONFIGURE STREAM command specifying this Stream ID.

7.40.4 Normal outputs

See Table 89 for the definition of normal outputs

7.40.5 Error outputs

If:

a) RC was set to one in the command, and
b) the device is able to return the amount of data requested for the command (e.g., an error occurred while reading from the media);

then the device shall set SE to one and clear ERR to zero.

If:

a) RC was set to one in the command, and
b) the device is not able to return the amount of data requested for the command (e.g., an ICRC error will be reported at command completion);

then the device shall clear SE to zero and set ERR to one.

If:

a) RC was cleared to zero in the command;
b) CCTL was not cleared to zero in the command, or CCTL was cleared to zero in the command and Default CCTL specified in the most recent CONFIGURE STREAM command for the Stream ID (see 7.9) was not cleared to zero; and
c) the time specified for command completion by CCTL (see 7.38.3.2) or Default CCTL (see 7.9.3) has been reached;

then the device shall clear SE to zero, set ERR to one, and set ABRT to one.

If:

a) RC was cleared to zero in the command;
b) CCTL was cleared to zero in the command; and
c) Default CCTL was cleared to zero in the most recent CONFIGURE STREAM command for the Stream ID (see 7.9);

then the device shall clear SE to zero, set ERR to one, and set ICRC, IDNF, and/or ABRT to one (i.e., indicating the error type).

See Table 110 for the definition of other error outputs.

7.41 READ STREAM EXT - 2Bh, PIO data-in

7.41.1 Feature Set

This command is mandatory for devices that implement the Streaming feature set.

7.41.2 Description

See 7.40.2 for the description of this command.

7.41.3 Inputs

See 7.40.3 for a description of the inputs for this command.

7.41.4 Normal outputs

See Table 89 for a description of the normal outputs.

7.41.5 Error outputs

See 7.40.5 for the description of error outputs.

7.42 READ VERIFY SECTOR(S) - 40h, Non-data

7.42.1 Feature Set
This command is mandatory for all devices that implement the General Feeature set

7.42.2 Description
This command is identical to READ SECTOR(S) command, except that no data is transferred from the device to the host. The device shall read the data from the media and verify that there are no errors.

7.42.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred. Bits 15:8 shall be cleared to zero
02h	LBA	MSB Address of first logical sector to be transferred. Bits 47:28 shall be cleared to zero. LSB
03h		
04h		
05h	Command	40h

7.42.4 Normal outputs
See Table 85

7.42.5 Error outputs
LBA bits 47:28 shall be cleared to zero. See Table 109.

7.43 READ VERIFY SECTOR(S) EXT - 42h, Non-data

7.43.1 Feature Set

This command is mandatory for devices implementing the 48-bit Address feature set

7.43.2 Description

This command is identical to READ SECTOR(S) EXT command, except that no data is transferred from the device to the host. The device shall read the data from the media and verify that there are no errors.

7.43.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred.
02h	LBA	MSB
03h		Address of first logical sector to be transferred.
04h		LSB
05h	Command	42h

7.43.4 Normal outputs

See Table 85

7.43.5 Error outputs

See Table 109.

7.44 SECURITY DISABLE PASSWORD - F6h, PIO data-out

7.44.1 Feature Set
This command is mandatory for devices that implement the Security Mode feature set.

7.44.2 Description
The SECURITY DISABLE PASSWORD command transfers 512 bytes of data from the host. Table 30 defines the content of this information. If the password selected by word 0 matches the password previously saved by the device, the device shall disable the Lock mode. This command shall not change the Master password. The Master password shall be reactivated when a User password is set (See 4.7).
This command shall only complete successfully if the Device is in Unlocked mode.

7.44.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	F6h

7.44.4 Normal outputs
See Table 85

7.44.5 Error outputs

The device shall return command aborted if the command is not supported, the device is in Locked mode, or the device is in Frozen mode. The device may return error status if an Interface CRC error has occurred. See Table 100.

7.44.6 Output Data Structure

Table 30 - SECURITY DISABLE PASSWORD and SECURITY UNLOCK data content

Word	Content
0	Control word Bit 0 Identifier 0=compare User password 1=compare Master password Bit (15:1) Reserved
1-16	Password (32 bytes)
17-255	Reserved

7.45 SECURITY ERASE PREPARE - F3h, Non-data

7.45.1 Feature Set

This command is mandatory for devices that implement the Security Mode feature set.

7.45.2 Description

The SECURITY ERASE PREPARE command shall be issued immediately before the SECURITY ERASE UNIT command to enable device erasing and unlocking. This command prevents accidental loss of data on the device.

7.45.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	F3h

7.45.4 Normal outputs

See Table 85

7.45.5 Error outputs

Abort shall be set to one if the device is in Frozen mode. See Table 100.

7.46 SECURITY ERASE UNIT - F4h, PIO data-out

7.46.1 Feature Set

This command is mandatory for devices that implement the Security Mode feature set.

7.46.2 Description

This command transfers 512 bytes of data from the host. Table 31 defines the content of this information. If the password does not match the password previously saved by the device, the device shall reject the command with command aborted.

The SECURITY ERASE PREPARE command shall be completed immediately prior to the SECURITY ERASE UNIT command. If the device receives a SECURITY ERASE UNIT command without an immediately prior SECURITY ERASE PREPARE command, the device shall command abort the SECURITY ERASE UNIT command. In addition, if a master or user password has not been set, the device shall abort the SECURITY ERASE UNIT command. A host may preceed the erasure process by always setting a master password through the use of SECURITY SET PASSWORD to ensure that the requirement for a password has been met.

When Normal Erase mode is specified, the SECURITY ERASE UNIT command shall write binary zeroes to all user data areas. The Enhanced Erase mode is optional. When Enhanced Erase mode is specified, the device shall write predetermined data patterns to all user data areas. In Enhanced Erase mode, all previously written user data shall be overwritten, including sectors that are no longer in use due to reallocation.

This command shall disable the device Lock mode, however, the Master password shall still be stored internally within the device and may be reactivated later when a new User password is set.

This command shall be immediately preceded by a SECURITY ERASE PREPARE command.

7.46.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	F4h

7.46.4 Normal outputs

See Table 85

7.46.5 Error outputs

Abort shall be set to one if the device is in Frozen mode, not preceded by a SECURITY ERASE PREPARE command, or if the data area is not successfully overwritten. The device may return error status if an Interface CRC error has occurred. See Table 100.

7.46.6 Output Data Structure

Table 31 - SECURITY ERASE UNIT data content

Word	Content
0	Control word Bit 0 Identifier 0=Compare User password 1=Compare Master password Bit 1 Erase mode 0=Normal Erase 1=Enhanced Erase Bit (15:2) Reserved
1-16	Password (32 bytes)
17-255	Reserved

7.47 SECURITY FREEZE LOCK - F5h, Non-data

7.47.1 Feature Set

This command is mandatory for devices that implement Security Mode feature set.

7.47.2 Description

The SECURITY FREEZE LOCK command shall set the device to Frozen mode. After command completion any other commands that update the device Lock mode shall be command aborted. Frozen mode shall be disabled by power-off or hardware reset. If SECURITY FREEZE LOCK is issued when the device is in Frozen mode, the command executes and the device shall remain in Frozen mode.

Commands disabled by SECURITY FREEZE LOCK are:

- SECURITY SET PASSWORD
- SECURITY UNLOCK
- SECURITY DISABLE PASSWORD
- SECURITY ERASE PREPARE
- SECURITY ERASE UNIT

7.47.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	F5h

7.47.4 Normal outputs

See Table 85

7.47.5 Error outputs

Abort shall be set to one if the device is in Frozen mode. See Table 100.

7.48 SECURITY SET PASSWORD - F1h, PIO data-out

7.48.1 Feature Set

This command is mandatory for devices that implement the Security Mode feature set.

7.48.2 Description

This command transfers 512 bytes of data from the host. Table 32 defines the content of this information. The data transferred controls the function of this command. Table 33 defines the interaction of the identifier and security level bits.

The revision code field shall be returned in the IDENTIFY DEVICE data word 92. The valid revision codes are 0001h through FFFEh. A value of 0000h or FFFFh indicates that the Master Password Revision Code is not supported.

7.48.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	F1h

7.48.4 Normal outputs

See Table 85

7.48.5 Error outputs

Abort shall be set to one if the device is in Frozen mode. The device may return error status if an Interface CRC error has occurred. See Table 100.

7.48.6 Output Data Structure

Table 32 - SECURITY SET PASSWORD data content

Word	Content
0	Control word Bit 0 Identifier 0=set User password 1=set Master password Bits (7:1) Reserved Bit 8 Security level 0=High 1=Maximum Bits (15:9) Reserved
1-16	Password (32 bytes)
17	Master Password Revision Code (valid if word 0 bit 0 = 1)
18-255	Reserved

Table 33 - Identifier and security level bit interaction

Identifier	Level	Command result
User	High	The password supplied with the command shall be saved as the new User password. The Lock mode shall be enabled from the next power-on or hardware reset. The device shall then be unlocked by either the User password or the previously set Master password.
User	Maximum	The password supplied with the command shall be saved as the new User password. The Lock mode shall be enabled from the next power-on or hardware reset. The device shall then be unlocked by only the User password. The Master password previously set is still stored in the device but shall not be used to unlock the device.
Master	High or Maximum	This combination shall set a Master password but shall not enable or disable the Lock mode. The security level is not changed. Master password revision code set to the value in Master Password Revision Code field.

7.49 SECURITY UNLOCK - F2h, PIO data-out

7.49.1 Feature Set

This command is mandatory for devices that implement the Security Mode feature set.

7.49.2 Description

This command transfers 512 bytes of data from the host. Table 32 defines the content of this information.

If the Identifier bit is set to Master and the device is in high security level, then the password supplied shall be compared with the stored Master password. If the device is in maximum security level then the unlock shall be rejected.

If the Identifier bit is set to user then the device shall compare the supplied password with the stored User password.

If the password compare fails then the device shall return command aborted to the host and decrements the unlock counter. This counter shall be initially set to five and shall be decremented for each password mismatch when SECURITY UNLOCK is issued and the device is locked. When this counter reaches zero then SECURITY UNLOCK and SECURITY ERASE UNIT commands shall be command aborted until a power-on reset or a hardware reset. SECURITY UNLOCK commands issued when the device is unlocked have no effect on the unlock counter.

7.49.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	F2h

7.49.4 Normal outputs

See Table 85

7.49.5 Error outputs

Abort shall be set to one if the device is in Frozen mode. The device may return error status if an Interface CRC error has occurred. See Table 100.

7.50 SERVICE - A2h, Packet or DMA queued

7.50.1 Feature Set

This command is mandatory for devices that implement the Overlapped Feature set

7.50.2 Description

The SERVICE command is used to provide data transfer and/or status of a command that was previously released.

The device shall have performed a release for a previous overlap READ DMA QUEUED, READ DMA QUEUED EXT, WRITE DMA QUEUED, WRITE DMA QUEUED FUA EXT or WRITE DMA QUEUED EXT command and shall have set the Service (see 6.2.9) bit to one to request the SERVICE command be issued to continue data transfer and/or provide command status (See 7.51.16).

7.50.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	A2h

7.50.4 Outputs

Outputs as a result of a SERVICE command are described in the command description for the command for which SERVICE is being requested.

7.51 SET FEATURES - EFh, Non-data

7.51.1 Feature Set

This command is mandatory for all devices.

7.51.2 Description

The set transfer mode subcommand is mandatory. Enable/disable write cache subcommands are mandatory when a write cache is implemented. Enable/disable Media Status Notification sub commands are mandatory if the Removable Media feature set is implemented. All other subcommands are optional.

This command is used by the host to establish parameters that affect the execution of certain device features. Table 34 defines these features.

At power-on, or after a hardware reset, the default settings of the functions specified by the subcommands are vendor specific.

Table 34 - SET FEATURES register definitions

Value	[Editors Note: Sync with historical annex]
00h	Reserved
01h	Enable 8-bit PIO transfer mode (CFA feature set only)
02h	Enable write cache
03h	Set transfer mode based on value in Count field. Table 35 defines values.
04h	Obsolete
05h	Enable advanced power management
06h	Enable Power-Up In Standby feature set.
07h	Power-Up In Standby feature set device spin-up.
08h	Reserved
09h	Reserved for Address offset reserved area boot method technical report **[Editors Note: This actually has a function in CFA, add the definition]**
0Ah	Enable CFA power mode 1
0Bh	Enable Write Read Verify feature set
0Ch-0Fh	Reserved
10h	Reserved for Serial ATA
11h-1Fh	Reserved
20h	Reserved for technical report INCITS TR-37-2004 (TLC)
21h	Reserved for technical report INCITS TR-37-2004 (TLC)
22h-30h	Reserved
31h	Disable Media Status Notification
32h	Reserved
33h	Obsolete
34h-41h	Reserved
42h	Enable Automatic Acoustic Management feature set
43h	Set Maximum Host Interface Sector Times
44h	Obsolete
45h-53h	Reserved
54h	Obsolete
55h	Disable read look-ahead feature
56h-5Ch	Vendor Specific
5Dh	Enable release interrupt
5Eh	Enable SERVICE interrupt
5Fh	Reserved for DT2014
60h-65h	Reserved
66h	Disable reverting to power-on defaults
67h-68h	Reserved
69h	**[Editors Note: CFA 2.1 defines this as a NOP for ?backwards compatability?]**
6Ah-76h	Reserved
77h	Obsolete
78h-80h	Reserved
81h	Disable 8-bit PIO transfer mode (CFA feature set only)
82h	Disable write cache
83h	Reserved
84h	Obsolete
85h	Disable advanced power management
86h	Disable Power-Up In Standby feature set.
87h	Reserved
88h	Obsolete
89h	Reserved for Address offset reserved area boot method technical report. **[Editors Note: This actually has a function in CFA, add both definitions]**
8Ah	Disable CFA power mode 1
8Bh	Disable Write Read Verify feature set
8Ch-8Fh	Reserved

Value	[Editors Note: Sync with historical annex]
90h	Reserved for Serial ATA
91h-94h	Reserved
95h	Enable Media Status Notification
96h-99h	Reserved
99h	Obsolete
9Ah	Obsolete
9Bh-A9h	Reserved
AAh	Enable read look-ahead feature
ABh	Obsolete
ACh-BAh	Reserved
BBh	Obsolete
BCh-C1h	Reserved
C2h	Disable Automatic Acoustic Management feature set
C3h-CBh	Reserved
CCh	Enable reverting to power-on defaults
CDh-D5h	Reserved
D6h-DCh	Vendor Specific
DDh	Disable release interrupt
DEh	Disable SERVICE interrupt
DFh	Reserved for DT2014
E0h	Vendor Specific
E1h-EFh	Reserved
F0h-FFh	Reserved for assignment by the CompactFlash™ Association

7.51.3 Enable/disable 8-bit PIO data transfer

Devices implementing the CFA feature set shall support 8-bit PIO data transfers. Devices not implementing the CFA feature set shall not support 8-bit PIO data transfers. When 8-bit PIO data transfer is enabled the Data register is 8-bits wide using only DD7 to DD0.

7.51.4 Enable/disable write cache

Subcommand codes 02h and 82h allow the host to enable or disable write cache in devices that implement write cache. When the subcommand disable write cache is issued, the device shall initiate the sequence to flush cache to non-volatile memory before command completion (See 7.14). These subcommands may affect caching for commands in the Streaming feature set.

7.51.5 Set transfer mode

A host selects the transfer mechanism by Set Transfer Mode, subcommand code 03h, and specifying a value in the Count field. The upper 5 bits define the type of transfer and the low order 3 bits encode the mode value. The host may change the selected modes by the SET FEATURES command.

Table 35 - Transfer mode values

Mode	Bits (7:3)	Bits (2:0)
PIO default mode	00000b	000b
PIO default mode, disable IORDY	00000b	001b
PIO flow control transfer mode	00001b	mode
Retired	00010b	na
Multiword DMA mode	00100b	mode
Ultra DMA mode	01000b	mode
Reserved	10000b	na
mode = transfer mode number		

If a device supports this standard, and receives a SET FEATURES command with a Set Transfer Mode parameter and a Count field value of “00000000b”, the device shall set the default PIO mode. If the value is “00000001b” and the device supports disabling of IORDY, then the device shall set the default PIO mode and disable IORDY. A device shall support all PIO modes below the highest mode supported, e.g., if PIO mode 1 is supported PIO mode 0 shall be supported.

Support of IORDY is mandatory when PIO mode 3 or above is the current mode of operation.

A device shall support all Multiword DMA modes below the highest mode supported, e.g., if Multiword DMA mode 1 is supported Multiword DMA mode 0 shall be supported.

A device shall support all Ultra DMA modes below the highest mode supported, e.g., if Ultra DMA mode 1 is supported Ultra DMA mode 0 shall be supported.

If an Ultra DMA mode is enabled any previously enabled Multiword DMA mode shall be disabled by the device. If a Multiword DMA mode is enabled any previously enabled Ultra DMA mode shall be disabled by the device.

For PATA systems using a cable assembly, the host shall determine that an 80-conductor cable assembly is connecting the host with the device(s) before enabling any Ultra DMA mode greater than 2 in the device(s).

7.51.6 Enable/disable advanced power management

Subcommand code 05h allows the host to enable Advanced Power Management. To enable Advanced Power Management, the host writes the Count field with the desired advanced power management level and then executes a SET FEATURES command with subcommand code 05h. The power management level is a scale from the lowest power consumption setting of 01h to the maximum performance level of FEh. Table 36 shows these values.

Table 36 - Advanced power management levels

Level	Count Field
Maximum performance	FEh
Intermediate power management levels without Standby	81h-FDh
Minimum power consumption without Standby	80h
Intermediate power management levels with Standby	02h-7Fh
Minimum power consumption with Standby	01h
Reserved	FFh
Reserved	00h

Device performance may increase with increasing power management levels. Device power consumption may increase with increasing power management levels. The power management levels may contain discrete bands. For example, a device may implement one power management method from 80h to A0h and a higher performance, higher power consumption method from level A1h to FEh. Advanced power management levels 80h and higher do not permit the device to spin down to save power.

Subcommand code 85h disables Advanced Power Management. Subcommand 85h may not be implemented on all devices that implement SET FEATURES subcommand 05h.

7.51.7 Enable/disable Power-Up In Standby feature set

Subcommand code 06h enables the Power-Up In Standby feature set. When this feature set is enabled, the device shall power-up into Standby mode, i.e., the device shall be ready to receive commands but shall not spinup (See 4.12). Having been enabled, this feature shall remain enabled through power-down, hardware reset and software rest.

Subcommand code 86h disables the Power-Up In Standby feature set. When this feature set is disabled, the device shall power-up into Active mode. The factory default for this feature set shall be disabled.

7.51.8 Power-Up In Standby feature set device spin-up

Subcommand code 07h shall cause a device that has powered-up into Standby to go to the Active state (See 4.12 and Figure 4).

7.51.9 Enable/disable CFA power mode 1

Subcommand code 0Ah enables CFA Power Mode 1. CFA devices may consume up to 500 mA maximum average RMS current for either 3.3 V or 5 V operation in Power Mode 1. CFA devices revert to Power Mode 1 on hardware or power-on reset. CFA devices revert to Power Mode 1 on software reset except when Set Features disable reverting to power-on defaults is set (See 7.17.7.83). Enabling CFA Power Mode 1 does not spin up rotating media devices.

Subcommand 8Ah disables CFA Power Mode 1, placing the device to CFA Power Mode 0. CFA devices may consume up to 75 mA maximum average RMS current for 3.3 V or 100 mA maximum average RMS current for 5 V operation in Power Mode 0.

A device in Power Mode 0 the device shall accept the following commands:

- IDENTIFY DEVICE
- SET FEATURES (function codes 0Ah and 8Ah)
- STANDBY
- STANDBY IMMEDIATE
- SLEEP
- CHECK POWER MODE
- EXECUTE DEVICE DIAGNOSTICS
- CFA REQUEST EXTENDED ERROR

A device in Power Mode 0 may accept any command that the device is capable of executing within the Power Mode 0 current restrictions. Commands that require more current than specified for Power Mode 0 shall be rejected with an abort error.

7.51.10 Enable/Disable Write Read Verify feature set

Subcommand code 0Bh enables the Write Read Verify feature set. When this feature set is supported and enabled, the device shall exhibit the following behavior. When this feature set is not supported, the command shall be aborted.

Count field shall specify the maximum number of logical sectors that shall be verified after any power-on reset or spin-up. LBA (7:0) contains the mode. See Table 37.

Table 37 – Write-Read-Verify Sector Counts

Mode	Description
00h	Enabled Always. The device shall perform a Write Read Verify for all write command received from the host.
01h	The first 65,536 logical sectors (located ANYWHERE, not just the LBA=0 thru LBA=65535) written by the host after every spinup (or reset) or after issuing this set features will be verified.
02h	Device may determine, for itself, how many logical sectors to do (‘automatic’ setting)
03h	The first (Verify Sector Count x 1024) logical sectors written by the host after every spinup or after issuing this set features will be verified
04h-FFh	Reserved
Note: When Mode 3 is not selected, the Verify Sector Count is defined as Ignored	

Subcommand code 8Bh disables the Write Read Verify feature set. When this feature set is not supported, the command shall be aborted. A subsequent IDENTIFY DEVICE or IDENTIFY PACKET DEVICE command shall reflect the disabled state of the feature set.

7.51.11 Enable/disable Media Status Notification

Subcommand code 31h disables Media Status Notification and leaves the media in an unlocked state. If Media Status Notification is disabled when this subcommand is received, the subcommand has no effect.

Subcommand code 95h enables Media Status Notification and clears any previous media lock state. This subcommand returns the device capabilities for media eject, media lock, previous state of Media Status Notification and the current version of Media Status Notification supported in the LBA field as described below.

Bits	Description
47:19	Reserved
18	Power Ejection (PEJ) - shall be set to one if the device has a power eject mechanism that is capable of physically ejecting the media when a MEDIA EJECT command is sent to the device. This bit shall be set to zero if the device only unlocks the media when the device receives a MEDIA EJECT command.
17	Lock - shall be set to one if the device is capable of locking the media preventing manual ejection.
16	Previously Enabled (PENA) - shall be set to one if Media Status Notification was enabled prior to the receipt of this command.
15:8	Version - Shall be set to the Media Status Notification version supported by the device (currently 0x00h).
7:0	Reserved

7.51.12 Enable/disable Automatic Acoustic Management

Subcommand code 42h allows the host to enable the Automatic Acoustic Management feature set. To enable the Automatic Acoustic Management feature set, the host writes the Count field with the requested automatic acoustic management level and executes a SET FEATURES command with subcommand code 42h. The acoustic management level is selected on a scale from 01h to FEh. Table 38 shows the acoustic management level values.

Enabling or disabling of the Automatic Acoustic Management feature set, and the current automatic acoustic management level setting shall be preserved by the device across all forms of reset, i.e. power-on, hardware, and software resets.

Table 38 - Automatic acoustic management levels

Level	Count Field
Reserved	FFh
Maximum performance	FEh
Intermediate acoustic management levels	81h-FDh
Minimum acoustic emanation level	80h
Retired	01h-7Fh
Vendor Specific	00h

Device performance may increase with increasing acoustic management levels. Device power consumption may decrease with decreasing acoustic management levels. The acoustic management levels may contain discrete bands. For example, a device may implement one acoustic management method from 80h to BFh and a higher performance, higher acoustic management method from level C0h to FEh.

Upon successful completion of this SET FEATURES subcommand, IDENTIFY DEVICE or IDENTIFY PACKET DEVICE data word 94, bits (7:0) shall be updated by the device. If the command is aborted by the device, the previous automatic acoustic management state shall be retained.

Subcommand code C2h disables the Automatic Acoustic Management feature set. Devices that implement SET FEATURES subcommand 42h are not required to implement subcommand C2h. If device successfully completes execution of this subcommand, then the acoustic behavior of the device shall be vendor-specific, and the device shall return zeros in bits (7:0) of word 94 and bit 9 of word 86 of the IDENTIFY DEVICE or IDENTIFY PACKET DEVICE data words.

Upon completion of SET FEATURES subcommands 42h and C2h, the device may update words (97:96) and word 104 in IDENTIFY DEVICE or IDENTIFY PACKET DEVICE data words, and the contents of the Stream Performance Parameters Log in the READ LOG EXT command.

7.51.13 Set Maximum Host Interface Sector Times

Subcommand code 43h allows the host to inform the device of a host interface rate limitation. This information shall be used by the device to meet the Command Completion Time Limits of the commands of the streaming feature set. To inform the device of a host interface rate limitation, the host writes the LSB and MSB value of its Typical PIO Host Interface Sector Time to the Count field and LBA (7:0) field and writes the LSB and MSB value of its Typical DMA Host Interface Sector Time to the LBA (23:8) field. The Typical Host Interface Sector Times have the same units as IDENTITY DEVICE data word 96 for DMA and word 104 for PIO. A value of zero indicates that the host interface shall be capable of transferring data at the maximum rate allowed by the selected transfer mode. The Typical PIO Mode Host Interface Sector Time includes the host's interrupt service time.

Upon completion of SET FEATURES subcommand 43h, the device may adjust IDENTIFY DEVICE data words (97:96), and the contents of the Stream Performance Parameters Log in the READ LOG EXT command to allow for the specified host interface sector time.

Field	Bits	Description
Count	15:8	Reserved
	7:0	Typical PIO Mode Host Interface Sector Time (7:0)
LBA	47:24	Reserved
	23:8	Typical DMA Mode Host Interface Sector Time
	7:0	Typical PIO Mode Host Interface Sector Time (15:8)

7.51.14 Enable/disable read look-ahead

Subcommand codes AAh and 55h allow the host to request the device to enable or disable read look-ahead. Error recovery performed by the device is vendor specific.

7.51.15 Enable/disable release interrupt

Subcommand codes 5Dh and DDh allow a host to enable or disable the asserting of Interrupt Pending when a device releases the bus for an overlapped PACKET command.

7.51.16 Enable/disable SERVICE interrupt

Subcommand codes 5Eh and DEh allow a host to enable or disable the asserting of an Interrupt Pending when DRQ is set to one in response to a SERVICE command.

7.51.17 Enable/disable reverting to defaults

Subcommand codes CCh and 66h allow the host to enable or disable the device from reverting to power-on default values. A setting of 66h allows settings that may have been modified since power-on to remain at the same setting after a software reset.

7.51.18 Inputs

Word	Name	Description
00h	Feature	Subcommand Code - Table 34 defines the value of the subcommand.
01h	Count	Subcommand specific
02h-04h	LBA	Subcommand specific
05h	Command	EFh

7.51.19 Normal outputs

See the subcommand descriptions. **[Editors Note: Is this statement right? I see places where the text describes the subcommand specific fields. I do not see much in the way of normal output returns.]**

See Table 85

7.51.20 Error outputs

Abort shall be set to one if any subcommand input value is not supported or is invalid. See Table 100.

7.52 SET MAX

7.52.1 SET MAX Overview

Individual SET MAX commands are identified by the value placed in the Feature field. Table 39 shows these Feature field values.

Table 39 - SET MAX Feature field values

Value	Command
00h	SET MAX ADDRESS
01h	SET MAX SET PASSWORD
02h	SET MAX LOCK
03h	SET MAX UNLOCK
04h	SET MAX FREEZE LOCK
05h-FFh	Reserved

7.52.2 SET MAX ADDRESS - F9h

7.52.2.1 Feature Set

This command is mandatory for devices that implement the Host Protected Area feature set. This command shall not be implemented if the Removable feature set is implemented.

7.52.2.2 Description

After successful command completion, all read and write access attempts to addresses greater than specified by the successful SET MAX ADDRESS command shall be rejected with an ID Not Found error (see clause 6.3.4). IDENTIFY DEVICE data words (61:60) shall reflect the maximum address set with this command.

If the 48-bit Address feature set is supported, the value placed in IDENTIFY DEVICE data words (103:100) shall be the same as the value placed in words (61:60).

Hosts shall not issue more than one non-volatile SET MAX ADDRESS or SET MAX ADDRESS EXT command after a power-on or hardware reset. Devices should report an IDNF error upon receiving a second non-volatile SET MAX ADDRESS command after a power-on or hardware reset.

The contents of IDENTIFY DEVICE data words and the max address shall not be changed if a SET MAX ADDRESS command fails.

After a successful SET MAX ADDRESS command using a new maximum LBA the content of all IDENTIFY DEVICE data words shall comply with 4.2.1 and the content of words (61:60) shall be equal to the new Maximum LBA + 1.

A successful READ NATIVE MAX ADDRESS command shall immediately precede a SET MAX ADDRESS command.

Issueing a SET MAX ADDRESS to the value returned by READ NATIVE MAX ADDRESS shall clear the HPA regardless of the maximum logical block address.

7.52.2.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	**Bit** **Description** 16:1 N/A 0 Volatile Value (VV) - If VV is set to one, the device shall preserve the maximum values over power-up or hardware reset. If VV is cleared to zero, the device shall revert to the most recent non-volatile maximum address value setting over power-up or hardware reset.
02h	LBA	MSB SET MAX LBA Bits 47:28 shall be cleared to zero
03h		
04h		LSB
05h	Command	F9h

7.52.2.4 Normal outputs

See Table 94. LBA bits 47:28 shall be cleared to zero.

7.52.2.5 Error outputs

If this command is not supported, the maximum value to be set exceeds the capacity of the device, a host protected area has been established by a SET MAX ADDRESS EXT command, or the device is in the Set_Max_Locked or Set_Max_Frozen state, then the device shall return command aborted. ID Not Found shall be set to one if the command was the second non-volatile SET MAX ADDRESS or SET MAX ADDRESS EXT command after power-on or hardware reset. Abort shall be set to one if the maximum value requested exceeds the device capacity, a host protected area has been estabished by a SET MAX ADDRESS EXT command, the device is in the Set_Max_Locked or Set_Max_Frozen state, or the command is not immediately preceded by a READ NATIVE MAX ADDRESS command. See Table 111

7.52.3 SET MAX SET PASSWORD - F9h/01h, PIO data-out

7.52.3.1 Feature Set

This command is mandatory for devices that implement the Host Protected Area feature set. This command shall not be implemented if the Removable feature set is implemented.

7.52.3.2 Description

This command requests a transfer of a single logical sector of data from the host. Table 40 defines the content of this sector of information. The password is retained by the device until the next power cycle. When the device accepts this command the device is in Set_Max_Unlocked state.

This command shall not be immediately preceded by a READ NATIVE MAX ADDRESS command. If this command is immediately preceded by a READ NATIVE MAX ADDRESS command, it shall be interpreted as a SET MAX ADDRESS command.

7.52.3.3 Inputs

Word	Name	Description
00h	Feature	01h - SET MAX PASSWORD
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	F9h

7.52.3.4 Normal outputs

See Table 85

7.52.3.5 Error outputs

Abort shall be set to one if the device is in the Set_Max_Locked or Set_Max_Frozen state. The device may return error status if an Interface CRC error has occurred. See Table 111.

7.52.3.6 Output Data Structure

Table 40 - SET MAX SET PASSWORD data content

Word	Content
0	Reserved
1-16	Password (32 bytes)
17-255	Reserved

7.52.4 SET MAX LOCK - F9h/02h, Non-data

7.52.4.1 Feature Set

This command is mandatory for devices that implement the Host Protected Area feature set. This command shall not be implemented if the Removable feature set is implemented.

7.52.4.2 Description

The SET MAX LOCK command sets the device into Set_Max_Locked state. After this command is completed any other SET MAX commands except SET MAX UNLOCK and SET MAX FREEZE LOCK shall be command aborted. The device shall remain in this state until a power cycle or command completion without error of a SET MAX UNLOCK or SET MAX FREEZE LOCK command.

This command shall not be immediately preceded by a READ NATIVE MAX ADDRESS command. If this command is immediately preceded by a READ NATIVE MAX ADDRESS command, it shall be interpreted as a SET MAX ADDRESS command.

7.52.4.3 Inputs

Word	Name	Description
00h	Feature	02h - SET MAX LOCK
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	F9h

7.52.4.4 Normal outputs

See Table 85

7.52.4.5 Error outputs

Abort shall be set to one if the device is in the Set_Max_Locked or Set_Max_Frozen state. See Table 101.

7.52.5 SET MAX UNLOCK - F9h/03h, PIO data-out

7.52.5.1 Feature Set

This command is mandatory for devices that implement the Host Protected Area feature set. This command shall not be implemented if the Removable feature set is implemented.

7.52.5.2 Description

This command requests a transfer of a single logical sector of data from the host. Table 40 defines the content of this sector of information.

The password supplied in the logical sector of data transferred shall be compared with the stored SET MAX password.

If the password compare fails, then the device shall return command aborted and decrement the unlock counter. On the acceptance of the SET MAX LOCK command, this counter is set to a value of five and shall be decremented for each password mismatch when SET MAX UNLOCK is issued and the device is locked. When this counter reaches zero, then the SET MAX UNLOCK command shall return command aborted until a power cycle.

If the password compare matches, then the device shall make a transition to the Set_Max_Unlocked state and all SET MAX commands shall be accepted.

This command shall not be immediately preceded by a READ NATIVE MAX ADDRESS command. If this command is immediately preceded by a READ NATIVE MAX ADDRESS command, it shall be interpreted as a SET MAX ADDRESS command.

7.52.5.3 Inputs

Word	Name	Description
00h	Feature	03h - SET MAX UNLOCK
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	F9h

7.52.5.4 Normal outputs

See Table 85

7.52.5.5 Error outputs

Abort shall be set to one if the device is not in the Set_Max_Locked state. The device may return error status if an Interface CRC error has occurred. See Table 101.

7.52.6 SET MAX FREEZE LOCK – F9h/04h, Non-data

7.52.6.1 Feature Set

This command is mandatory for devices that implement the Host Protected Area feature set. This command shall not be implemented if the Removable feature set is implemented.

7.52.6.2 Description

The SET MAX FREEZE LOCK command sets the device to Set_Max_Frozen state. After command completion any subsequent SET MAX commands shall be command aborted.
Commands disabled by SET MAX FREEZE LOCK are:

- SET MAX ADDRESS
- SET MAX SET PASSWORD
- SET MAX LOCK
- SET MAX UNLOCK

This command shall not be immediately preceded by a READ NATIVE MAX ADDRESS command. If this command is immediately preceded by a READ NATIVE MAX ADDRESS command, it shall be interpreted as a SET MAX ADDRESS command.

7.52.6.3 Inputs

Word	Name	Description
00h	Feature	04h - SET MAX FREEZE LOCK
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	F9h

7.52.6.4 Normal outputs

See Table 85

7.52.6.5 Error outputs

Abort shall be set to one if the device is not in the Set_Max_Unlocked state.**.** SeeTable 101.

7.53 SET MAX ADDRESS EXT - 37h, Non-data

7.53.1 Feature Set

This command is mandatory for devices that implement both the Host Protected Area feature set and 48-bit Address feature set. This command shall not be implemented if the Removable feature set is implemented.

7.53.2 Description

After successful command completion, all read and write access attempts to addresses greater than specified by the successful SET MAX ADDRESS EXT command shall be rejected with an IDNF error.

Hosts shall not issue more than one non-volatile SET MAX ADDRESS or SET MAX ADDRESS EXT command after a power-on or hardware reset. Devices shall report an IDNF error upon receiving a second non-volatile SET MAX ADDRESS EXT command after a power-on or hardware reset.

The contents of IDENTIFY DEVICE data words and the max address shall not be changed if a SET MAX ADDRESS EXT command fails.

After a successful SET MAX ADDRESS EXT command using a new maximum LBA the content of all IDENTIFY DEVICE data words shall comply with 6.2.1.

A successful READ NATIVE MAX ADDRESS EXT command shall immediately precede a SET MAX ADDRESS EXT command.

7.53.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	**Bit** **Description** 16:1 Reserved 0 Volatile Value (VV) - If VV is set to one, the device shall preserve the maximum values over power-up or hardware reset. If VV is cleared to zero, the device shall revert to the most recent non-volatile maximum address value setting over power-up or hardware reset.
02h	LBA	MSB
03h		SET MAX LBA
04h		LSB
05h	Command	37h

7.53.4 Normal outputs

See Table 94

7.53.5 Error outputs

If this command is not supported, the maximum value to be set exceeds the capacity of the device, a host protected area has been established by a SET MAX ADDRESS command, the command is not immediately preceded by a READ NATIVE MAX ADDRESS EXT command, or the device is in the Set_Max_Locked or Set_Max_Frozen state, then the device shall return command aborted. ID Not Found shall be set to one if the command was the second non-volatile SET MAX ADDRESS or SET MAX ADDRESS EXT command after power-on or hardware reset. Abort shall be set to one if the maximum value requested exceeds the device capacity, a host protected area has been established by a SET MAX ADDRESS command, or the command is not immediately preceded by a READ NATIVE MAX ADDRESS EXT command. See Table 111.

7.54 SET MULTIPLE MODE - C6h, Non-data

7.54.1 Feature Set
This command is mandatory for devices implementing the General feature set

7.54.2 Description
This command establishes the number of logical sectors in the DRQ data block count for READ MULTIPLE, READ MULTIPLE EXT, WRITE MULTIPLE, and WRITE MULTIPLE EXT commands.

Devices shall support the DRQ data block size specified in the IDENTIFY DEVICE parameter word 47, bits (7:0), and may also support smaller values.

Upon receipt of the command, the device checks the Count field. If the content of the Count field is not zero, the Count field contains a valid value, and the DRQ data block count is supported, then the value in the Count field is used for all subsequent READ MULTIPLE, READ MULTIPLE EXT, WRITE MULTIPLE, and WRITE MULTIPLE EXT commands and their execution is enabled. If the content of the Count field is zero, the device may:

a) disable multiple mode and respond with command aborted to all subsequent READ MULTIPLE, READ MULTIPLE EXT, WRITE MULTIPLE, and WRITE MULTIPLE EXT commands;
b) respond with command aborted to the SET MULTIPLE MODE command;
c) retain the previous multiple mode settings.

After a successful SET MULTIPLE command the device shall report the valid value set by that command in bits (7:0) in word 59 in the IDENTIFY DEVICE data.

After a power-on or hardware reset, if bit 8 is set to one and bits (7:0) are cleared to zero in word 59 of the IDENTIFY DEVICE data, a SET MULTIPLE command is required before issuing a READ MULTIPLE, READ MULTIPLE EXT, WRITE MULTIPLE, or WRITE MULTIPLE EXT command. If bit 8 is set to one and bits (7:0) are not cleared to zero, a SET MULTIPLE command may be issue to change the multiple value required before issuing a READ MULTIPLE, READ MULTIPLE EXT, WRITE MULTIPLE, or WRITE MULTIPLE EXT command.

7.54.3 Inputs
[Editors Note: Shouldn’t this be part of the description?]

If the content of the Count field is not zero, then the Count field contains the number of logical sectors per block for the device to be used on all following READ/WRITE MULTIPLE commands. The content of the Count field shall be less than or equal to the value in bits (7:0) in word 47 in the IDENTIFY DEVICE data. The host should set the content of the Count field to 1, 2, 4, 8, 16, 32, 64 or 128.

If the content of the Count field is zero and the SET MULTIPLE command completes without error, then the device shall respond to any subsequent read multiple or write multiple command with command aborted until a subsequent successful SET MULTIPLE command completion where the Count field is not set to zero.

Word	Name	Description
00h	Feature	N/A
01h	Count	Logical sectors per block
02h-04h	LBA	N/A
05h	Command	C6h

7.54.4 Normal outputs
See Table 85

7.54.5 Error outputs
Abort shall be set to one if the block count is not supported. See Table 100.

7.55 SLEEP - E6h, Non-data

7.55.1 Feature Set

This command is mandatory for devices implementing the Power Management feature set. The Power Management feature set is mandatory for devices not implementing the PACKET Command set This command is mandatory when power management is not implemented by the PACKET Command set implemented by the device.

7.55.2 Description

This command is the only way to cause the device to enter Sleep mode. The only way to bring the device out of sleep mode is transport specific.

[Editors Note: This text should be in the parallel document: This command shall cause the device to set the BSY bit to one, prepare to enter Sleep mode, clear the BSY bit to zero and assert INTRQ. The host shall read the Status register in order to clear the Interrupt Pending and allow the device to enter Sleep mode. In Sleep mode, the device shall only respond to the assertion of the RESET- signal and the writing of the SRST bit in the Device Control register and shall release the device driven signal lines (See Figure 4). The host shall not attempt to access the Command Block registers while the device is in Sleep mode.

Because some host systems may not read the Status register and clear the Interrupt Pending, a device may release INTRQ and enter Sleep mode after a vendor specific time period of not less than 2 s.

The only way to recover from Sleep mode is with a software reset, a hardware reset, or a DEVICE RESET command.]

A device shall not power-on in Sleep mode nor remain in Sleep mode following a reset sequence.

7.55.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	E6h

7.55.4 Normal outputs

See Table 85

7.55.5 Error outputs

See Table 100.

7.56 SMART

7.56.1 Overview

Individual SMART commands are identified by the value placed in the Feature field. Table 41 shows these values.

Table 41 - SMART Feature register values

Value	Command
00h-CFh	Reserved
D0h	SMART READ DATA
D1h	Obsolete
D2h	SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE
D3h	Obsolete
D4h	SMART EXECUTE OFF-LINE IMMEDIATE
D5h	SMART READ LOG
D6h	SMART WRITE LOG
D7h	Obsolete
D8h	SMART ENABLE OPERATIONS
D9h	SMART DISABLE OPERATIONS
DAh	SMART RETURN STATUS
DBh	Obsolete
DCh-DFh	Reserved
E0h-FFh	vendor specific

7.56.2 SMART DISABLE OPERATIONS - B0h/D9h, Non-data

7.56.2.1 Feature Set

This command is mandatory for devices that implement the SMART feature set.

7.56.2.2 Description

This command disables all SMART capabilities within the device including any and all timer and event count functions related exclusively to this feature. After command acceptance the device shall disable all SMART operations. SMART data shall no longer be monitored or saved by the device. The state of SMART, either enabled or disabled, shall be preserved by the device across power cycles.

After receipt of this command by the device, all other SMART commands including SMART DISABLE OPERATIONS commands, with the exception of SMART ENABLE OPERATIONS, are disabled and invalid and shall be command aborted by the device.

7.56.2.3 Inputs

The Feature field shall be set to D9h. The LBA field (15:8) shall be set to 4Fh. The LBA field (23:16) shall be set to C2h.

Word	Name	Description
00h	Feature	D9h - SMART DISABLE OPERATIONS
01h	Count	N/A
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 C24Fh 7:0 N/A
05h	Command	B0h

7.56.2.4 Normal outputs

See Table 85

7.56.2.5 Error outputs

Abort shall be set to one if SMART is not enabled, or if an input value is invalid. See Table 100.

7.56.3 SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE - B0h/D2h, Non-data

7.56.3.1 Feature Set

This command is mandatory for devices that implement the SMART feature set.

7.56.3.2 Description

This command enables and disables the optional attribute autosave feature of the device. This command may either allow the device, after some vendor specified event, to save the device updated attribute values to non-volatile memory; or this command may cause the autosave feature to be disabled. The state of the attribute autosave feature (either enabled or disabled) shall be preserved by the device across power cycles.

A value of zero written by the host into the device's Count field before issuing this command shall cause this feature to be disabled. Disabling this feature does not preclude the device from saving SMART data to non-volatile memory during some other normal operation such as during a power-on or power-off sequence or during an error recovery sequence.

A value of F1h written by the host into the device's Count field before issuing this command shall cause this feature to be enabled. Any other meaning of this value or any other non-zero value written by the host into this register before issuing this command may differ from device to device. The meaning of any non-zero value written to this register at this time shall be preserved by the device across power cycles.

If this command is not supported by the device, the device shall return command aborted upon receipt from the host.

During execution of the autosave routine the device shall not set BSY to one nor clear DRDY to zero. If the device receives a command from the host while executing the autosave routine the device shall begin processing the command within two seconds.

7.56.3.3 Inputs

Word	Name	Description
00h	Feature	D2h - SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE
01h	Count	**Value** **Description** 00h Disable attribute autosave 01h-F0h Reserved F1h Enable attribute autosave F2h-FFh Reserved
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 C24Fh 7:0 N/A
05h	Command	B0h

7.56.3.4 Normal outputs

See Table 85

7.56.3.5 Error outputs

Abort shall be set to one if SMART is not enabled, or if an input value is invalid. See Table 100.

7.56.4 SMART ENABLE OPERATIONS - B0h/D8h, Non-data

7.56.4.1 Feature Set

This command is mandatory for devices that implement the SMART feature set.

7.56.4.2 Description

This command enables access to all SMART capabilities within the device. Prior to receipt of this command SMART data are neither monitored nor saved by the device. The state of SMART (either enabled or disabled) shall be preserved by the device across power cycles. Once enabled, the receipt of subsequent SMART ENABLE OPERATIONS commands shall not affect any SMART data or functions.

7.56.4.3 Inputs

Word	Name	Description
00h	Feature	D8h - SMART ENABLE OPERATIONS
01h	Count	N/A
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 C24Fh 7:0 N/A
05h	Command	B0h

7.56.4.4 Normal outputs

See Table 85

7.56.4.5 Error outputs

See Table 100.

7.56.5 SMART EXECUTE OFF-LINE IMMEDIATE - B0h/D4h, Non-data

7.56.5.1 Feature Set

This command is optional for devices that implement the SMART feature set.

7.56.5.2 Description

This command causes the device to immediately initiate the optional set of activities that collect SMART data in an off-line mode and then save this data to the device's non-volatile memory, or execute a self-diagnostic test routine in either captive or off-line mode.

Table 42 - SMART EXECUTE OFF-LINE IMMEDIATE Subcommands

Value	Description of subcommand to be executed
0	Execute SMART off-line routine immediately in off-line mode
1	Execute SMART Short self-test routine immediately in off-line mode
2	Execute SMART Extended self-test routine immediately in off-line mode
3	Execute SMART Conveyance self-test routine immediately in off-line mode
4	Execute SMART Selective self-test routine immediately in off-line mode
5-63	Reserved
64-126	Vendor specific
127	Abort off-line mode self-test routine
128	Reserved
129	Execute SMART Short self-test routine immediately in captive mode
130	Execute SMART Extended self-test routine immediately in captive mode
131	Execute SMART Conveyance self-test routine immediately in captive mode
132	Execute SMART Selective self-test routine immediately in captive mode
133-191	Reserved
192-255	Vendor specific

7.56.5.3 Off-line mode

The following describes the protocol for executing a SMART EXECUTE OFF-LINE IMMEDIATE subcommand routine (including a self-test routine) in the off-line mode.

1) The device shall execute command completion before executing the subcommand routine.
2) The device shall remain ready to receive a new command during execution of the subcommand routine.
3) If the device is in the process of performing the subcommand routine and is interrupted by any new command from the host except a SLEEP, SMART DISABLE OPERATIONS, SMART EXECUTE OFF-LINE IMMEDIATE, or STANDBY IMMEDIATE command, the device shall suspend or abort the subcommand routine and service the host within two seconds after receipt of the new command. After servicing the interrupting command from the host the device may immediately re-initiate or resume the subcommand routine without any additional commands from the host (See 7.56.6.6).
4) If the device is in the process of performing a subcommand routine and is interrupted by a SLEEP command from the host, the device may abort the subcommand routine and execute the SLEEP command. If the device is in the process of performing any self-test routine and is interrupted by a SLEEP command from the host, the device shall abort the subcommand routine and execute the SLEEP command.
5) If the device is in the process of performing the subcommand routine and is interrupted by a SMART DISABLE OPERATIONS command from the host, the device shall suspend or abort the subcommand routine and service the host within two seconds after receipt of the command. Upon receipt of the next SMART ENABLE OPERATIONS command the device may, either re-initiate the subcommand routine or resume the subcommand routine from where it had been previously suspended.
6) If the device is in the process of performing the subcommand routine and is interrupted by a SMART EXECUTE OFF-LINE IMMEDIATE command from the host, the device shall abort the subcommand routine and service the host within two seconds after receipt of the command. The device shall then service the new SMART EXECUTE OFF-LINE IMMEDIATE subcommand.
7) If the device is in the process of performing the subcommand routine and is interrupted by a STANDBY IMMEDIATE or IDLE IMMEDIATE command from the host, the device shall suspend or abort the subcommand routine, and service the host within two seconds after receipt of the

command. After receiving a new command that causes the device to exit a power saving mode, the device shall initiate or resume the subcommand routine without any additional commands from the host unless these activities were aborted by the host (See 7.56.6.1).

8) While the device is performing the subcommand routine it shall not automatically change power states (e.g., as a result of its Standby timer expiring).
9) If a test failure occurs while a device is performing a self-test routine the device may discontinue the testing and place the test results in the Self-test execution status byte (See Table 43).

7.56.5.4 Captive mode

When executing a self-test in captive mode, the device executes the self-test routine after receipt of the command. At the end of the routine the device places the results of this routine in the Self-test execution status byte (See Table 43) and reports command completion. If an error occurs while a device is performing the routine the device may discontinue its testing, place the results of this routine in the Self-test execution status byte, and complete the command.

7.56.5.5 SMART off-line routine

This routine shall only be performed in the off-line mode. The results of this routine are placed in the Off-line data collection status byte (See Table 44).

7.56.5.6 SMART Short self-test routine

Depending on the value in the LBA field (7:0), this self-test routine may be performed in either the captive or the off-line mode. This self-test routine should take on the order of ones of minutes to complete (See 7.56.6.1).

7.56.5.7 SMART Extended self-test routine

Depending on the value in the LBA field (7:0), this self-test routine may be performed in either the captive or the off-line mode. This self-test routine should take on the order of tens of minutes to complete (See 7.56.6.1).

7.56.5.8 SMART Conveyance self-test routine

Depending on the value in the LBA field (7:0), this self-test routine may be performed in either the captive or the off-line mode. This self-test routine is intended to identify damage incurred during transporting of the device. This self-test routine should take on the order of minutes to complete (See 7.56.6.1).

7.56.5.9 SMART Selective self-test routine

The SMART Selective self-test routine is an optional self-test routine. If the routine is implemented, all features of the routine shall be implemented. Support for the routine is indicated in off-line data collection capabilities (See 7.56.6.6).

When the value in the LBA field (7:0) is 4 or 132, the Selective self-test routine shall be performed. This self-test routine shall include the initial tests performed by the Extended self-test routine plus a selectable read scan. The host shall not write the Selective self-test log while the execution of a Selective self-test command is in progress.

The user may choose to do read scan only on specific areas of the media. To do this, user shall set the test spans desired in the Selective self-test log and set the flags in the Feature flags field of the Selective self-test log to indicate do not perform off-line scan. In this case, the test spans defined shall be read scanned in their entirety. The Selective self-test log is updated as the self-test proceeds indicating test progress. When all specified test spans have been completed, the test is terminated and the appropriate self-test execution status is reported in the SMART READ DATA response depending on the occurrence of errors. Figure 9 shows an example of a Selective self-test definition with three test spans defined. In this example, the test terminates when all three test spans have been scanned.

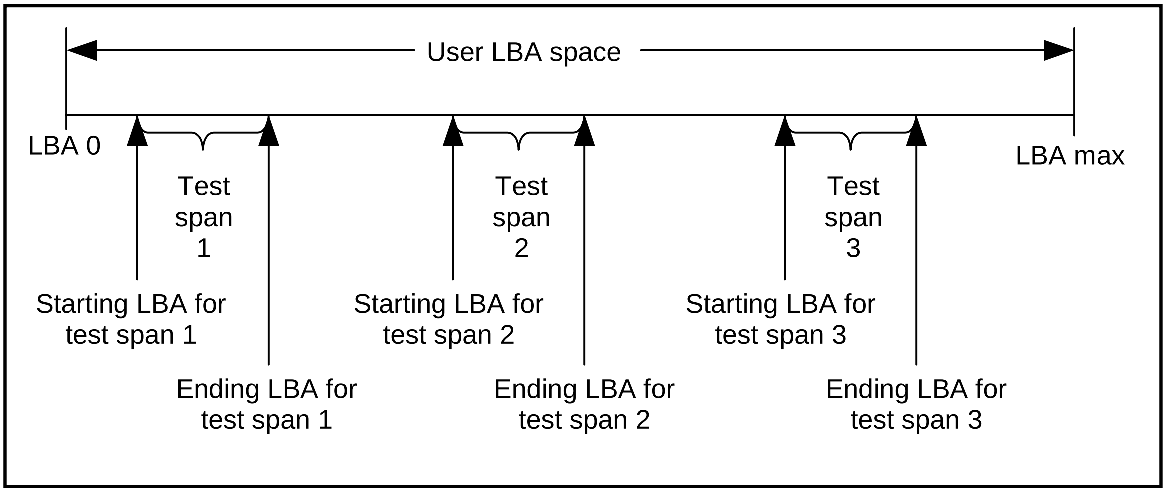


Figure 9 - Selective self-test test span example

After the scan of the selected spans described above, a user may wish to have the rest of media read scanned as an off-line scan. In this case, the user shall set the flag to enable off-line scan in addition to the other settings. If an error occurs during the scanning of the test spans, the error is reported in the self-test execution status in the SMART READ DATA response and the off-line scan is not executed. When the test spans defined have been scanned, the device shall then set the off-line scan pending and active flags in the Selective self-test log to one, the span under test to a value greater than five, the self-test execution status in the SMART READ DATA response to 00h, set a value of 03h in the off-line data collection status in the SMART READ DATA response and shall proceed to do an off-line read scan through all areas not included in the test spans. This off-line read scan shall completed as rapidly as possible, no pauses between block reads, and any errors encountered shall not be reported to the host. Instead error locations may be logged for future reallocation. If the device is powered-down before the off-line scan is completed, the off-line scan shall resume when the device is again powered up. From power-up, the resumption of the scan shall be delayed the time indicated in the Selective self-test pending time field in the Selective self-test log. During this delay time the pending flag shall be set to one and the active flag shall be set to zero in the Selective self-test log. Once the time expires, the active flag shall be set to one, and the off-line scan shall resume. When the entire media has been scanned, the off-line scan shall terminate, both the pending and active flags shall be cleared to zero, and the off-line data collection status in the SMART READ DATA response shall be set to 02h indicating completion.

During execution of the Selective self-test, the self-test executions time byte in the Device SMART Data Structure may be updated but the accuracy may not be exact because of the nature of the test span segments. For this reason, the time to complete off-line testing and the self-test polling times are not valid. Progress through the test spans is indicated in the selective self-test log.

A hardware or software reset shall abort the Selective self-test except when the pending bit is set to one in the Selective self-test log (See 7.56.7.2.7). The receipt of a SMART EXECUTE OFF-LINE IMMEDIATE command with 0Fh, Abort off-line test routine, in the LBA field (7:0) shall abort Selective self-test regardless of where the device is in the execution of the command. If a subsequent self-test is issued while a selective self-test is in progress, the selective self-test is aborted and the requested self-test is executed.

7.56.5.10 Inputs

Word	Name	Description
00h	Feature	D4h - SMART EXECUTE OFF-LINE IMMEDIATE
01h	Count	N/A
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 C24Fh 7:0 Table 42 defines the subcommand that shall be executed
05h	Command	B0h

7.56.5.11 Normal Outputs

See Table 95.

7.56.5.12 Error Outputs

ID Not Found shall be set to one if SMART data sector's ID field could not be found. Abort shall be set to one if SMART is not enabled or if a self-test fails while executing a sequence in captive mode. See Table 112.

7.56.6 SMART READ DATA - B0h/D0h, PIO data-in

7.56.6.1 Feature Set

This command is optional for devices that implement the SMART feature set.

7.56.6.2 Description

This command returns the Device SMART data structure to the host.

Table 43 defines the 512 bytes that make up the Device SMART data structure. All multi-byte fields shown in this structure follow the byte ordering described in Volume 1, Clause 3.

Table 43 - Device SMART data structure

Byte	F/V	Descriptions
0-361	X	Vendor specific
362	V	Off-line data collection status
363	X	Self-test execution status byte
364-365	V	Total time in seconds to complete off-line data collection activity
366	X	Vendor specific
367	F	Off-line data collection capability
368-369	F	SMART capability
370	F	Error logging capability 7-1 Reserved 0 1=Device error logging supported
371	X	Vendor specific
372	F	Short self-test routine recommended polling time (in minutes)
373	F	Extended self-test routine recommended polling time (7:0) in minutes. If FFh, use bytes 375 and 376 for the polling time.
374	F	Conveyance self-test routine recommended polling time (in minutes)
375	F	Extended self-test routine recommended polling time (7:0) in minutes
376	F	Extended self-test routine recommended polling time (15:8) in minutes
377-385	R	Reserved
386-510	X	Vendor specific
511	V	Data structure checksum
Key: F=the content of the byte is fixed and does not change. V=the content of the byte is variable and may change depending on the state of the device or the commands executed by the device. X=the content of the byte is vendor specific and may be fixed or variable. R=the content of the byte is reserved and shall be zero.		

7.56.6.3 Off-line collection status byte

The value of the off-line data collection status byte defines the current status of the off-line activities of the device. Table 44 lists the values and their respective definitions.

Table 44 - Off-line data collection status byte values

Value	Definition
00h or 80h	Off-line data collection activity was never started.
01h	Reserved
02h or 82h	Off-line data collection activity was completed without error.
03h	Off-line activity in progress.
04h or 84h	Off-line data collection activity was suspended by an interrupting command from host.
05h or 85h	Off-line data collection activity was aborted by an interrupting command from host.
06h or 86h	Off-line data collection activity was aborted by the device with a fatal error.
07h-3Fh	Reserved
40h-7Fh	Vendor specific
81h	Reserved
83h	Reserved
87h-BFh	Reserved
C0h-FFh	Vendor specific

7.56.6.4 Self-test execution status byte

The self-test execution status byte reports the execution status of the self-test routine.

- Bits (3:0) (Percent Self-Test Remaining) The value in these bits indicates an approximation of the percent of the self-test routine remaining until completion in ten percent increments. Valid values are 9 through 0. A value of 0 indicates the self-test routine is complete. A value of 9 indicates 90% of total test time remaining.
- Bits (7:4) (Self-test Execution Status) The value in these bits indicates the current Self-test Execution Status (See Table 45**)**.

Table 45 - Self-test execution status values

Value	Description
0	The previous self-test routine completed without error or no self-test has ever been run
1	The self-test routine was aborted by the host
2	The self-test routine was interrupted by the host with a hardware or software reset
3	A fatal error or unknown test error occurred while the device was executing its self-test routineand the device was unable to complete the self-test routine.
4	The previous self-test completed having a test element that failed and the test element that failed is not known.
5	The previous self-test completed having the electrical element of the test failed.
6	The previous self-test completed having the servo (and/or seek) test element of the test failed.
7	The previous self-test completed having the read element of the test failed.
8	The previous self-test completed having a test element that failed and the device is suspected of having handling damage.
9-14	Reserved.
15	Self-test routine in progress.

7.56.6.5 Total time to complete off-line data collection

The total time in seconds to complete off-line data collection activity word specifies how many seconds the device requires to complete the sequence of off-line data collection activity. Valid values for this word are from 0001h to FFFFh.

7.56.6.6 Off-line data collection capabilities

The following describes the definition for the off-line data collection capability bits. If the value of all of these bits is cleared to zero, then no off-line data collection is implemented by this device. **[Editors Note: would this be better as a table? It would be clearer yes]**

- Bit 0 (EXECUTE OFF-LINE IMMEDIATE implemented bit) **-** If this bit is set to one, then the SMART EXECUTE OFF-LINE IMMEDIATE command is implemented by this device. If this bit is cleared to zero, then the SMART EXECUTE OFF-LINE IMMEDIATE command is not implemented by this device.

- Bit 1 (vendor specific).
- Bit 2 (abort/restart off-line by host bit) - If this bit is set to one, then the device shall abort all off-line data collection activity initiated by an SMART EXECUTE OFF-LINE IMMEDIATE command upon receipt of a new command within 2 seconds of receiving the new command. If this bit is cleared to zero, the device shall suspend off-line data collection activity after an interrupting command and resume off-line data collection activity after some vendor-specified event.
- Bit 3 (off-line read scanning implemented bit) - If this bit is cleared to zero, the device does not support off-line read scanning. If this bit is set to one, the device supports off-line read scanning.
- Bit 4 (self-test implemented bit) - If this bit is cleared to zero, the device does not implement the Short and Extended self-test routines. If this bit is set to one, the device implements the Short and Extended self-test routines.
- Bit 5 (conveyance self-test implemented bit) - If this bit is cleared to zero, the device does not implement the Conveyance self-test routines. If this bit is set to one, the device implements the Conveyance self-test routines.
- Bit 6 (Selective self-test implemented bit) - If this bit is cleared to zero, the device does not implement the Selective self-test routine. If this bit is set to one, the device implements the Selective self-test routine.
- Bit 7 (Reserved).

7.56.6.7 SMART capablilities
The following describes the definition for the SMART capabilities bits.

- Bit 0 - If this bit is set to one, the device saves SMART data prior to going into a power saving mode (Idle, Standby, or Sleep) or immediately upon return to Active or Idle mode from a Standby mode. If this bit is cleared to zero, the device does not save SMART data prior to going into a power saving mode (Idle, Standby, or Sleep) or immediately upon return to Active or Idle mode from a Standby mode.
- Bit 1 - This bit shall be set to one to indicate that the device supports the SMART ENABLE/DISABLE ATTRIBUTE AUTOSAVE command.
- Bits (15:2) (Reserved).

7.56.6.8 Self-test routine recommended polling time
The self-test routine recommended polling time shall be equal to the estimated number of minutes that is the minimum recommended time before which the host should first poll check for test completion status. Actual test time could be several times this value. The host should wait at least this long before sending the first SMART READ DATA command to check for test completion status. Polling Checking before this time could extend the self-test execution time or abort the test depending on the state of bit 2 of the offline data capability bits. Subsequent checking by the host shall be at a vendor specific interval.

7.56.6.9 Data structure checksum
The data structure checksum is the two's complement of the sum of the first 511 bytes in the data structure. Each byte shall be added with unsigned arithmetic, and overflow shall be ignored. The sum of all 512 bytes will be zero when the checksum is correct. The checksum is placed in byte 511.

7.56.6.10 Inputs

Word	Name	Description
00h	Feature	D0h - SMART READ DATA
01h	Count	N/A
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 C24Fh 7:0 N/A
05h	Command	B0h

7.56.6.11 Normal outputs
See Table 85.

7.56.6.12 Error outputs
Uncorrectable Error shall be set to one if SMART data is uncorrectable. ID Note Found shall be set to one if SMART data sector's ID field could not be found or a data structure checksum occurred. Abort shall be set to one if SMART is not enabled, or if register values are invalid. The device may return error status if an Interface CRC error has occurred. See Table 108.

Note: There is no defined mechanism for a device to return an ICRC error status that may have occurred during the last data block of a PIO-in data transfer, there may be other mechanisms in which a host can verify that an Interface CRC error occurred in these cases.

7.56.7 SMART READ LOG - B0h/D5h

7.56.7.1 Feature Set

This command is optional for devices that implement the SMART featureset.

7.56.7.2 Description

[Editors Note: I believe that there is quite a bit of overlap with the READ LOG EXT description. There is also many references to registers that need to be fixed.]

7.56.7.2.1 Overview

This command returns the specified log to the host.

7.56.7.2.2 SMART Log Directory

Table 46 defines the 512 bytes that make up the SMART Log Directory, which is optional. If implemented, the SMART Log Directory is SMART Log address zero, and is defined as one logical sector long.

Table 46 - SMART Log Directory

Byte	Descriptions
0-1	SMART Logging Version
2	Number of logical sectors in the log at log address 1
3	Reserved
4	Number of logical sectors in the log at log address 2
5	Reserved
…	…
510	Number of logical sectors in the log at log address 255
511	Reserved

The value of the SMART Logging Version word shall be 01h if the drive supports multi-sector SMART logs.

If the drive does not support multi-sector SMART logs, then log number zero is defined as reserved, and the drive shall return a command aborted response to the host's request to read log number zero.

7.56.7.2.3 Host Vendor Specific Logs

If the drive supports multi-sector logs, then the logs at log addresses 80-9Fh (Host Vendor Specific addresses) shall each be defined as 16 logical sectors long. The content of the Host Vendor Specific log addresses shall be common to both Smart Log Commands and General Purpose Log Commands. This means that if the host places data in a Host Vendor Specific page using SMART WRITE LOG, and then issues a READ LOG EXT to the same page, that the host receives the same data that was originally stored by SMART WRITE LOG.

7.56.7.2.4 Summary error log sector

Table 47 defines the 512 bytes that make up the SMART summary error log sector. All multi-byte fields shown in this structure follow the byte ordering described in clause 3.2.7. Summary error log data structures shall include UNC errors, IDNF errors for which the address requested was valid, servo errors, write fault errors, etc. Summary error log data structures shall not include errors attributed to the receipt of faulty commands such as command codes not implemented by the device or requests with invalid parameters or invalid addresses. If the device supports comprehensive error log (address 02h), then the summary error log sector duplicates the last five error entries in the comprehensive error log. The summary error log supports 28-bit addressing only.

Table 47 - SMART summary error log sector

Byte	Descriptions
0	SMART error log version
1	Error log index
2-91	First error log data structure
92-181	Second error log data structure
182-271	Third error log data structure
272-361	Fourth error log data structure
362-451	Fifth error log data structure
452-453	Device error count
454-510	Reserved
511	Data structure checksum

7.56.7.2.4.1 Error log version

The value of the SMART summary error log version byte shall be 01h.

7.56.7.2.4.2 Error log index

The error log index indicates the error log data structure representing the most recent error. Only values 5 through 0 are valid. If there are no error log entries, the value of the error log index shall be zero.

7.56.7.2.4.3 Error log data structure

An error log data structure shall be presented for each of the last five errors reported by the device. These error log data structure entries are viewed as a circular buffer. That is, the first error shall create the first error log data structure; the second error, the second error log structure; etc. The sixth error shall create an error log data structure that replaces the first error log data structure; the seventh error replaces the second error log structure, etc. The error log pointer indicates the most recent error log structure. If fewer than five errors have occurred, the unused error log structure entries shall be zero filled. Table 48 describes the content of a valid error log data structure.

Table 48 - Error log data structure

Byte	Descriptions
n thru n+11	First command data structure
n+12 thru n+23	Second command data structure
n+24 thru n+35	Third command data structure
n+36 thru n+47	Fourth command data structure
n+48 thru n+59	Fifth command data structure
n+60 thru n+89	Error data structure

7.56.7.2.4.3.1 Command data structure

The fifth command data structure shall contain the command or reset for which the error is being reported. The fourth command data structure should contain the command or reset that preceded the command or reset for which the error is being reported, the third command data structure should contain the command or reset preceding the one in the fourth command data structure, etc. If fewer than four commands and resets preceded the command or reset for which the error is being reported, the unused command data structures shall be zero filled, for example, if only three commands and resets preceded the command or reset for which the error is being reported, the first command data structure shall be zero filled. In some devices, the hardware implementation may preclude the device from reporting the commands that preceded the command for which the error is being reported or that preceded a reset. In this case, the command data structures are zero filled.

If the command data structure represents a command or software reset, the content of the command data structure shall be as shown in Table 49. If the command data structure represents a hardware reset, the content of byte n shall be FFh, the content of bytes n+1 through n+7 are vendor specific, and the content of bytes n+8 through n+11 shall contain the timestamp.

Table 49 - Command data structure

Byte	Descriptions
n	Transport specific value when the Command was initiated. See the appropriate transport standard, reference Device Control register.
n+1	Content of the Feature field when the Command was initiated.
n+2	Content of the Count field when the Command was initiated.
n+3	Content of the LBA field (7:0) when the Command was initiated.
n+4	Content of the LBA field (15:8) when the Command was initiated.
n+5	Content of the LBA field (23:16) when the Command was initiated.
n+6	Transport specific value when the Command was initiated. See the appropriate transport standard, reference Device or Device/Head register.
n+7	Content written to the Command register when the Command was initiated
n+8	Timestamp (least significant byte)
n+9	Timestamp (next least significant byte)
n+10	Timestamp (next most significant byte)
n+11	Timestamp (most significant byte)

Timestamp shall be the time since power-on in milliseconds when command acceptance occurred. This timestamp may wrap around.

7.56.7.2.4.3.2 Error data structure

The error data structure shall contain the error description of the command for which an error was reported as described in Table 50. If the error was logged for a hardware reset, the content of bytes n+1 through n+7 shall be vendor specific and the remaining bytes shall be as defined in Table 50.

Table 50 - Error data structure

Byte	Descriptions
n	Reserved
n+1	Content of the Error field after command completion occurred.
n+2	Content of the Count field after command completion occurred.
n+3	Content of the LBA field (7:0) after command completion occurred.
n+4	Content of the LBA field (15:8) after command completion occurred.
n+5	Content of the LBA field (23:16) after command completion occurred.
n+6	Transport specific value after command completion occured. See the appropriate transport standard, reference Device Control register.
n+7	Content written to the Status field after command completion occurred.
n+8 thru n+26	Extended error information
n+27	State
n+28	Life timestamp (least significant byte)
n+29	Life timestamp (most significant byte)

Extended error information shall be vendor specific.

State shall contain a value indicating the state of the device when command was written to the Command register or the reset occurred as described in Table 51.

Table 51 - State field values

Value	State
x0h	Unknown
x1h	Sleep
x2h	Standby
x3h	Active/Idle
x4h	Executing SMART off-line or self-test
x5h-xAh	Reserved
xBh-xFh	Vendor unique
The value of x is vendor specific and may be different for each state.	

Sleep indicates the reset for which the error is being reported was received when the device was in the Sleep mode.

Standby indicates the command or reset for which the error is being reported was received when the device was in the Standby mode.

Active/Idle indicates the command or reset for which the error is being reported was received when the device was in the Active or Idle mode. **[Editors Note: was "and BSY=0" I do not know if removing the BSY statement changes the report. I do not see a BSY=1 entry]**

Executing SMART off-line or self-test indicates the command or reset for which the error is being reported was received when the device was in the process of executing a SMART off-line or self-test.

Life timestamp shall contain the power-on lifetime of the device in hours when command completion occurred.

7.56.7.2.4.4 Device error count

The device error count field shall contain the total number of errors attributable to the device that have been reported by the device during the life of the device. These errors shall include UNC errors, IDNF errors for which the address requested was valid, servo errors, write fault errors, etc. This count shall not include errors attributed to the receipt of faulty commands such as commands codes not implemented by the device or requests with invalid parameters or invalid addresses. If the maximum value for this field is reached, the count shall remain at the maximum value when additional errors are encountered and logged.

7.56.7.2.4.5 Data structure checksum

The data structure checksum is the two's complement of the sum of the first 511 bytes in the data structure. Each byte shall be added with unsigned arithmetic, and overflow shall be ignored. The sum of all 512 bytes will be zero when the checksum is correct. The checksum is placed in byte 511.

7.56.7.2.5 Comprehensive error log

Table 52 defines the format of each of the sectors that comprise the SMART comprehensive error log. The SMART Comprehensive error log provides logging for 28-bit addressing only. For 48-bit addressing See 7.32.2.2. The maximum size of the SMART comprehensive error log shall be 51 logical sectors. Devices may support fewer than 51 logical sectors. All multi-byte fields shown in this structure follow the byte ordering described in volume 1, Clause 3. The comprehensive error log data structures shall include UNC errors, IDNF errors for which the address requested was valid, servo errors, write fault errors, etc. Comprehensive error log data structures shall not include errors attributed to the receipt of faulty commands such as command codes not supported by the device or requests with invalid parameters or invalid addresses.

Table 52 - Comprehensive error log

Byte	First sector	Subsequent sectors
0	SMART error log version	Reserved
1	Error log index	Reserved
2-91	First error log data structure	Data structure 5n+1
92-181	Second error log data structure	Data structure 5n+2
182-271	Third error log data structure	Data structure 5n+3
272-361	Fourth error log data structure	Data structure 5n+4
362-451	Fifth error log data structure	Data structure 5n+5
452-453	Device error count	Reserved
454-510	Reserved	Reserved
511	Data structure checksum	Data structure checksum
n is the logical sector number within the log. The first logical sector is sector zero		

7.56.7.2.5.1 Error log version

The value of the error log version byte shall be set to 01h.

7.56.7.2.5.2 Error log index

The error log index indicates the error log data structure representing the most recent error. If there have been no error log entries, the error log index is set to zero. Valid values for the error log index are zero to 255.

7.56.7.2.5.3 Error log data structure

The error log is viewed as a circular buffer. The device may support from two to 51 error log sectors. When the last supported error log sector has been filled, the next error shall create an error log data structure that replaces the first error log data structure in logical sector zero. The next error after that shall create an error log data structure that replaces the second error log data structure in logical sector zero. The sixth error after the log has filled shall replace the first error log data structure in logical sector one, and so on.

The error log index indicates the most recent error log data structure. Unused error log data structures shall be filled with zeros.

The content of the error log data structure entries is defined in 7.56.7.2.4.3.

7.56.7.2.5.4 Device error count

The device error count field is defined in 7.56.7.2.4.4.

7.56.7.2.5.5 Data structure checksum

The data structure checksum is defined in 7.56.7.2.4.5.

7.56.7.2.6 Self-test log sector [Editors Note: Wouldn't it be better to call these log pages? Log sizes do not change with the sector size…]

Table 53 defines the 512 bytes that make up the SMART self-test log sector. All multi-byte fields shown in this structure follow the byte ordering described in clause 3.2.7. The self-test log sector supports 28-bit addressing only.

Table 53 - Self-test log data structure

Byte	Descriptions
0-1	Self-test log data structure revision number
2-25	First descriptor entry
26-49	Second descriptor entry
.....	....
482-505	Twenty-first descriptor entry
506-507	Vendor specific
508	Self-test index
509-510	Reserved
511	Data structure checksum

This log is viewed as a circular buffer. The first entry shall begin at byte 2, the second entry shall begin at byte 26, and so on until the twenty-second entry, that shall replace the first entry. Then, the twenty-third entry shall replace the second entry, and so on. If fewer than 21 self-tests have been performed by the device, the unused descriptor entries shall be filled with zeroes.

7.56.7.2.6.1 Self-test log data structure revision number

The value of the self-test log data structure revision number shall be 0001h.

7.56.7.2.6.2 Self-test log descriptor entry

The content of the self-test descriptor entry is shown in Table 54.

Table 54 - Self-test log descriptor entry

Byte	Descriptions
n	Content of the LBA field (7:0).
n+1	Content of the self-test execution status byte.
n+2	Life timestamp (least significant byte).
n+3	Life timestamp (most significant byte).
n+4	Content of the self-test failure checkpoint byte.
n+5	Failing LBA (7:0).
n+6	Failing LBA (15:8).
n+7	Failing LBA (23:16).
n+8	Failing LBA (27:24).
n+9 to n+23	Vendor specific.

Content of the LBA field (7:0) shall be the content of the LBA field (7:0) when the nth self-test subcommand was issued (See 7.56.5.1).

Content of the self-test execution status byte shall be the content of the self-test execution status byte when the nth self-test was completed (See 7.56.6.4).

Life timestamp shall contain the power-on lifetime of the device in hours when the nth self-test subcommand was completed.

Content of the self-test failure checkpoint byte may contain additional information about the self-test that failed.

The failing LBA shall be the LBA of the uncorrectable logical sector that caused the test to fail. If the device encountered more than one uncorrectable logical sector during the test, this field shall indicate the LBA of the first uncorrectable logical sector encountered. If the test passed or the test failed for some reason other than an uncorrectable logical sector, the value of this field is undefined.

7.56.7.2.6.3 Self-test index

The self-test index shall point to the most recent entry. Initially, when the log is empty, the index shall be set to zero. It shall be set to one when the first entry is made, two for the second entry, etc., until the 22nd entry, when the index shall be reset to one.

7.56.7.2.6.4 Data structure checksum

The data structure checksum is the two's complement of the sum of the first 511 bytes in the data structure. Each byte shall be added with unsigned arithmetic, and overflow shall be ignored. The sum of all 512 bytes is zero when the checksum is correct. The checksum is placed in byte 511.

7.56.7.2.7 Selective self-test log

The Selective self-test log is a log that may be both written and read by the host. This log allows the host to select the parameters for the self-test and to monitor the progress of the self-test. Table 55 defines the content of the Selective self-test log.

Table 55 - Selective self-test log

Byte	Description	Read/write
0-1	Data structure revision number	R/W
2-9	Starting LBA for test span 1	R/W
10-17	Ending LBA for test span 1	R/W
18-25	Starting LBA for test span 2	R/W
26-33	Ending LBA for test span 2	R/W
34-41	Starting LBA for test span 3	R/W
42-49	Ending LBA for test span 3	R/W
50-57	Starting LBA for test span 4	R/W
58-65	Ending LBA for test span 4	R/W
66-73	Starting LBA for test span 5	R/W
74-81	Ending LBA for test span 5	R/W
82-337	Reserved	Reserved
338-491	Vendor specific	Vendor specific
492-499	Current LBA under test	Read
500-501	Current span under test	Read
502-503	Feature flags	R/W
504-507	Vendor specific	Vendor specific
508-509	Selective self-test pending time	R/W
510	Reserved	Reserved
511	Data structure checksum	R/W

7.56.7.2.7.1 Data structure revision number

The value of the data structure revision number filed shall be 01h. This value shall be written by the host and returned unmodified by the device.

7.56.7.2.7.2 Test span definition

The Selective self-test log provides for the definition of up to five test spans. The starting LBA for each test span is the LBA of the first logical sector tested in the test span and the ending LBA for each test span is the last LBA tested in the test span. If the starting and ending LBA values for a test span are both zero, a test span is not defined and not tested. These values shall be written by the host and returned unmodified by the device.

7.56.7.2.7.3 Current LBA under test

The Current LBA under test field shall be written with a value of zero by the host. As the self-test progresses, the device shall modify this value to contain the beginning LBA of the 65,536 logical sector block currently being tested. When the self-test including the off-line scan between test spans has been completed, a zero value is placed in this field.

7.56.7.2.7.4 Current span under test

The Current span under test field shall be written with a value of zero by the host. As the self-test progresses, the device shall modify this value to contain the test span number of the current span being tested. If an off-line scan between test spans is selected, a value greater then five is placed in this field during the off-line scan. When the self-test including the off-line scan between test spans has been completed, a zero value is placed in this field.

7.56.7.2.7.5 Feature flags

The Feature flags define the features of Selective self-test to be executed (See Table 56).

Table 56 - Selective self-test feature flags

Bit	Description
0	Vendor specific
1	When set to one, perform off-line scan after selective test.
2	Vendor specific
3	When set to one, off-line scan after selective test is pending.
4	When set to one, off-line scan after selective test is active.
5-15	Reserved.

Bit (1) shall be written by the host and returned unmodified by the device. Bits (4:3) shall be written as zeros by the host and the device shall modify them as the test progresses.

7.56.7.2.7.6 Selective self-test pending time

The selective self-test pending time is the time in minutes from power-on to the resumption of the off-line testing if the pending bit is set. At the expiration of this time, sets the active bit to one, and resumes the off-line scan that had begun before power-down.

7.56.7.2.7.7 Data structure checksum

The data structure checksum is defined in 7.56.7.2.4.5.

7.56.7.3 Inputs

Word	Name	Description
00h	Feature	D5h - SMART READ LOG
01h	Count	Specifies the number of logical sectors to be read from the specified log. The log transferred by the drive shall start at the first logical sector in the specified log, regardless of the sector count requested. Bits 15:8 shall be cleared to zero
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 C24Fh 7:0 Specifies the log to be returned as described in Table 29. If this command is implemented, all address values for which the contents are defined shall be implemented and all address values defined as host vendor specific shall be implemented. The host vendor specific logs may be used by the host to store any data desired. If a host vendor specific log has never been written by the host, when read the content of the log shall be zeros. Device vendor specific logs may be used by the device vendor to store any data and need only be implemented if used.
05h	Command	B0h

7.56.7.4 Normal outputs

See Table 85

7.56.7.5 Error outputs

Uncorrectable Error shall be set to one if SMART data is uncorrectable. ID Note Found shall be set to one if SMART data sector's ID field could not be found or a data structure checksum occurred. Abort shall be set to one if SMART is not enabled, or if register values are invalid. See Table 108.

7.56.8 SMART RETURN STATUS - B0h/DAh, Non-data

7.56.8.1 Feature Set

This command is mandatory for devices that implement the SMART feature set.

7.56.8.2 Description

This command causes the device to communicate the reliability status of the device to the host. If a threshold exceeded condition is not detected by the device, the device shall set the LBA field (15:8) to 4Fh and the LBA field (23:16) to C2h. If a threshold exceeded condition is detected by the device, the device shall set the LBA field (15:8) to F4h and the LBA field (23:16) to 2Ch.

7.56.8.3 Inputs

Word	Name	Description
00h	Feature	DAh - SMART RETURN STATUS
01h	Count	N/A
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 C24Fh 7:0 Specifies the log to be returned as described in Table 29. If this command is implemented, all address values for which the contents are defined shall be implemented and all address values defined as host vendor specific shall be implemented. The host vendor specific logs may be used by the host to store any data desired. If a host vendor specific log has never been written by the host, when read the content of the log shall be zeros. Device vendor specific logs may be used by the device vendor to store any data and need only be implemented if used.
05h	Command	B0h

7.56.8.4 Normal outputs

See Table 96

7.56.8.5 Error outputs

Abort shall be set to one if SMART is not enabled. See Table 100.

7.56.9 SMART WRITE LOG - D6h, PIO data-out

7.56.9.1 Feature Set

This command is optional for devices that implement the SMART feature set.

7.56.9.2 Description

[Editors Note: This description seems a bit thin to me. There is a reference to the log table list in the command]

This command writes the specified number of 512 byte data sectors to the specified log. **[Editors Note: Should we call this a sector**]

7.56.9.3 Inputs

The Feature field shall be set to D6h. The Count field shall specify the number of logical sectors that shall be written to the log number specified by the LBA field (7:0). The LBA field (15:8) shall be set to 4Fh. The LBA field (23:16) shall be set to C2h.

Word	Name	Description
00h	Feature	D6h - SMART WRITE LOG
01h	Count	Specifies the number of logical sectors that shall be written to the specified log. The log transferred to the drive shall be stored by the drive starting at the first logical sector in the specified log. Bits 15:8 shall be cleared to zero
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 C24Fh 7:0 Specifies the log to be written as described in Table 29. If this command is implemented, all address values defined as host vendor specific shall be implemented.
05h	Command	B0h

7.56.9.4 Normal outputs

See Table 85

7.56.9.5 Error outputs

ID Note Found shall be set to one if SMART log sector's ID field could not be found. Abort shall be set to one if SMART is not enabled, if the log sector address is not implemented. The device may return error status if an Interface CRC error has occurred. See Table 111.

7.57 STANDBY - E2h, Non-data

7.57.1 Feature Set
This commans is mandatory for devices that implement the Power Management feature set

7.57.2 Description
This command causes the device to enter the Standby mode.

If the Count field is non-zero then the Standby timer shall be enabled. The value in the Count field shall be used to determine the time programmed into the Standby timer (See Table 16).

If the Count field is zero then the Standby timer is disabled.

7.57.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	This value shall determine the time period programmed into the Standby timer. Table 16 defines these values.
02h-04h	LBA	N/A
05h	Command	E2h

7.57.4 Normal outputs
See Table 85

7.57.5 Error outputs
See Table 100.

7.58 STANDBY IMMEDIATE - E0h, Non-data

7.58.1 Feature Set

This commans is mandatory for devices that implement the Power Management feature set

7.58.2 Description

This command causes the device to immediately enter the Standby mode.

7.58.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	E2h

7.58.4 Normal outputs

See Table 85

7.58.5 Error outputs

See Table 100.

7.59 TRUSTED RECEIVE – 5Ch

Reserved for Trusted Computing Group

7.60 TRUSTED RECEIVE DMA – 5Dh

Reserved for Trusted Computing Group

7.61 TRUSTED SEND – 5Eh

Reserved for Trusted Computing Group

7.62 TRUSTED SEND DMA – 5Fh

Reserved for Trusted Computing Group

7.63 WRITE BUFFER - E8h, PIO data-out

7.63.1 Feature Set

This command is optional for devices that implement the General feature set

7.63.2 Description

This command enables the host to write the contents of one logical sector in the device's buffer.

The READ BUFFER and WRITE BUFFER commands shall be synchronized within the device such that sequential WRITE BUFFER and READ BUFFER commands access the same bytes within the buffer.

7.63.3 Inputs

Word	Name	Description
00h	Feature	N/A
01h	Count	N/A
02h-04h	LBA	N/A
05h	Command	E8h

7.63.4 Normal outputs

See Table 85

7.63.5 Error outputs

The device may return error status if an Interface CRC error has occurred. See Table 100.

7.64 WRITE DMA - CAh, DMA

7.64.1 Feature Set
This command is mandatory for devices that implement the General feature set

7.64.2 Description
The WRITE DMA command allows the host to write data using the DMA data transfer protocol.

7.64.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred. Bits 15:8 shall be cleared to zero
02h	LBA	MSB
03h		Address of first logical sector to be transferred. Bits 47:28 shall be cleared to zero
04h		LSB
05h	Command	C8h

7.64.4 Normal outputs
See Table 85

7.64.5 Error outputs
LBA bits 47:28 shall be cleared to zero. See Table 113.

7.65 WRITE DMA EXT - 35h, DMA

7.65.1 Feature Set
This command is mandatory for devices that implement the 48-bit Address feature set

7.65.2 Description
The WRITE DMA EXT command allows the host to write data using the DMA data transfer protocol.

7.65.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65,536 logical sectors are to be transferred.
02h	LBA	MSB
03h		Address of first logical sector to be transferred.
04h		LSB
05h	Command	C8h

7.65.4 Normal outputs
See Table 85

7.65.5 Error outputs
See Table 113.

7.66 WRITE DMA FUA EXT - 3Dh, DMA

7.66.1 Feature Set
This command is mandatory for devices that implement the 48-bit Address feature set

7.66.2 Description
The WRITE DMA FUA EXT command provides the same function as the WRITE DMA EXT command except that regardless of whether write caching in the device is enabled or not, the user data shall be written to the media before ending status for the command is reported.

7.66.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65,536 logical sectors are to be transferred.
02h	LBA	MSB
03h		Address of first logical sector to be transferred.
04h		LSB
05h	Command	C8h

7.66.4 Normal outputs
See Table 85

7.66.5 Error outputs
See Table 113.

7.67 WRITE DMA QUEUED - CCh, DMA queued

7.67.1 Feature Set

This command is mandatory for devices that implement the Overlapped feature set

7.67.2 Description

This command executes in a similar manner to a WRITE DMA command. The device may perform a release or may execute the data transfer without performing a release if the data is ready to transfer.

If the device performs a release, the host shall reselect the device using the SERVICE command.

Once the data transfer is begun, the device shall not perform a release until the entire data transfer has been completed.

7.67.3 Inputs

Word	Name	Description
00h	Feature	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred. Bits 15:8 shall be cleared to zero
01h	Count	**Bit** **Description** 15:8 Reserved 7:3 Tag - See clause 6.4.4 2:0 N/A
02h	LBA	MSB
03h		Address of first logical sector to be transferred. Bits 47:28 snall be cleared to zero.
04h		LSB
05h	Command	CCh

7.67.4 Normal outputs

7.67.4.1 Data transmission

Data transfer may occur after receipt of the command or may occur after the receipt of a SERVICE command. When the device is ready to transfer data requested by a data transfer command, the device sets the following field content to initiate the data transfer. See Table 93 for the layout of the normal outputs data structure. Release shall be cleared to zero, Input/Output Shall be cleared to zero, Command/Data shall be cleared to zero.

7.67.4.2 Release

If the device performs a release before transferring data for this command, the field content upon performing a release shall be as shown in Table 93. Release shall be set to one, Input/Output Shall be cleared to zero, Command/Data shall be cleared to zero.

7.67.4.3 Service request

When the device is ready to transfer data or complete a command after the command has performed a release, the device shall set the SERV bit and not change the state of any other register bit. When the SERVICE command is received, the device shall set outputs as described in data transfer, command completion, or error outputs depending on the service the device requires.

7.67.4.4 Command completion

When the transfer of all requested data has occurred without error, the field content shall be as shown below. See Table 93 for the layout of the normal outputs data structure. Release shall be cleared to zero, Input/Output Shall be set to one, Command/Data shall be set to one.

7.67.5 Error outputs

The Count field contains the Tag for this command if the device supports command queuing. The device shall return command aborted if the command is not supported. The device shall return command aborted if the device supports command queuing and the Tag is invalid. An unrecoverable error encountered during the execution of this command results in the termination of the command and the Command Block registers contain the logical sector where the first unrecoverable error occurred. If write cache is enabled unrecoverable errors may not be reliably reported as they may occur after the completion of the command. If a queue existed, the unrecoverable error shall cause the queue to abort. **[Editors Note: Do we still need I/O and C/D? I am not sure they are defined correctly here]**

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7 Interface CRC - See clause 6.3.6 6 Write Protect - See clause 6.3.13 5 Media Change - See clause 6.3.7 4 ID Not Found - See clause 6.3.4 3 Media Change Request - See clause 6.3.8 2 Abort - See clause 6.3.1 1 No Media - See clause 6.3.10 0 Obsolete
01h	Interrupt Reasont	**Bit** **Description** 7:3 Tag - See clause 6.4.4. If the device supports command queuing, this field shall contain the Tag of the command being released. 2 Release - See clause 6.4.1. Shall be cleared to zero 1 Input/Output - See clause 6.4.2. Shall be set to one 0 Command/Data - See clause 6.4.1. Shall be set to one
02h	LBA	MSB Address of first unrecoverable error. Bits 47:28 shall be cleared to zero. LSB
03h		
04h		
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 Service - See clause 6.2.9 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

7.68 WRITE DMA QUEUED EXT - 36h, DMA queued

7.68.1 Feature Set

This command is mandatory for devices that implement both the Overlapped feature set and 48-bit Address feature set

7.68.2 Description

This command executes in a similar manner to a WRITE DMA EXT command. The device may perform a release the bus or may execute the data transfer without performing a release if the data is ready to transfer.

If the device performs a release, the host shall reselect the device using the SERVICE command.

Once the data transfer is begun, the device shall not perform a release until the entire data transfer has been completed.

7.68.3 Inputs

Word	Name	Description
00h	Feature	The number of logical sectors to be transferred. A value of 0000h indicates that 65,536 logical sectors are to be transferred.
01h	Count	**Bit** **Description** 15:8 Reserved 7:3 Tag - See clause 6.4.4 2:0 N/A
02h	LBA	MSB
03h		Address of first logical sector to be transferred
04h		LSB
05h	Command	36h

7.68.4 Normal outputs

See Clause 7.67.4

7.68.5 Error outputs

The Interrupt Reason field contains the Tag for this command if the device supports command queuing. The device shall return command aborted if the command is not supported. The device shall return command aborted if the device supports command queuing and the Tag is invalid. An unrecoverable error encountered during the execution of this command results in the termination of the command and the Command Block registers contain the logical sector where the first unrecoverable error occurred. If write cache is enabled unrecoverable errors may not be reliably reported as they may occur after the completion of the command. If a queue existed, the unrecoverable error shall cause the queue to abort. The device may remain BSY for some time when responding to these errors. **[Editors Note: Do we still need I/O and C/D? I am not sure they are defined correctly here]**

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7 Interface CRC - See clause 6.3.6 6 Write Protect - See clause 6.3.13 5 Media Change - See clause 6.3.7 4 ID Not Found - See clause 6.3.4 3 Media Change Request - See clause 6.3.8 2 Abort - See clause 6.3.1 1 No Media - See clause 6.3.10 0 Obsolete
01h	Interrupt Reason	**Bit** **Description** 7:3 Tag - See clause 6.4.4. If the device supports command queuing, this field shall contain the Tag of the command being released. 2 Release - See clause 6.4.1. Shall be cleared to zero 1 Input/Output - See clause 6.4.2. Shall be set to one 0 Command/Data - See clause 6.4.1. Shall be set to one
02h 03h 04h	LBA	MSB Address of first unrecoverable error LSB
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 Service - See clause 6.2.9 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

7.69 WRITE DMA QUEUED FUA EXT - 3Eh, DMA queued

7.69.1 Feature Set

This command is mandatory for devices that implement both the Overlapped feature set and 48-bit Address feature set.

7.69.2 Description

This command executes in a similar manner to a WRITE DMA EXT command. The device may perform a release or may execute the data transfer without performing a release if the data is ready to transfer.

If the device performs a release, the host shall reselect the device using the SERVICE command.

Once the data transfer is begun, the device shall not perform a release until the entire data transfer has been completed.

The WRITE DMA QUEUED FUA EXT command provides the same function as the WRITE DMA EXT command. It is an Overlapped feature set command and when issued it shall not cause an existing queue to be aborted. However, regardless of whether write caching in the device is enabled or not, the user data shall be written to the media before ending status for the command is reported.

7.69.3 Inputs

Word	Name	Description
00h	Feature	The number of logical sectors to be transferred. A value of 0000h indicates that 65,536 logical sectors are to be transferred.
01h	Count	**Bit** **Description** 15:8 Reserved 7:3 Tag - See clause 6.4.4 2:0 N/A
02h	LBA	MSB
03h		Address of first logical sector to be transferred
04h		LSB
05h	Command	36h

7.69.4 Normal outputs

See Clause 7.67.4

7.69.5 Error outputs

See Clause 7.68.5

7.70 WRITE LOG EXT - 3Fh, PIO data-out

7.70.1 Feature Set
This command is mandatory for devices that implement the General Purpose Logging feature set.

7.70.2 Description
This command writes a specified number of 512 byte data logical sectors to the specified log. [Editors Note: This mentioned DRQ Block. I think it really meant sector…].

7.70.3 Inputs

<table>
<tr><th>Word</th><th>Name</th><th>Description</th></tr>
<tr><td>00h</td><td>Feature</td><td>Reserved</td></tr>
<tr><td>01h</td><td>Count</td><td>Sector Count - Specifies the number of logical sectors that shall be written to the specified log. If the number is greater than the number indicated in the Log directory (which is available in Log number zero), the device shall return command aborted. The log transferred to the drive shall be stored by the drive starting at the first logical sector in the specified log.</td></tr>
<tr><td>02h-04h</td><td>LBA</td><td><table>
<tr><th>Bit</th><th>Description</th></tr>
<tr><td>47:32</td><td>Reserved</td></tr>
<tr><td>31:16</td><td>Sector Offset - Specifies the first logical sector of the log to be written.</td></tr>
<tr><td>15:8</td><td>Reserved</td></tr>
<tr><td>7:0</td><td>Log Address - Specifies the log to be written as described in Table 29. A device may support a subset of the available logs. Support for individual logs is determined by support for the associated feature set. Support of the associated log(s) is mandatory for devices implementing the associated feature set. If this command is implemented, all address values defined as host vendor specific shall be implemented. These host vendor specific logs may be used by the host to store any data desired. Support for device vendor specific logs is optional. If the host attempts to write to a read only (RO) log address, the device shall return command aborted. [Editors Note: Some of this stuff looks like it would be better stated in the command description. Yes]</td></tr>
</table></td></tr>
<tr><td>05h</td><td>Command</td><td>3Fh</td></tr>
</table>

7.70.4 Normal outputs
See Table 85

7.70.5 Error outputs
If the device does not support this command, if the feature set associated with the log specified in the LBA field (7:0) is not supported or enabled, or if the values in the Features, Count, or LBA (47:8) are invalid, the device shall return command aborted. If the host attempts to write to a read only (RO) log address, the device shall return command aborted. ID Not Found shall be set to one if the log sector's ID field was not found or data structure checksum error occurred. Abort shall be set to one if the feature associated with the log specified in bit 7:0 of the LBA field is not supported or not enabled. The device may return error status if an Interface CRC error has occurred. See Table 111.

7.71 WRITE LOG DMA EXT - 47h, DMA

7.71.1 Feature Set
This command is optional for devices implementing the General Purpose Logging feature set

7.71.2 Description
See clause 7.70.2

7.71.3 Inputs
See clause 7.70.3

7.71.4 Normal Outputs
See clause 7.70.4

7.71.5 Error Outputs
See clause 7.70.5

7.72 WRITE MULTIPLE - C3h, PIO data-out

7.72.1 Feature Set

This command is mandatory for devices that implement the General feature set

7.72.2 Description

This command writes the number of logical sectors specified in the Count field.

The number of logical sectors per DRQ data block is defined by the content of word 59 of the IDENTIFY DEVICE response.

When the WRITE MULTIPLE command is issued, the Count field contains the number of logical sectors (not the number of DRQ data blocks) requested.

If the number of requested logical sectors is not evenly divisible by the DRQ data block count, as many full blocks as possible are transferred, followed by a final, partial block transfer. The partial block transfer is for n logical sectors, where:

n = Remainder (sector count/ DRQ data block count).

If the WRITE MULTIPLE command is received when write multiple commands are disabled, the Write Multiple operation shall be rejected with command aborted.

Device errors encountered during WRITE MULTIPLE commands are posted after the attempted device write of the DRQ data block or partial DRQ data block transferred. The command ends with the logical sector in error, even if the error was in the middle of a DRQ data block. Subsequent DRQ data blocks are not transferred in the event of an error.

The contents of the Command Structure following the transfer of a DRQ data block that had a logical sector in error are undefined. The host should retry the transfer as individual requests to obtain valid error information.

If bit 8 of IDENTIFY DEVICE data word 59 is cleared to zero, a successful SET MULTIPLE MODE command shall proceed a WRITE MULTIPLE command.

7.72.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred. Bits 15:8 shall be cleared to zero
02h	LBA	MSB Address of first logical sector to be transferred. Bits 47:28 shall be cleared to zero LSB
03h		
04h		
05h	Command	C3h

7.72.4 Normal outputs

See Table 85

7.72.5 Error outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The return fields contain the address of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. LBA field Bits 47:28 shall be cleared to zero. The device may return error status if an Interface CRC error has occurred. See Table 113.

7.73 WRITE MULTIPLE EXT - 39h, PIO data-out

7.73.1 Feature Set

This command is mandatory for devices that implement the 48-bit Address feature set

7.73.2 Description

This command writes the number of logical sectors specified in the Count field.

The number of logical sectors per DRQ data block is defined by the content of word 59 in the IDENTIFY DEVICE response.

When the WRITE MULTIPLE EXT command is issued, the Count field contains the number of logical sectors (not the number of DRQ data blocks) requested.

If the number of requested logical sectors is not evenly divisible by the DRQ data block count, as many full blocks as possible are transferred, followed by a final, partial block transfer. The partial block transfer is for n logical sectors, where:

n = Remainder (sector count / DRQ data block count).

If the WRITE MULTIPLE EXT command is received when write multiple commands are disabled, the Write Multiple operation shall be rejected with command aborted.

Device errors encountered during WRITE MULTIPLE EXT commands are posted after the attempted device write of the DRQ data block or partial DRQ data block transferred. The command ends with the logical sector in error, even if the error was in the middle of a DRQ data block. Subsequent DRQ data blocks are not transferred in the event of an error.

The contents of the Command Structure following the transfer of a data block that had a logical sector in error are undefined. The host should retry the transfer as individual requests to obtain valid error information.

If bit 8 of IDENTIFY DEVICE data word 59 is cleared to zero, a successful SET MULTIPLE MODE command shall proceed a WRITE MULTIPLE EXT command.

7.73.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65,536 logical sectors are to be transferred.
02h	LBA	MSB Address of first logical sector to be transferred. LSB
03h		
04h		
05h	Command	C3h

7.73.4 Normal outputs

See Table 85

7.73.5 Error outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The return fields contain the address of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. The device may return error status if an Interface CRC error has occurred. See Table 113.

7.74 WRITE MULTIPLE FUA EXT - CEh, PIO data-out

7.74.1 Feature Set

This command is mandatory for devices that implement the 48-bit Address feature set

7.74.2 Description

The WRITE MULTIPLE FUA EXT command provides the same functionality as the WRITE MULTIPLE EXT command except that regardless of whether write caching in the device is enabled or not, the user data shall be written to the media before ending status for the command is reported.

If bit 8 of IDENTIFY DEVICE data word 59 is cleared to zero, a successful SET MULTIPLE MODE command shall proceed a WRITE MULTIPLE FUA EXT command.

7.74.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65,536 logical sectors are to be transferred.
02h	LBA	MSB
03h		Address of first logical sector to be transferred.
04h		LSB
05h	Command	C3h

7.74.4 Normal outputs

See Table 85

7.74.5 Error outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The return fields contain the address of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. The device may return error status if an Interface CRC error has occurred. See Table 113

7.75 WRITE SECTOR(S) - 30h, PIO data-out

7.75.1 Feature Set
This command is mandatory for devices that implement the General feature set

7.75.2 Description
This command writes from 1 to 256 logical sectors as specified in the Count field. A count of 0 requests 256 logical sectors.

7.75.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	The number of logical sectors to be transferred. A value of 00h indicates that 256 logical sectors are to be transferred. Bits 15:8 shall be cleared to zero
02h	LBA	MSB Address of first logical sector to be transferred. Bits 47:28 shall be cleared to zero LSB
03h		
04h		
05h	Command	C3h

7.75.4 Normal outputs
See Table 85

7.75.5 Error outputs
An unrecoverable error encountered during the execution of this command results in the termination of the command. The return fields contain the address of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. LBA field Bits 47:28 shall be cleared to zero. The device may return error status if an Interface CRC error has occurred. See Table 113.

7.76 WRITE SECTOR(S) EXT - 34h, PIO data-out

7.76.1 Feature Set

This command is mandatory for devices that implement the 48-bit Address feature set

7.76.2 Description

This command writes from 1 to 65,536 logical sectors as specified in the Count field. A sector count value of 0000h requests 65,536 logical sectors.

7.76.3 Inputs

Word	Name	Description
00h	Feature	Reserved
01h	Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65,536 logical sectors are to be transferred. Bits 15:8 shall be cleared to zero
02h	LBA	MSB
03h		Address of first logical sector to be transferred
04h		LSB
05h	Command	C3h

7.76.4 Normal outputs

See Table 85

7.76.5 Error outputs

An unrecoverable error encountered during the execution of this command results in the termination of the command. The return fields contain the address of the logical sector where the first unrecoverable error occurred. The amount of data transferred is indeterminate. The device may return error status if an Interface CRC error has occurred. See Table 113.

7.77 WRITE STREAM DMA EXT - 3Ah, DMA

7.77.1 Feature Set

This command is mandatory for devices that implement the Streaming feature set.

7.77.2 Description

The WRITE STREAM DMA EXT command provides a method for a host to write data within an allotted time using the DMA data transfer protocol. This command allows for the host to specify that additional actions are to be performed by the device prior to the completion of the command.

7.77.3 Inputs

7.77.3.1 Inputs overview

Word	Name	Description
00h	Feature	**Bit** **Description** 15:8 Command Completion Time Limit (CCTL)- see 7.77.3.2).. 7 Obsolete 6 Write Continuous - See 7.77.3.3 5 Flush - See 7.77.3.4 4 Obsolete 3 Reserved 2:0 Stream ID – See 7.77.3.5
01h	Count	The number of logical sectors to be transferred. A value of 0000h indicates that 65536 logical sectors are to be transferred.
02h	LBA	MSB
03h		Address of first logical sector to be transferred.
04h		LSB
05h	Command	3Ah

7.77.3.2 Command Completion Time Limit (CCTL)

CCTL is the time allowed for the current command's completion is calculated as follows:

CCTL = (content of Feature (15:8)) $*$ (IDENTIFY DEVICE data words (99:98)) microseconds

7.77.3.3 If the valuCONFIGURE STREAM command for this Stream ID. If the Default Command Completion Time Limit is zero, or no previous Configure Stream command was defined for this Stream ID, the result is vendor specific. The time is measured from the write of the command register to the final INTRQ for command completionWrite Continuous (WC)

WC specifies whether the Write Continuous mode is enabled or disabled.

If WC is set to one, then:

a) the device shall not stop processing the command due to errors;
b) if an error occurs during data transfer or while writing data to media before command completion or before the amount of time allowed for command completion based on the setting of CCTL (see 7.38.3.2) or Default CCTL (see 7.9.3) is reached, then the device:
    1) shall continue to transfer the amount of data requested;
    2) may continue writing data to the media;
    3) shall report command completion after all data for the command has been transferred; and
    4) shall save the error information in the Write Streaming Error log; or
c) if the amount of time allowed for command completion based on the setting of CCTL (see 7.38.3.2) or Default CCTL (see 7.9.3) is reached, then the device:

1) shall stop processing the command;
2) shall report command completion;
3) shall set CCTO in the Write Streaming Error log to one; and
4) may continue writing data to the media.

If WC is cleared to zero and an error occurs, then the device:

a) shall stop processing the command and report command completion; and
b) may continue writing data to the media.

7.77.3.4 Flush

If Flush is set to one, Default CCTL is cleared to zero, and CCTL is cleared to zero, then the device shall write all data for the specified stream to the media before command completion is reported.

If Flush is set to one and Default CCTL was not cleared to zero in the most recent CONFIGURE STREAM command (see 7.9) for the Stream ID, then the device shall report command completion within the time specified by Default CCTL (see 7.9.3.4).

If Flush is set to one and CCTL is not cleared to zero, then the device shall report command completion within (CCTL ∗ (IDENTIFY DEVICE data words (99:98)) microseconds.

If Flush is set to one and either Default CCTL was not cleared to zero in the most recent CONFIGURE STREAM command (see 7.9) for the Stream ID, or CCTL is not cleared to zero, then device:

a) shall measure the time before reporting command completion from command acceptance;
b) shall set CCTO to one if all of the data for the command has been received by the device, but the device has not yet written all of the data to its media; and
c) should continue writing data to its media after reporting command completion.

7.77.3.5 Stream ID

Stream ID specifies the stream to be written. The device shall operate according to the parameters specified by the most recent successful CONFIGURE STREAM command specifying this Stream ID. Any write to the device media or internal device buffer management as a result of the Stream ID is vendor specific.

7.77.4 Normal Outputs

See Table 89 for the definition of normal outputs.

7.77.5 Error Outputs

If

a) WC was set to one in the command, and
b) the device is able to accept the amount of data requested for the command (e.g., an error occurred while writing to the media);

then the device shall set SE to one and clear ERR to zero.

If:

a) WC was set to one in the command, and
b) the device is not able to return the amount of data requested for the command (e.g., an ICRC error will be reported at command completion);

then the device shall clear SE to zero and set ERR to one;

If:

a) WC was cleared to zero in the command;
b) CCTL was not cleared to zero in the command, or CCTL was cleared to zero in the command and Default CCTL specified in the most recent CONFIGURE STREAM command (see 7.9) for the Stream ID was not cleared to zero; and
c) the time specified for command completion by CCTL (see 7.38.3.2) or Default CCTL (see 7.9.3) has been reached;

then the device shall clear SE to zero, set ERR to one, and set ABRT to one whether or not all data has been flushed to media.

If:

a) WC was cleared to zero in the command;
b) CCTL was cleared to zero in the command; and
c) Default CCTL specified in the most recent CONFIGURE STREAM command (see 7.9) for the Stream ID was cleared to zero;

then the device shall clear SE to zero, set ERR to one, and set ICRC, IDNF, and/or ABRT to one (i.e., indicating the error type).

See Table 114 for the definition of other error outputs.

7.78 WRITE STREAM EXT - 3Bh, PIO data-out

7.78.1 Feature Set

This command is mandatory for devices that implement the Streaming feature set.

7.78.2 Description

See 7.77.2 for the description of this command.

7.78.3 Inputs

See 7.77.3 for the inputs to this command

7.78.4 Normal Outputs

See Table 89 for normal outputs.

7.78.5 Error Outputs

See 7.77.5 for error outputs.

7.79 WRITE UNCORRECTABLE EXT - 45h, Non-data

7.79.1 Feature Set

This command is optional for devices implementing the general feature set.

7.79.2 Description

The Write Uncorrectable EXT command is used to cause the device to report an uncorrectable error when the target sector is subsequently read.

When the Feature field contains a value of 5xh the Write Uncorrectable EXT command shall cause the device to indicate a failure when reads to any of the sectors that are contained in physical block of the specified sector are performed. These sectors are referred to as ‘pseudo uncorrectable’ sectors. In this case whenever a pseudo uncorrectable sector is accessed via a read command the drive shall perform normal error recovery to the fullest extent and then set the UNC and ERR bits to indicate the sector is bad.

When the Features register contains a value of Axh the Write Uncorrectable EXT command shall cause the device to flag the specified sector as ‘flagged uncorrectable’ which will cause the device to indicate a failure when reads to the specified sector are performed. These sectors are referred to as ‘flagged uncorrectable’ sectors. In this case whenever a ‘flagged uncorrectable’ sector is accessed via a read command the drive shall set the UNC and ERR bits to indicate the sector is bad

If this command is sent to the device with the content of the Features register set to anything other than what is defined above the device shall abort the command.

Commands that return UNC and ERR when a pseudo uncorrectable or flagged uncorrectable sector is read include: READ DMA, READ DMA EXT, READ DMA QUEUED, READ DMA QUEUED EXT, READ MULTIPLE, READ MULTIPLE EXT, READ SECTOR(S), READ SECTOR(S) EXT, READ VERIFY SECTOR(S), READ VERIFY SECTOR(S) EXT, READ STREAM EXT, READ STREAM DMA EXT. If the host writes to a ‘pseudo uncorrectable’ or ‘flagged uncorrectable’ sector, the drive shall attempt to write the data to the sector. The write shall clear the uncorrectable status of the sector and make the sector good if possible and the device shall verify that the sector can now be read without error. It is possible that an ‘uncorrectable’ sector location has actual physical errors. In this case read commands and/or write commands shall return ERR status information that is consistent with the error.

If the LOG feature is set to x5h sectors that have been made pseudo uncorrectable when read back shall be listed as failed in the standard error logs and shall cause SMART utilities to indicate failure if too many sectors are uncorrectable. The LOG feature set to xAh shall indicate that reading of pseudo uncorrectable sectors shall not be logged as an error in any standardized error logs.

The pseudo uncorrectable or flagged uncorrectable status of a sector shall remain through a power cycle. If the drive is unable to process a Write Uncorrectable EXT command for any reason the device shall abort the command.

7.79.3 Inputs

Word	Name	Description
00h	Feature	Large Physical Sector / Log **[Editors Note: How about: Write Uncorrectable options.]** Bits 15:8 are reserved. Bits 7:0 — Description 00h-54h — Reserved 55h — Create a pseudo-uncorrectable error with logging 56h-59h — Reserved 5A — Create a pseudo-uncorrectable error without logging 5Bh-A4h — Reserved A5 — Created a flagged error with logging A6h-A9h — Resereved AA — Create a flagged error without logging ABh-FFH — Reserved
01h	Count	The number of sectors to be marked. A value of 0000h indicates that 65,536 sectors are to be marked.
02h	LBA	MSB
03h		Address of first sector to be marked.
04h		LSB
05h	Command	45h

7.79.4 Normal Outputs

See Table 85

7.79.5 Error Outputs

See Table 100

8 SCT Command Transport

8.1 Overview

The SCT Command Transport feature set provides a method for a host to send commands and data to a device and for a device to send data and status to a host using log pages. Log page E0h is used to issue commands and return status. Log page E1h is used to transport data.

There are two methods to access the log pages defined for the SCT Command Transport feature set:
a) using SMART READ LOG and SMART WRITE LOG commands; and
b) using READ LOG (DMA) EXT and WRITE LOG (DMA) EXT commands.

Both sets of commands access the same log pages and provide the same capabilities. The two methods are also used in the same way: a command is issued, data is transferred (if necessary), and status may be retrieved multiple times if desired.

If the General Purpose Logging feature set is not supported by the device, then the READ LOG EXT and WRITE LOG EXT commands shall not be issued by the host.

If the SMART feature set is not supported by the device, then the SMART READ LOG and SMART WRITE LOG commands shall not be issued by the host.

If the SMART feature set is supported but not enabled, then a device that implements this feature set shall support SMART READ LOG and SMART WRITE LOG commands to log addresses E0h and E1h.

Sending a key sector to log page E0h starts the command process. The key sector specifies Action and Function Codes along with the parameters that are required to perform the action. The SCT command response (either error or command) is the same for both methods of issuing commands.

SCT commands are executed like other ATA commands, therefore they take precedence over any background function the device may be performing when the SCT command is issued (i.e., a function initiated by a SMART EXECUTE OFFLINE IMMEDIATE command). Some SCT commands indicate command completion and return status while the SCT command is still executing [mse: it would be good to have an “e.g.” here].

The commands that are defined in the SCT Command Transport feature set are subject to requirements documented in the ATA-8 standards (i.e., if the Security Mode feature set is enabled and a password has not been issued to unlock the device, then all SCT commands shall be aborted by the device).

A device supporting the SCT Command Transport feature set should report a length of one in the log directory for log pages E0h and E1h. The length of log page E1h does not indicate the length of an SCT Command Transport feature set data transfer. This differs from the requirement in this standard that the log page directory report the actual length of the specified log pages.

8.1.1 Device addressing methods

Standard ATA commands employ either LBA or Logical CHS addressing using both 28-bit and 48-bit capability. SCT commands only support 48-bit addressing.

For LBA access all user sectors on the device are numbered in a one-dimensional sequence from 0 to the maximum number of user sectors minus one. ATA Commands support 28-bits of LBA addressing and ATA Extended commands support 48-bits of LBA addressing. All SCT commands support 48-bits of LBA address. In this method, all defective cylinders, heads and sectors are mapped out by defect management, rendering them inaccessible.

8.1.2 SCT command nesting and interspersing with standard commands

Standard ATA commands may be interspersed with SCT commands, but SCT commands cannot be nested. SCT commands that do not require a subsequent data transfer operation are not interspersed with any ATA commands or each other. SCT commands that do require data transfer, on the other hand, may not be nested; that is, if a key command that requires a data transfer is issued, all data transfer - to or from the host - shall complete before another SCT command is issued. In most cases, however, ATA read/write commands may be inserted in between data transfers for SCT commands, that is, between complete SMART Read Log/Write Log commands. Furthermore, any reset (power-on, software or hardware) shall cause the SCT command to be aborted.

8.1.3 Resets

If an SCT command is executing, any reset including Soft Reset (SRST), Hard Reset, COMRESET, and Power-On Reset (POR) shall cause the command to be terminated. This could result in partial command execution or data loss. There is no indication once the device becomes ready that the previous command was terminated.

POR and COMRESET clear the SCT Status Response fields (i.e., Extended Status Code, Action Code, and Function Code). All other resets preserve the SCT Status Response fields except extended status code which is cleared to zero.

8.2 Processing SCT commands

8.2.1 Processing SCT commands overview

There are four phases involved in processing of SCT commands. These phases are:

1) Capability identification (see 8.2.2);
2) Command transfer (see 8.2.3);
3) Data transfer (see 8.2.4); and
4) Status (see 8.2.5).

8.2.2 SCT capability identification

Capability Identification is performed by the host issuing an IDENTIFY DEVICE command to determine if the SCT Command Transport feature set is enabled and which Action Codes are supported (see 7.17.7.86).

8.2.3 SCT command transfer

Transfer of an SCT command occurs when a 512-byte data packet is created by the host and written to log page E0h. The 512-byte data packet contains a single command as defined in the SCT Command Transport feature set.

Table 57 defines how a host shall set the fields to issue a SMART WRITE LOG command to send an SCT command.

Table 57 – Fields to issue an SCT command using SMART WRITE LOG

Word	Name	Description
00h	Feature	D6h - SMART WRITE LOG
01h	Count	**Bit** **Description** 15:8 Reserved 7:0 01h
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 C24Fh 7:0 E0h - Log Address
05h	Command	B0h - SMART

Table 58 defines how a host shall set the fields to issue a WRITE LOG EXT command to send an SCT command.

Table 58 – Fields to issue an SCT command using WRITE LOG EXT

Word	Name	Description
00h	Feature	Reserved
01h	Count	0001h
02h-04h	LBA	**Bit** **Description** 47:32 Reserved 31:16 0000h 15:8 Reserved 7:0 E0 - Log Address
05h	Command	3Fh – WRITE LOG EXT [Editors Note: Add DMA version globally]

Table 59 defines how a device shall set the fields after successful completion of an SCT command.

Table 59 – Successful SCT command response

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7:0 00h
01h	Count	Reserved
02h-04h	LBA	Reserved
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5:1 N/A 0 0 (Error - See clause 6.2.3)

Table 60 defines how a device shall set the fields after an error occurred during processing of an SCT command.

Table 60 – SCT command error response

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7:5 N/A 4 ID Not Found - See clause 6.3.4. 3 N/A 2 Abort - See Clause 6.3.1. 1 N/A 0 Obsolete
01h	Count	**Bit** **Description** 15:8 Reserved 7:0 Extended Status Code LSB (see Table 61)
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 SCT Command dependent. 7:0 Extended Status Code MSB (see Table 61)
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5:1 N/A 0 1b (Error - See clause 6.2.3)

Table 61 – Extended Status codes

Status Code	Definition
0000h	Command complete without error
0001h	Invalid Function Code
0002h	Input LBA out of range
0003h	Request sector count overflow. The number of sectors requested to transfer (Sector Count register) in the read or write log command is larger than required by SCT command
0004h	Invalid Function code in Error Recovery command [mse: this is confusing. when is this used versus the 0001h version?]
0005h	Invalid Selection code in Error Recovery command
0006h	Host read command timer is less than minimum value
0007h	Host write command timer is less than minimum value
0008h	Background SCT command was aborted because of an interrupting host command
0009h	Background SCT command was terminated because of unrecoverable error
000Ah	Invalid Function code in Long Sector Access command [mse: this is confusing. when is this used versus the 0001h version?]

Status Code	Definition
000Bh	SCT data transfer command was issued without first issuing an SCT command
000Ch	Invalid Function code in Feature Control command [mse: this is confusing. when is this used versus the 0001h version?]
000Dh	Invalid Feature code in Feature Control command
000Eh	Invalid New State value in Feature Control command
000Fh	Invalid Option Flags value in Feature Control command
0010h	Invalid SCT Action code
0011h	Invalid Table ID (table not supported)
0012h	Command was aborted due to device security being locked
0013h	Invalid revision code
0014h	Foreground SCT operation was terminated because of unrecoverable error
0015h-BFFFh	Reserved
C000h-FFEFh	Vendor specific
FFF0h-FFFEh	Reserved
FFFFh	SCT command executing in background

[mse: there previously were two codes that have been removed. One was something like “waiting for data from the host” and the other was something like “waiting to send data to the host”. Why were these removed? I think they were useful and would like to see them added back in.]

8.2.4 SCT data transfer

Once an SCT command for a data transfer has been issued, status is checked and data is transferred using log page E1h. Up to 255 sectors of data may be transferred at a time. If the SCT command requires more than 255 sectors of data transfer and SMART READ LOG or SMART WRITE LOG commands are used to transfer the data, the data may be written or read in up to 255 sector increments. If READ LOG EXT or WRITE LOG EXT commands are used to transfer data, up to 65,535 sectors (i.e., approximately 33MB) may be transferred by a single command. If more than 65,535 sectors are required, then multiple READ LOG EXT or WRITE LOG EXT commands are issued. Table 62 defines how a host shall set the fields for data transfer using a SMART READ LOG or SMART WRITE LOG command.

Table 62 – SCT data transfer using SMART READ LOG or SMART WRITE LOG

Word	Name	Description
00h	Feature	D5h/D6h (SMART READ LOG/SMART WRITE LOG subcommand code)
01h	Count	**Bit** **Description** 15:8 Reserved 7:0 Number of sectors to transfer
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 C24Fh 7:0 E1h - Log Address
05h	Command	B0h - SMART

Table 63 defines how a host shall set the fields for data transfer using a READ LOG EXT or WRITE LOG EXT command.

Table 63 – SCT data transfer using READ LOG EXT or WRITE LOG EXT

Word	Name	Description
00h	Feature	Reserved
01h	Count	Number of sectors to transferr
02h-04h	LBA	**Bit** **Description** 47:32 Reserved 31:16 0000h 15:8 Reserved 7:0 E1 - Log Address
05h	Command	2F/3Fh – READ LOG EXT/WRITE LOG EXT

8.2.5 SCT status

Status for an SCT command may be read at any time by reading log page E0h. If the command involves data transfer, the host shall check status before data is transferred to ensure that the device is ready. The host shall also check status when the command is complete to confirm that the data was transferred successfully. When the command is complete, the host may check status a third time to determine if the command succeeded, failed, or partially succeeded.

Once an SCT command has been issued, status is reported in the ATA fields. This status indicates that the command was accepted or that an error occurred. This ATA status return does not indicate successful completion of the SCT actions, except Foreground LBA Segment Access commands that require the completion of the SCT action (e.g., LBA Segment Access with function code 0101h and 0102h). Some commands may take several minutes or even hours to execute. In this case, the host determines execution progress by requesting SCT status. Some commands may require setup time before they a device is ready to receive data. SCT status is used to determine when the device is read to receive data.

Reading log page E0h retrieves the status information. The SCT status may be acquired any time that the host is allowed to send a command to the device. This command shall not change the power state of the device, nor terminate any background activity, including any SCT command in progress. This means if the device is in the Standby or Idle state, then the log request shall succeed.

Table 64 defines how a host shall set the fields for retrieving status using a SMART READ LOG command.

Table 64 – SCT status request using SMART READ LOG

Word	Name	Description
00h	Feature	D5h (SMART READ LOG subcommand code)
01h	Count	**Bit** **Description** 15:8 Reserved 7:0 01h
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 C24Fh 7:0 E0h (Log Address)
05h	Command	B0h - SMART

Table 65 defines how a host shall set the fields for retrieving status using a READ LOG EXT command.

Table 65 – SCT status request using READ LOG EXT

Word	Name	Description
00h	Feature	Reserved
01h	Count	0001h
02h-04h	LBA	**Bit** **Description** 47:32 Reserved 31:16 0001h 15:8 Reserved 7:0 E0 (Log Address)
05h	Command	2Fh – READ LOG EXT

Table 66 defines the format of the status response information that shall be set by the device in log page E0h. [Editors Note: Include caption in table header]

Table 66 – Format of SCT status response

Byte	Type	Field Name	Description
1:0	Word	Format Version	0002h - Status Response format version number.
3:2	Word	SCT Version	Manufacturer’s vendor specific implementation version number
5:4	Word	SCT Spec.	0001h - Highest level of ATA8-ACS supported.
9:6	DWord	Status Flags	Bit 0: Segment Initialized Flag. If this bit is set to 1, an Write Same command write to all LBAs of the device has completed without error. This bit shall be cleared to 0 when any user LBA is written, even if write cache is enabled. This bit is also cleared if the capacity of the device is changed via SETMAX, SETMAX EXT or DCO. This bit is preserved through a power cycle. Bits 1-31: Reserved
10	Byte	Device State	0 = Active waiting for a command 1 = Stand-by 2 = Sleep 3 = DST executing in background 4 = SMART Off-line Data Collection executing in background 5 = SCT command executing in background
13:11	Byte [3]	reserved	
15:14	Word	Extended Status Code	Status of last SCT command issued. FFFFh if SCT command executing in background (See Table 61).
17:16	Word	Action Code	Action code of last SCT command issued. If the Extended Status Code is FFFFh this is the Action Code of the command that is currently executing
19:18	Word	Function Code	Function code of last SCT command issued. If the Extended Status Code is FFFFh this is the Function Code of the command that is currently executing
39:20	Byte [20]	reserved	
47:40	QWord	LBA	Current LBA of SCT command executing in background. If there is no command currently executing in the background, this field is undefined.
199:48	Byte [152]	reserved	00h
200	Byte	HDA Temp	Current device HDA temperature in degrees Celsius. This is a 2’s complement number. 80h indicates that this value is invalid.
201	Byte	Reserved	
202	Byte	Max Temp	Maximum HDA temperature in degrees Celsius seen this power cycle. This is a 2’s complement number. 80h indicates that this value is invalid.
203	Byte	Reserved	
204	Byte	Life Max Temp	Maximum HDA temperature in degrees Celsius seen for the life of the device. This is a 2’s complement number. 80h indicates that this value is invalid.

Byte	Type	Field Name	Description
479:205	Byte [275]	reserved	
511:480	Byte [32]	Vendor Specific	

8.3 SCT Command Set

An SCT command shall be 512 bytes long. While an SCT command is in progress a host may use an SCT status request to retrieve status information (e.g., to determine if a command active or complete, the current LBA, or error information) about the current SCT command.

Table 67 defines the generic format of an SCT command written to log page E0h.

Table 67 – SCT command format

Byte	Field	Words	Description
1:0	Action Code	1	This field specifies the command type and the type of data being accessed (e.g., sector or long sector), or the action being performed (e.g., a seek on the device). (See table 13 for definition of the Action Code field contents.)
3:2	Function Code	1	This field specifies the type of access and varies by command (e.g., this field specifies read, write, or verify).
x:4	Parameter1	Depends on command	Depends on command
y:x+1	Parameter2	Depends on command	Depends on command
…	...	...	...
	Total Words	256	

Table 68 – SCT Action Codes

Action Code	Description
0000h	Reserved
0001h	Long Sector Access
0002h	Write Same
0003h	Error Recovery Control
0004h	Features Control
0005h	SCT Data Tables
0006h	Vendor specific
0007h - BFFFh	Reserved
C000h - FFFFh	Vendor specific

8.3.1 Long Sector Access command

The function performed by the Long Sector Access command is based on the obsolete ATA READ LONG/WRITE LONG capability, and has been extended beyond 28-bit addressing.

The Long Sector data format for both reads and writes is two blocks long (i.e., each block is 512 bytes long). The first block contains the user data. The second data block contains the error correction and detection bytes. The remainder of the second block should contain zeros. Once the SCT command has been issued and the status response indicates that the device is ready to transfer data, log page E1h should be read or written to transfer the data. Long Sector Access commands cause a forced unit access to occur.

Table 69 defines the format of a Long Sector Access command written to log page E0h.

Table 69 – Long Sector Access command

Word	Name	Value	Description
0	Action Code	0001h	Read or Write a sector with full ECC or CRC data
1	Function Code	0001h	Read Long function
		0002h	Write Long function
2	LBA	QWord	Sector to be read or written

Table 70 defines the format of the status response for a Long Sector Access command.

Table 70 – Long Sector Access command status response

Word	Name	Description
00h	Error	**Bit Description** 15:8 Reserved 7:5 N/A 4 ID Not Found - See clause 6.3.4. 3 N/A 2 Abort - See Clause 6.3.1. 1 N/A 0 Obsolete
01h	Count	**Bit Description** 15:8 Reserved 7:0 Number of ECC/CRC bytes, LSB
02h-04h	LBA	**Bit Description** 47:24 Reserved 23:8 0002h – Number of sectors requested 7:0 Number of ECC/RCR bytes, MSB
05h	Status	**Bit Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5:1 N/A 0 Error - See clause 6.2.3

Table 71 defines the format of the data to be written to log sector E1h for a Long Sector Access command.

Table 71 – Long Sector Format

Field	Size	Description
First Block		
User Data	512	This is the data normally sent or returned by a read or write command. This data may be encoded.
Second Block		
ECC/CRC Data	Vendor Specific	Error correction and detection bytes in vendor-specific format. The number of bytes is returned as status response data on both read and write operations.
Reserved	Remainder of block	All zeros

8.3.2 Write Same

The Write Same command provides the ability for the host to specify that the device shall write a specific pattern to its media.

The Write Same command shall cause the device to begin writing sectors from the first sector specified by the command in the Start field (see Table 72) in incrementing order until the number of sectors specified by the command in the Count field (see Table 72) have been written. If the Count field contains all zeros, then the device shall write all sectors beginning with the sector specified by the Start field through the last user LBA on the device. If the Host Protected Area feature set is implemented by and enabled on the device, then this feature set shall determine the last user LBA. This command shall not write over a hidden partition when hidden partitions are enabled using the Host Protected Area feature set. Automatic sector reassignment is permitted during the operation of this function.

If the Start field or the Start field plus the Count field specify an LBA greater than the last user LBA, then the device shall report an error and abort the command. If the Start field and the Count field contain zero, then the device shall write the specified pattern to all user LBAs on the device.

Any new command other than an SCT status request, including IDENTIFY DEVICE, received by the device while this command is in progress shall terminate the Long Segment Access command. The device shall process the new command.

While a background Write Same command is in progress, the SCT status error code shall be set to FFFFh. If the command completes without error, then the SCT status error code shall be set to 0000h. The SCT status error code shall be set to a value less than FFFFh and greater than 0000h if the command is terminated prematurely for any reason.

Once the key sector has been issued, if the Function Code was 0002h and the TF Data indicates that the drive is ready to receive data, log page E1h should be written to transfer the data.

For the Foreground SCT LBA Segment Access command with function code 0101h the Command Completion Status of the Write Log Address E0h shall indicate the success or failure of the LBA Segment Access command. For the Foreground SCT LBA Segment Access command with function Code 0102h the Command Completion Status of the Write Log Address E1h shall indicate the success or failure of the LBA Segment Access command. The Status and Error registers of the Output indicate the relevant status/error values as defined in ATA/ATAPI-7 specification. In the case of an error an SCT Status Request can be made using a Smart Read Log page E0h to obtain a more detailed analysis of the error.

This command may change the Segment Initialized Flag. If the command writes all the user addressable sectors and completes without encountering an error or being aborted, then the Segment Initialized Flag (i.e., bit 0 of the Status Flags in the SCT status) shall be set to one. A write to any user addressable sector on the device, except one caused by another Write Same command with the Start field and the Count field set to zero (i.e., an Write Same command causing the device to write to all user LBAs), shall cause the Segment Initialized Flag to be cleared. Reallocations as a result of reading data (foreground or background) shall not clear the Device Zeroed flag.

Table 72 defines the format of a Write Same command written to log page E0h.

Table 72 – Write Same command

Word	Name	Value	Description
0	Action Code	0002h	This action writes a pattern or sector of data repeatedly to the media.
1	Function Code	0001h	Repeat Write Pattern
		0002h	Repeat Write Sector
		0003h	Repeat Write Pattern Foreground
		0004h	Repeat Write Sector Foreground
		0005h-FFFFh	Reserved
5:2	Start	QWord	First LBA
9:6	Count	QWord	Number of sectors to fill
11:10	Pattern	DWord	If the Function Code is 0001h or 0003h, this field contains a 32-bit pattern that is written on the media starting at the location specified in words two through five.

Table 73 defines the format of the status response for a Write Same command.

Table 73 – Write Same command status response

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7:5 N/A 4 ID Not Found - See clause 6.3.4. 3 N/A 2 Abort - See Clause 6.3.1. 1 N/A 0 Obsolete
01h	Count	Reserved
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 0001h – Number of sectors requested 7:0 Reserved
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11 5:1 N/A 0 Error - See clause 6.2.3

8.3.3 Error Recovery Control command

The Error Recovery Control command is used to set time limits for read and write error recovery. For non-queued commands, these timers apply to command completion at the host interface. For queued commands where in-order data delivery is enabled, these timers begin counting when the device begins to execute the command, not when the command is sent to the device. These timers do not apply to streaming commands or to queued commands when out-of-order data delivery is enabled. Time limits for error recovery may be used in a data redundant RAID environment where it is more desirable to have the device report a data error rather than risk having it being dropped from the RAID.

The typical usage for this command is when an ATA or SATA device has its write cache function enabled. With write cache enabled, the device cannot report an error on a write command. This is because the write command with which a device is experiencing difficulty is one for which the device has reported status (i.e., considered by the host to be complete). This leaves no recourse for the device other than to reallocate any sectors with which it is experiencing difficulty.

Table 74 defines the format of an Error Recovery Control command written to log page E0h.

Table 74 – Error Recovery Control command

Word	Name	Value	Description
0	Action Code	0003h	Set the read and write error recovery time
1	Function Code	0001h	Set New Value
		0002h	Return Current Value
2	Selection Code	0001h	Read Command Timer
		0002h	Write Command Timer
3	Value	Word	If the function code is 0001h then this field contains the recovery time limit in 100 ms units (i.e., a value of 1 = 100 ms, 2 = 200 ms, etc.). The tolerance is vendor specific.

The Read Command Timer sets an upper limit for the amount of time a device processes a read command. This limit is the amount of time the device shall process a read command in total but, in some cases, a read command requires more than one access to the media. The minimum value for the Read Command Timer is one. Setting this value to zero shall disable Read Command time-out, allowing the device to perform all available error recovery procedures without time limit.

If the Read Command Timer is going to expire while the device is performing error recovery, the device shall stop processing the command and report an uncorrectable ECC error for the LBA that was causing error recovery to be invoked prior to timer expiration. Note that the LBA might be recoverable given more time for error recovery. At this point the host may reconstruct the data for the failing LBA from the other devices in a RAID and issue a write command to the target LBA, allowing the device to attempt vendor specific error recovery on the suspect LBA.

The Write Command Timer sets the upper limit for the amount of time a device processes a write command. The minimum value for this command is one. Setting this value to zero shall disable Write Command time-out, allowing the device to perform all available error recovery procedures without a time limit.

The Write Command Timer has the effect of controlling how aggressively the device reallocates write data when encountering write errors. A large Write Command Timer value allows the device to use more available error recovery procedures for dealing with write errors. A small Write Command Timer value forces the device to attempt to reallocate sectors that may have otherwise been written without error. If the timer is about to expire, then the device should attempt to reallocate the data before the timer expires. If the device is unable to complete data reallocation before the timer expires then the devices fails the command when the timer expires. When write cache is enabled the operation of the timer is vendor specific.

A host implementer should use the Write Command Timer with great caution as a very small timer value could cause a device to permanently reallocate good sectors as the result of temporary, external conditions (e.g., induced vibration).

Read and Write Command Timer values are set to default values at power-on but may be altered by an SCT command at any time. These settings are unaffected by software (soft) or hardware (pin 1 or COMRESET) reset.

Table 75 defines the format of the status response for a Error Recovery Control command.

Table 75 – Error Recovery Control command status response

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7:5 N/A 4 ID Not Found - See clause 6.3.4. 3 N/A 2 Abort - See Clause 6.3.1. 1 N/A 0 Obsolete
01h	Count	If Function Code was 0002h, then this is the LSB of the requested recovery limit. Otherwise, this field is Reserved.
02h-04h	LBA	**Bit** **Description** 47:8 Reserved 7:0 If Function Code was 0002h, then this is the MSB of the requested recovery limit. Otherwise, this field is Reserved.
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11 5:1 N/A 0 Error - See clause 6.2.3

8.3.4 Feature Control command

The Feature Control command is used to determine and set the state (i.e., enabled or disabled) of the features specified by the command.

Table 76 defines the format of a Feature Control command written to log page E0h.

Table 76 – Feature Control command

Word	Name	Value	Description
0	Action Code	0004h	Set or return the state of device features defined in Table 77
1	Function Code	0001h	Set state for a feature
		0002h	Return the current state of a feature
		0003h	Return feature option flags
2	Feature Code	Word	See Table 77 for definition of the Feature Codes
3	State	Word	Feature Code dependent value
			Bit **Description** 15:1 Reserved

			0	If the function code is 0001h, setting bit 0 to one causes the requested feature state change to be preserved across power cycles. If the function code is 0001h, setting bit 0 to zero causes the requested feature state change to be volatile. A hard reset causes the device to revert to default, or last non-volatile setting.

Table 77 – Feature Code List

Feature Code	State Definition
0001h	If State is set to 0001h, then the SET FEATURES command shall determine the state of write cache (see 7.51.4). If State is set to 0002h, then write cache shall be enabled. If State is set to 0003h, then write cache shall be disabled. If State is set to 0002h or 0003h, then write cache shall be set to the specified state, and any attempt to change the write cache settings using a SET FEATURES command shall not result in an error but shall not change the operational state of the write cache. In all cases, bit 5 of word 85 in the IDENTIFY DEVICE information shall reflect the current operational state of write cache (i.e., if set to one, then write cache is enabled, and if set to zero, then write cache is disabled. The default is State set to 0001h.
0002h	If State is set to 0001h, then Write Cache Reordering shall be enabled (i.e., disk write scheduling may be reordered by the device). If State is set to 0002h, then Write Cache Reordering shall be disabled, and disk write scheduling is executed on a first-in-first-out (FIFO) basis. If write cache is disabled, then the current Write Cache Reordering state is remembered but has no effect on non-cached writes, which are always written in the order received. The state of Write Cache Reordering has no effect on queued commands. The default is State set to 0001h.
0003h	The value in State sets the time interval for temperature logging. State set to 0000h is invalid. State may be set to 0001h to FFFFh to specify the temperature logging interval in minutes This value applies to the Absolute HDA Temperature History queue. Issuing this command shall cause the queue to be reset and any prior values in the queues shall be lost. Queue Index shall be set to zero and the first queue location for shall be set to the current value. All remaining queue locations are set to 80h. The Sample Period, Max Op Limit, Over Limit, Min Op Limit and Under Limit values are preserved. (See Table 17.) The default is State set to 0001h.
0004h – CFFFh	Reserved
D000h - FFFFh	Vendor Specific

Table 78 defines the format of the status response for a Feature Control command.

Table 78 – Feature Control command status response

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7:5 N/A 4 ID Not Found - See clause 6.3.4. 3 N/A 2 Abort - See Clause 6.3.1. 1 N/A 0 Obsolete
01h	Count	If the Function Code was set to 0002h this is the Feature State LSB If the Function Code was set to 0003h this is the Option Flags LSB Otherwise this field is reserved
02h-04h	LBA	**Bit** **Description** 47:8 Reserved 7:0 If the Function Code was set to 0002h this is the Feature State MSB If the Function Code was set to 0003h this is the Option Flags MSB Otherwise this field is Reserved
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11 5:1 N/A 0 Error - See clause 6.2.3

8.3.5 SCT Data Table command

The SCT Data Table command is used to read the specified data table.

Table 79 defines the format of an SCT Data Table command written to log page E0h.

Table 79 – SCT Data Table command

Word	Name	Value	Description
0	Action Code	0005h	Read a data table
1	Function Code	0001h	Read Table
2	Table ID	Word	See Table 80 for a list of data tables

Table 80 – SCT Data Tables (by Table Identifier)

Table Id	Description
0000h	Invalid
0001h	Reserved
0002h	HDA Temperature History Table (in absolute degrees C). (See Table 81)
0003h - CFFFh	Reserved
D000h - FFFFh	Vendor Specific

Table 81 – Absolute HDA Temperature

Byte	Size	Field Name	Description
1:0	Word	Format Version	0002h - Data table format version
3:2	Word	Sampling Period	Absolute HDA Temperature sampling period in minutes. This is how often the device samples its temperature sensor. This period takes precedence over new read or write operations, but does not interrupt operations in process. The Sampling Period may be smaller that the timer interval between entries in the history queue. A value of 0000h in this field indicates that sampling is disabled.
5:4	Word	Interval	The timer interval between entries in the history queue. The default value of this field is vendor specific. This value should not be less than the Sampling Period.
6	Byte	Max Op Limit	Maximum recommended continuous operating temperature (see Note 3). This is a one byte two's complement number that allows a range from -127 °C to +127 °C to be indicated. 80h is an invalid value. This is a fixed value.
7	Byte	Over Limit	Maximum temperature limit. Operating the device above this temperature may cause physical damage to the device (see Note 3). This is a one-byte two's complement number that allows a range from -127 °C to +127 °C to be indicated. 80h is an invalid value. This is a fixed value.
8	Byte	Min Op Limit	Minimum recommended continuous operating limit (see Note 3). This is a one byte 2's complement number that allows a range from -127 °C to +127 °C to be indicated. 80h is an invalid value. This is a fixed value.
9	Byte	Under Limit	Minimum temperature limit. Operating the device below this temperature may cause physical damage to the device (see Note 3). This is a one-byte two's complement number that allows a range from -127 °C to +127 °C to be indicated. 80h is an invalid value. This is a fixed value.
29:10	Byte [20]	reserved	[Editors Note: Change the word queue to something else]
31:30	Word	Queue Size	Number of entry locations in history queue. This number shall be in the range of 128 to 478.
33:32	Word	Queue Index	Last updated entry in queue. Queue Index is zero-based, so Queue Index 0000h is the first location in the buffer (i.e., at offset 34). The most recent temperature entered in the buffer is at Queue Index + 34 (see Notes 1 and 2).

Byte	Size	Field Name	Description
Queue Size + 33:34	Byte [Queue Size]	Queue Buffer	This is a circular buffer of absolute HDA Temperature values. Other device activities, such as data transfer, take priority over writing this data to non-volatile storage. These are one-byte two's complement numbers that allow a range from -127 °C to +127 °C to be indicated. A value of 80h indicates an initial value or a discontinuity in temperature recording. The time between samples may vary because commands shall not be interrupted. The sampling period is the minimum time between samples (see Note 1). If the host changes the logging interval using the volatile option, then the interval between entries in the queue may change between power cycles with no indication to the host.
511:Queue Size + 34	Byte [512 -Queue Size - 34]	reserved	Shall be zero.
Note 1 - The Absolute HDA Temperature History is preserved across power cycles with the requirement that when the device powers up, a new entry is made in the history queue with a value of 80h (i.e., an invalid absolute temperature value). This allows an application viewing the history to see the discontinuity in temperature resulting from the device being turned off. If the device does not sample temperatures during a certain power state (e.g., Sleep or Standby), then a value of 80h is entered into the history queue to indicate that temperature sensing has resumed. Note 2 - When the Absolute HDA Temperature history is cleared (e.g., for new devices or after changing the Logging Interval) the Queue Index shall be set to zero and the first queue location shall be set to the current Absolute HDA Temperature value. All remaining queue locations shall be set to 80h. Note 3 - These values should take into account the accuracy of the temperature sensor. The placement, accuracy, and granularity of temperature sensors to support Table 81 are vendor specific.			

Table 82 defines the format of the status response for an SCT Data Table command.

Table 82 – Feature Control command status response

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7:5 N/A 4 ID Not Found - See clause 6.3.4. 3 N/A 2 Abort - See Clause 6.3.1. 1 N/A 0 Obsolete
01h	Count	Reserved
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 0001h – Number of sectors requested 7:0 Reserved
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11 5:1 N/A 0 Error - See clause 6.2.3

9 Normal & Error Outputs

9.1 Overview

The commands listed in clause 7 each have sections labeled "Normal Outputs" and "Error Outputs". Clauses 9.2 and 9.3 document the return data format for all the commands described in clause 7. Each command in clause 7 may provide additional information about a normal or error output, but all the information that is referenced in clause 9 applies to the command as well.

9.2 Normal Outputs

The following tables document all the possible normal outputs a command returns.

Table 83 – Extended Error Code

Word	Name	Description
00h	Error	Extended error code (See Table 6)
01h	Count	Vendor Specific
02h	LBA	MSB Bits 27:0 shall be Vendor Specific Bits 47:28 shall be cleared to zero LSB
03h		
04h		
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5:1 N/A 0 Error - See clause 6.2.3

Table 84 –Error Bit Defined For Normal Output

Word	Name	Description
00h	Error	Reserved
01h	Count	Reserved
02h-04h	LBA	Reserved
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault – See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 85 – Device Fault w/Error Bit Defined For Normal Output

Word	Name	Description
00h	Error	Reserved
01h	Count	Reserved
02h-04h	LBA	Reserved
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault – See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 86 – Normal Output

Word	Name	Description
00h	Error	Reserved
01h	Count	Reserved
02h-04h	LBA	Reserved
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5:1 N/A 0 Error - See clause 6.2.3

Table 87 – Media Card Type Normal Output

Word	Name	Description
00h	Error	Reserved
01h	Count	55h
02h-04h	LBA	**Bit** **Description** 47:25 Reserved 24:8 Card specific Data 7:0 Shall be set to AAh
05h	Device/ Status	**Bit** **Description** 15:12 Reserved 11 Write Protect - shall be set to one if the device is write protected, Write Protect shall be cleared to zero if the device is not write protected. 10:8 **Media Type** **Value** **Description** 000b Reserved 001b SD Memory Card 010b MMC Card 011b SD-IO Card 100b Smart Media Card 101b-111b Reserved **Bit** **Description** 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4:1 N/A 0 Error - See clause 6.2.3

Table 88 – Check Power Mode

Word	Name	Description
00h	Error	Reserved
01h	Count	**Value** **Description** 00h Device is in Standby mode. 40h Reserved for e05106 41h Reserved for e05106 80h Device is in Idle mode FFh Device is in Active mode or Idle mode.
02h-04h	LBA	Reserved
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 89 – Stream Normal

Word	Name	Description
00h	Error	Reserved
01h	Count	Reserved
02h-04h	LBA	Reserved
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Stream Error - See clause 6.2.8 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 90 – Device Reset and Execute Diagnostics

Word	Name	Description
00h	Error	Diagnostic Results - The diagnostic code as described in Table 11.

Word	Name	Bit	General	Packet	Reserved for SATA	Reserved for SATA	Reserved for CE-ATA	All other signatures reserved
01h	Count	7:0	01h	01h	01h	01h	Reserved for CE-ATA	
02h-04h	LBA	47:24	Reserved	Reserved	Reserved	Reserved	Reserved	
		23:16	00h	14h	C3h	96h	AAh	
		15:8	00h	EBh	3Ch	69h	CEh	
		7:0	01h	01h	01h	01h	Reserved for CE-ATA	

Word	Name	Description
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 91 – IDLE Unload

Word	Name	Description
00h	Error	Reserved
01h	Count	Reserved
02h-04h	LBA	0000000000C4h
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 92 – ATAPI Normal Output

Word	Name	Description
00h	Error	Reserved
01h	Interrupt Reason	**Bit** **Description** 7:3 Tag - See clause 6.4.4 2 Obsolete 1 Input/Output - See clause 6.4.2. 0 Command/Data - See clause 6.4.1. Shall be set to zero
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 Byte Count 7:0 Reserved
05h	Status	**Bit** **Description** 15:8 Reserved 7 Transport Dependent - See clause 6.2.11. 6 N/A 5 DMA Ready - See clause 6.2.8. 4 Service - See clause 6.2.9. 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Check Condition - See clause 6.2.2. Shall be cleared to zero

Table 93 – Queued Normal Output

Word	Name	Description
00h	Error	N/A
01h	Interrupt Reason	**Bit** **Description** 7:3 Tag - See clause 6.4.4 2 Release - See clause 6.4.1. 1 Input/Output - See clause 6.4.2. 0 Command/Data - See clause 6.4.1.
02h-04h	LBA	Reserved
05h	Status	**Bit** **Description** 15:8 Reserved 7 Transport Dependent - See clause 6.2.11. 6 N/A 5 Device Fault - See clause 6.2.4 4 Service - See clause 6.2.9. 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3. Shall be cleared to zero **[Editors Note: ATA7 called this CHK, but only for 1 case in READ DMA queued. I think this was a typo.]**

Table 94 – SETMAX Normal Output

Word	Name	Description
00h	Error	Reserved
01h	Count	Reserved
02h	LBA	MSB
03h		Max address
04h		LSB
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 95 – SMART Off-Line Immediate Normal Output

Word	Name	Description
00h	Error	Reserved
01h	Count	Reserved
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 **Value** **Description** C24Fh Subcommand specified a captive self-test that has executed without failure. N/A the subcommand specified an off-line routine including an off-line self-test routine. 7:0 N/A
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2 N/A 1 N/A 0 Error - See clause 6.2.3

Table 96 – SMART Return Status Normal Output

Word	Name	Description
00h	Error	Reserved
01h	Count	Reserved
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 **Value** **Description** C24Fh The device has not detected a threshold exceeded condition 2CF4 The device has detected a threshold exceeded condition 7:0 N/A
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2 N/A 1 N/A 0 Error - See clause 6.2.3

9.3 Error Outputs

The following tables document all the possible error outputs a command returns. References to these tables are found in clause 7

References to this table is found in clause: 7.2

Table 97 –CFA Error Status

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7:5 N/A 4 ID Not Found - See clause 6.3.4 3 N/A 2 Abort - See Clause 6.3.1 1 N/A 0 Media Error - See clause 6.3.5
01h	Count	Reserved
02h	LBA	MSB
03h		Address of first unrecoverable error Bits 47:28 shall be cleared to zero
04h		LSB
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4:1 N/A 0 Error - See clause 6.2.3

References to this table is found in clause: 7.5, 7.6

Table 98 – CFA Error Status w/DRQ

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7:5 N/A 4 ID Not Found - See clause 6.3.4 3 N/A 2 Abort - See Clause 6.3.1 1 N/A 0 Media Error - See clause 6.3.5
01h	Count	Reserved
02h	LBA	MSB Address of first unrecoverable error Bits 47:28 shall be cleared to zero LSB
03h		
04h		
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11 5 Device Fault - See clause 6.2.4 4 Transport Dependent - See clause 6.2.11 3:1 N/A 0 Error - See clause 6.2.3

Table 99 – Abort Only Error Status

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7:3 N/A 2 Abort - See clause 6.3.1 1:0 N/A
01h	Count	Reserved
02h	LBA	MSB Reserved LSB
03h		
04h		
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4:1 N/A 0 Error - See clause 6.2.3

References to this table is found in clause: 7.7, 7.8, 7.10.1, 7.10.2, 7.10.3, 7.12, 7.18, 7.19, 7.20, 7.27, 7.36, 7.37, 7.44, 7.45, 7.46, 7.47, 7.48, 7.49, 7.51, 7.54, 7.55, 7.56.2, 7.56.3, 7.56.4, 7.56.8, 7.57, 7.58, 7.63, 7.79

Table 100 – Abort w/bit 3 Error Status

Word	Name	Description
00h	Error	**Bit Description** 15:8 Reserved 7 Interface CRC - See clause 6.3.6 6:3 N/A 2 Abort - See Clause 6.3.1 1:0 N/A
01h	Count	Reserved
02h-04h	LBA	Reserved
05h	Status	**Bit Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

References to this table is found in clause: 7.36, 7.37, 7.52.4, 7.52.5, 7.52.6

Table 101 – Abort wo/bit 3 Error Status

Word	Name	Description
00h	Error	**Bit Description** 15:8 Reserved 7 Interface CRC - See clause 6.3.6 6:3 N/A 2 Abort - See Clause 6.3.1 1:0 N/A
01h	Count	Reserved
02h-04h	LBA	Reserved
05h	Status	**Bit Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5:1 N/A 0 Error - See clause 6.2.3

References to this table is found in clause: 7.9

Table 102 – Stream Error

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7:3 N/A 2 Abort - See Clause 6.3.1. 1 N/A 0 Obsolete
01h	Count	Reserved
02h-04h	LBA	Reserved
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Stream Error - See clause 6.2.8 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 103 – Write Error

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7:3 N/A 2 Abort - See clause 6.3.1 1:0 N/A
01h	Count	Reserved
02h-04h	LBA	MSB Address of first unrecoverable error LSB
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 104 –Media Status

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7 N/A 6 Write Protect - See clause 6.3.13 5 Media Change - 6.3.7 4 N/A 3 Meda Change Request - See clause 6.3.8 2 Abort - See clause 6.3.1. 1 No Media - See clause 6.3.10 0 Obsolete
01h	Count	Reserved
02h-04h	LBA	Reserved
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 105 –Media Eject

Word	Name	Description
00h	Error	**Bit Description** 15:8 Reserved 7:3 N/A 2 Abort - See clause 6.3.1. 1 No Media - See clause 6.3.10. 0 Obsolete
01h	Count	Reserved
02h-04h	LBA	Reserved
05h	Status	**Bit Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 106 –Media Lock

Word	Name	Description
00h	Error	**Bit Description** 15:8 Reserved 7:4 N/A 3 Media Change Request - See clause 6.3.8 2 Abort - See clause 6.3.1. 1 No Media - See clause 6.3.10. 0 Obsolete
01h	Count	N/A
02h-04h	LBA	N/A
05h	Status	**Bit Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 107 – Read DMA Error

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7 Interface CRC - See clause 6.3.6 6 Uncorrectable Error - See clause 6.3.12 5 Media Change - See clause 6.3.7 4 ID Not Found - See clause 6.3.4 3 Media Change Request - See clause 6.3.8 2 Abort - See clause 6.3.1 1 No Media - See clause 6.3.10 0 Obsolete
01h	Count	Reserved
02h	LBA	MSB
03h		Address of first unrecoverable error.
04h		LSB
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 108 –Read Log Ext Error

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7 Interface CRC - See clause 6.3.6 6 Uncorrectable Error - See clause 6.3.12 5 N/A 4 ID Not Found - See clause 6.3.4 3 N/A 2 Abort - See clause 6.3.1. 1 N/A 0 Obsolete
01h	Count	Reserved
02h-04h	LBA	Reserved
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 109 –Read PIO Error

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7 Interface CRC - See clause 6.3.6 6 Uncorrectable Error - See clause 6.3.12 5 Media Change - See clause 6.3.7 4 ID Not Found - See clause 6.3.4 3 Media Change Request - See clause 6.3.8 2 Abort - See clause 6.3.1 1 No Media - See clause 6.3.10 0 Obsolete
01h	Count	Reserved
02h	LBA	MSB
03h		Address of first unrecoverable error.
04h		LSB
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 110 –Read Stream Error

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7 Interface CRC - See clause 6.3.6 6 Uncorrectable Error - See clause 6.3.12 5 Media Change - See clause 6.3.7 4 ID Not Found - See clause 6.3.4 3 Media Change Request - See clause 6.3.8 2 Abort - See clause 6.3.1 1 No Media - See clause 6.3.10 0 Command Completion Time Limit Out - See clause 6.3.2
01h	Count	Length of Stream Error - number of contiguous logical sectors containing potentially bad data, beginning with the LBA of the first logical sector with an uncorrectable error.
02h	LBA	MSB
03h		Address of first unrecoverable error.
04h		LSB
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Stream Error - See clause 6.2.10. 4 Deferred Write Error - See clause 6.2.7. 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3.

Table 111 –Setmax Error

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7:5 N/A 4 ID Not Found - See clause 6.3.4. 3 N/A 2 Abort - See Clause 6.3.1. 1 N/A 0 Obsolete **[Editors Note: I think N/A was a typo in ATA7]**
01h	Count	Reserved
02h-04h	LBA	Reserved
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5:1 N/A **[Editors Note: This is interesting, ATA7 and 8 document the normal outputs with the DF and DRQ bits]** 0 Error - See clause 6.2.3

Table 112 –SMART Error

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7:5 N/A 4 ID Not Found - See clause 6.3.4. 3 N/A 2 Abort - See clause 6.3.1. 1 N/A 0 Obsolete
01h	Count	Reserved
02h-04h	LBA	**Bit** **Description** 47:24 Reserved 23:8 **Value** **Description** C24Fh Subcommand specified a captive self-test and some error other than a self-test routine failure occurred (i.e., if the sub-command is not supported or register values are invalid) 2CF4h the subcommand specified a captive self-test routine which has failed during execution. N/A the subcommand specified an off-line routine including an off-line self-test routine. 7:0 N/A
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 113 –Writre Error

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7 Interface CRC - See clause 6.3.6 6 Write Protect - See clause 6.3.13 5 Media Change - See clause 6.3.7 4 ID Not Found - See clause 6.3.4 3 Media Change Request - See clause 6.3.8 2 Abort - See clause 6.3.1. 1 No Media - See clause 6.3.10 0 N/A
01h	Count	Reserved
02h	LBA	MSB
03h		Address of first unrecoverable error.
04h		LSB
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Device Fault - See clause 6.2.4 4 N/A 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3

Table 114 –Writre Stream Error

Word	Name	Description
00h	Error	**Bit** **Description** 15:8 Reserved 7 Interface CRC - See clause 6.3.6 6 Write Protect - See clause 6.3.13 5 Media Change - See clause 6.3.7 4 ID Not Found - See clause 6.3.4 3 Media Change Request - See clause 6.3.8 2 Abort - See clause 6.3.1 1 No Media - See clause 6.3.10 0 Command Completion Time Limit Out - See clause 6.3.2
01h	Count	Length of Stream Error - number of contiguous logical sectors containing potentially bad data, beginning with the LBA of the first logical sector with an uncorrectable error.
02h	LBA	MSB
03h		Address of first unrecoverable error.
04h		LSB
05h	Status	**Bit** **Description** 15:8 Reserved 7:6 Transport Dependent - See clause 6.2.11. 5 Stream Error - See clause 6.2.10. 4 Deferred Write Error - See clause 6.2.7. 3 Transport Dependent - See clause 6.2.11. 2:1 N/A 0 Error - See clause 6.2.3.

ANNEX A - BIBLIOGRAPHY (INFORMATIVE)

Address Offset Reserved Area Boot, INCITS TR-27:2001

A.X. Widmer and P.A. Franaszek, “A DC-Balanced, Partitioned-Block, 8b/10b Transmission Code”. IBM Journal of Research and Development, 27, no. 5: 440-451 (September, 1983)

U.S. Patent 4,486,739. Peter A. Franaszek and Albert X. Widmer. Byte Oriented DC Balanced (0,4) 8b/10b Partitioned Block Transmission Code. (December 4, 1984)

[Editors Note: Do we still need this annex?]

ANNEX B - COMMAND SET SUMMARY (INFORMATIVE)

The following four tables are provided to facilitate the understanding of the command set. Table 115 provides information on which command codes are currently defined. Table 116 provides a list of all of the commands in order of command code with the required use for each. Table 117 provides a summary of all commands in alphabetical order with the required use for each. Table 118 documents the assignment history of each opcode by ATA standard. Table 119 documents the assignment history of each SET FEATURES code by ATA standard.

Table 115 - Command Matrix

	x0	**x1**	**x2**	**x3**	**x4**	**x5**	**x6**	**x7**	**x8**	**x9**	**xA**	**xB**	**xC**	**xD**	**xE**	**xF**
0x	C	R	R	C	R	R	R	R	C	R	R	R	R	R	R	R
1x	O	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
2x	C	O	O	O	C	C	C	C	R	C	C	C	R	R	R	C
3x	C	O	O	O	C	C	C	C	C	C	C	C	O	C	C	C
4x	C	O	C	R	R	C*	R	C*	R	R	R	R	R	R	R	R
5x	O	C*	R	R	R	R	R	C*	R	R	R	R	T*	T*	T*	T*
6x	S	S	S	S	S	S	S	S	R	R	R	R	R	R	R	R
7x	O	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
8x	V	V	V	V	V	V	V	F	V	V	V	V	V	V	V	V
9x	C	O	C	R	E	E	E	E	E	E	V	R	R	R	R	R
Ax	C	C	C	R	R	R	R	R	R	R	R	R	R	R	R	R
Bx	C	C	R	R	R	R	Z*	R	A	A	A	A	A	A	A	A
Cx	F	V	V	V	C	C	C	C	C	O	C	O	C	C	C	R
Dx	R	C	M	M	M	R	R	R	R	R	C	E	E	E	C	C
Ex	C	C	C	C	C	C	C	C	C	E	C	R	C	C	O	C
Fx	V	C	C	C	C	C	C	V	C	C	V	V	V	V	V	V

Key:

C = a defined command.
R = Reserved, undefined in current specifications.
V = Vendor specific commands.
O = Obsolete.
E=a retired command.
F=If the device does not implement the CFA feature set, this command code is Vendor specific.
A=Reserved for assignment by the CompactFlash™ Association

M=Reserved for the Media Card Pass Through Command feature set.
S=Reserved for Serial ATA
T=Reserved for Trusted Computing
Z=Reserved for e05106
* indicates that the entry in this table has changed from ATA/ATAPI-7, INCITS xxx-xxxx.

Table 116 - Command codes (sorted by command code)

Protocol	Command	General Feature Set	Packet Feature Set	Command code
ND	NOP	O	M	00h
	Reserved			01h-01h
ND	CFA REQUEST EXTENDED ERROR	O	N	03h
	Reserved			04h-07h
DR	DEVICE RESET	N	M	08h
	Reserved			09h-0Fh
	Obsolete			10h
	Retired			11h-1Fh
PI	READ SECTOR(S)	M	M	20h
	Obsolete			21h-23h
PI	READ SECTOR(S) EXT	O	N	24h
DM	READ DMA EXT	O	N	25h
DMQ	READ DMA QUEUED EXT	O	N	26h
ND	READ NATIVE MAX ADDRESS EXT	O	N	27h
	Reserved			28h
PI	READ MULTIPLE EXT	O	N	29h
DM	READ STREAM DMA EXT	O	N	2Ah
PI	READ STREAM EXT	O	N	2Bh
	Reserved			2Ch-2Fh
PI	READ LOG EXT	O	O	2Fh
PO	WRITE SECTOR(S)	M	N	30h
	Obsolete			31h-33h
PO	WRITE SECTOR(S) EXT	O	N	34h
DM	WRITE DMA EXT	O	N	35h
DMQ	WRITE DMA QUEUED EXT	O	N	36h
ND	SET MAX ADDRESS EXT	O	N	37h
PO	CFA WRITE SECTORS WITHOUT ERASE	O	N	38h
PO	WRITE MULTIPLE EXT	O	N	39h
DM	WRITE STREAM DMA EXT	O	N	3Ah
PO	WRITE STREAM EXT	O	N	3Bh
	Obsolete			3Ch
DM	WRITE DMA FUA EXT	O	N	3Dh
DMQ	WRITE DMA QUEUED FUA EXT	O	N	3Eh
PO	WRITE LOG EXT	O	O	3Fh
ND	READ VERIFY SECTOR(S)	M	N	40h
	Obsolete			41h
ND	READ VERIFY SECTOR(S) EXT	O	N	42h
	Reserved			43h-44h
ND	WRITE UNCORRECTABLE EXT	O	N	45h
	Reserved			46h
DM	READ LOG DMA EXT	O	O	47h
	Reserved			48h-4Fh
	Obsolete			50h
ND	CONFIGURE STREAM	O	O	51H
	Reserved			52h-56h
DM	WRITE LOG DMA EXT	O	O	57h
	Reserved			58h-6Fh
	Obsolete			70h
	Retired			71h-7Fh
VS	Vendor Specific			80h-86h
PI	CFA TRANSLATE SECTOR **[Editors Note:**	O	N	87h

Table 116 - Command codes (sorted by command code)

Protocol	Command	General Feature Set	Packet Feature Set	Command code
	This was also in the VS list]			
VS	Vendor Specific			88h-8Fh
DD	EXECUTE DEVICE DIAGNOSTIC	M	M	90h
	Reserved			91h
PO	DOWNLOAD MICROCODE	O	N	92h
	Reserved			93h
	Retired			94h-99h
	Vendor Specific			9Ah
	Reserved			9Bh-9Fh
P	PACKET	N	M	A0h
PI	IDENTIFY PACKET DEVICE	N	M	A1h
P/DMQ	SERVICE	O	O	A2h
	Reserved			A3h-AFH
ND	SMART DISABLE OPERATIONS **[Editors Note: Can we list this as SMART?]**	O	N	B0h
ND	SMART ENABLE/DISABLE AUTOSAVE	O	N	B0h
ND	SMART ENABLE OPERATIONS	O	N	B0h
ND	SMART EXECUTE OFF-LINE IMMEDIATE	O	N	B0h
PI	SMART READ DATA	O	N	B0h
PI	SMART READ LOG	O	N	B0h
ND	SMART RETURN STATUS	O	N	B0h
PO	SMART WRITE LOG	O	N	B0h
ND	DEVICE CONFIGURATION FREEZE LOCK **[Editors Note: Can we list this as DCO and drop the rest. This only thing this shows is protocol which is already in the commands. Is there value in the protocol column at all?]**	O	O	B1h
PI	DEVICE CONFIGURATION IDENTIFY	O	O	B1h
ND	DEVICE CONFIGURATION RESTORE	O	O	B1h
PO	DEVICE CONFIGURATION SET	O	O	B1h
	Reserved			B2h-B5h
	Reserved for e05106	O	O	B6h
	Reserved			B7h-BFh
ND	CFA ERASE SECTORS **[Editors Note: This was listed in the VS area as well]**	F	N	C0h
VS	Vendor Specific			C1h-C3h
PI	READ MULTIPLE	M	N	C4h
PO	WRITE MULTIPLE	M	N	C5h
ND	SET MULTIPLE MODE	M	N	C6h
DMQ	READ DMA QUEUED	O	N	C7h
DM	READ DMA	M	N	C8h
	Obsolete			C9h
DM	WRITE DMA	M	N	CAh
	Obsolete			CBh
DMQ	WRITE DMA QUEUED	O	N	CCh
PO	CFA WRITE MULTIPLE WITHOUT ERASE	O	N	CDh
PO	WRITE MULTIPLE FUA EXT	O	N	CEh
	Reserved			CFh
	Reserved			D0h
ND	CHECK MEDIA CARD TYPE	O	N	D1h
	Reserved			D2h-D9h

Table 116 - Command codes (sorted by command code)

Protocol	Command	General Feature Set	Packet Feature Set	Command code
ND	GET MEDIA STATUS	O	O	DAh
	Retired			DBh-DDh
ND	MEDIA LOCK	O	N	DEh
ND	MEDIA UNLOCK	O	N	DFh
ND	STANDBY IMMEDIATE	M	M	E0h
ND	IDLE IMMEDIATE	M	M	E1h
ND	STANDBY	M	O	E2h
ND	IDLE	M	O	E3h
PI	READ BUFFER	O	N	E4h
ND	CHECK POWER MODE	M	M	E5h
ND	SLEEP	M	M	E6h
ND	FLUSH CACHE	M	O	E7h
PO	WRITE BUFFER	O	N	E8h
	Retired			E9h
ND	FLUSH CACHE EXT	O	N	EAh
	Reserved			EBh
PI	IDENTIFY DEVICE	M	M	ECh
ND	MEDIA EJECT	O	N	EDh
	Obsolete			EEh
ND	SET FEATURES	M	M	EFh
VS	Vendor Specific			F0h
PO	SECURITY SET PASSWORD	O	O	F1h
PO	SECURITY UNLOCK	O	O	F2h
ND	SECURITY ERASE PREPARE	O	O	F3h
PO	SECURITY ERASE UNIT	O	O	F4h
ND	SECURITY FREEZE LOCK	O	O	F5h
PO	SECURITY DISABLE PASSWORD	O	O	F6h
	Vendor Specific			F7h
ND	READ NATIVE MAX ADDRESS	O	O	F8h
ND	SET MAX ADDRESS	O	O	F9h
VS	Vendor Specific			FAh-FFh

Key:

ND = Non-data command
PI = PIO data-in command
PO = PIO data-out command
DM = DMA command
DMQ = DMA QUEUED command
DR = DEVICE RESET command
DD = EXECUTE DEVICE DIAGNOSTIC command
P = PACKET command

VS = Vendor specfic

M = Mandatory
O = Optional
N = Use prohibited
V = Vendor specific implementation
E = Retired
B = Obsolete
R = Reserved
F=If the device does not implement the CFA feature set, this command code is Vendor specific.

Table 117 - Command codes (sorted by command name)

Protocol	Command	General Feature Set	Packet Feature Set	Command code
				91H
ND	CFA ERASE SECTORS **[Editors Note: This was listed in the VS area as well]**	F	N	C0h
ND	CFA REQUEST EXTENDED ERROR	O	N	03h
PI	CFA TRANSLATE SECTOR **[Editors Note: This was also in the VS list]**	O	N	87h
PO	CFA WRITE MULTIPLE WITHOUT ERASE	O	N	CDh
PO	CFA WRITE SECTORS WITHOUT ERASE	O	N	38h
ND	CHECK MEDIA CARD TYPE	O	N	D1h
ND	CHECK POWER MODE	M	M	E5h
ND	CONFIGURE STREAM	O	O	51H
ND	DEVICE CONFIGURATION FREEZE LOCK	O	O	B1h
PI	DEVICE CONFIGURATION IDENTIFY	O	O	B1h
ND	DEVICE CONFIGURATION RESTORE	O	O	B1h
PO	DEVICE CONFIGURATION SET	O	O	B1h
DR	DEVICE RESET	N	M	08h
PO	DOWNLOAD MICROCODE	O	N	92h
DD	EXECUTE DEVICE DIAGNOSTIC	M	M	90h
ND	FLUSH CACHE	M	O	E7h
ND	FLUSH CACHE EXT	O	N	EAh
ND	GET MEDIA STATUS	O	O	DAh
PI	IDENTIFY DEVICE	M	M	ECh
PI	IDENTIFY PACKET DEVICE	N	M	A1h
ND	IDLE	M	O	E3h
ND	IDLE IMMEDIATE	M	M	E1h
ND	MEDIA EJECT	O	N	EDh
ND	MEDIA LOCK	O	N	DEh
ND	MEDIA UNLOCK	O	N	DFh
ND	NOP	O	M	00h
	Obsolete	10h, 21h-23h, 31h, 32h-33h, 3Ch, 41h, 50h, 70h, C9h, CBh, EEh		
P	PACKET	N	M	A0h
PI	READ BUFFER	O	N	E4h
DM	READ DMA	M	N	C8h
DM	READ DMA EXT	O	N	25h
DMQ	READ DMA QUEUED	O	N	C7h
DMQ	READ DMA QUEUED EXT	O	N	26h
DM	READ LOG DMA EXT	O	O	47h
PI	READ LOG EXT	O	O	2Fh
PI	READ MULTIPLE	M	N	C4h
PI	READ MULTIPLE EXT	O	N	29h
ND	READ NATIVE MAX ADDRESS	O	O	F8h
ND	READ NATIVE MAX ADDRESS EXT	O	N	27h
PI	READ SECTOR(S)	M	M	20h
PI	READ SECTOR(S) EXT	O	N	24h
DM	READ STREAM DMA EXT	O	N	2Ah
PI	READ STREAM EXT	O	N	2Bh
ND	READ VERIFY SECTOR(S)	M	N	40h
ND	READ VERIFY SECTOR(S) EXT	O	N	42h
	Reserved	01h-02h, 04h-07h, 09h-0fh, 28h, 2Ch-2Eh, 43h-44h, 46h, 48h-4Fh, 52h-6Fh, 93h, 9Bh-9Fh, A3h-AFh, B2h-B5h, B7h-BFh,CFh-D0h, D2h-D9h, EBh		

Table 117 - Command codes (sorted by command name)

Protocol	Command	General Feature Set	Packet Feature Set	Command code
	Reserved for e05106	O	O	B6h
	Retired	11h-1Fh,71h-7Fh, 94h-99h, DBh-DDh, E9h		
PO	SECURITY DISABLE PASSWORD	O	O	F6h
ND	SECURITY ERASE PREPARE	O	O	F3h
PO	SECURITY ERASE UNIT	O	O	F4h
ND	SECURITY FREEZE LOCK	O	O	F5h
PO	SECURITY SET PASSWORD	O	O	F1h
PO	SECURITY UNLOCK	O	O	F2h
P/DMQ	SERVICE	O	O	A2h
ND	SET FEATURES	M	M	EFh
ND	SET MAX ADDRESS	O	O	F9h
ND	SET MAX ADDRESS EXT	O	N	37h
ND	SET MULTIPLE MODE	M	N	C6h
ND	SLEEP	M	M	E6h
ND	SMART DISABLE OPERATIONS	O	N	B0h
ND	SMART ENABLE OPERATIONS	O	N	B0h
ND	SMART ENABLE/DISABLE AUTOSAVE	O	N	B0h
ND	SMART EXECUTE OFF-LINE IMMEDIATE	O	N	B0h
PI	SMART READ DATA	O	N	B0h
PI	SMART READ LOG	O	N	B0h
ND	SMART RETURN STATUS	O	N	B0h
PO	SMART WRITE LOG	O	N	B0h
ND	STANDBY	M	O	E2h
ND	STANDBY IMMEDIATE	M	M	E0h
VS	Vendor Specific	80h-8Fh,9Ah,C1-C3h,F0h,F7h,FA-FFh		
PO	WRITE BUFFER	O	N	E8h
DM	WRITE DMA	M	N	CAh
DM	WRITE DMA EXT	O	N	35h
DM	WRITE DMA FUA EXT	O	N	3Dh
DMQ	WRITE DMA QUEUED	O	N	CCh
DMQ	WRITE DMA QUEUED EXT	O	N	36h
DMQ	WRITE DMA QUEUED FUA EXT	O	N	3Eh
DM	WRITE LOG DMA EXT	O	O	57h
PO	WRITE LOG EXT	O	O	3Fh
PO	WRITE MULTIPLE	M	N	C5h
PO	WRITE MULTIPLE EXT	O	N	39h
PO	WRITE MULTIPLE FUA EXT	O	N	CEh
PO	WRITE SECTOR(S)	M	N	30h
PO	WRITE SECTOR(S) EXT	O	N	34h
DM	WRITE STREAM DMA EXT	O	N	3Ah
PO	WRITE STREAM EXT	O	N	3Bh
ND	WRITE UNCORRECTABLE EXT	O	N	45h

Key:

ND = Non-data command
PI = PIO data-in command
PO = PIO data-out command
DM = DMA command
DMQ = DMA QUEUED command
DR = DEVICE RESET command
DD = EXECUTE DEVICE DIAGNOSTIC command
P = PACKET command
VS = Vendor specfic

M = Mandatory
O = Optional
N = Use prohibited
V = Vendor specific implementation
E = Retired
B = Obsolete
R = Reserved
F=If the device does not implement the CFA feature set, this command code is Vendor specific.

Table 118 - Historical Command Assignments

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8
00h	NO-OP	C	C	C	C	C	C	C	C
01h		R	R	R	R	R	R	R	R
02h		R	R	R	R	R	R	R	R
03h	CFA REQUEST EXTENDED ERROR	R	R	R	C	C	C	C	C
04h		R	R	R	R	R	R	R	R
05h		R	R	R	R	R	R	R	R
06h		R	R	R	R	R	R	R	R
07h		R	R	R	R	R	R	R	R
08h	ATAPI Soft Reset / DEVICE RESET	R	R	ATAPI soft reset	DEVICE RESET	C	C	C	C
09h		R	R	R	R	R	R	R	R
0Ah		R	R	R	R	R	R	R	R
0Bh		R	R	R	R	R	R	R	R
0Ch		R	R	R	R	R	R	R	R
0Dh		R	R	R	R	R	R	R	R
0Eh		R	R	R	R	R	R	R	R
0Fh		R	R	R	R	R	R	R	R
10h	RECALIBRATE	C	C	C	O	O	O	O	O
11h	RECALIBRATE	C	C	O	E	E	E	E	E
12h	RECALIBRATE	C	C	O	E	E	E	E	E
13h	RECALIBRATE	C	C	O	E	E	E	E	E
14h	RECALIBRATE	C	C	O	E	E	E	E	E
15h	RECALIBRATE	C	C	O	E	E	E	E	E
16h	RECALIBRATE	C	C	O	E	E	E	E	E
17h	RECALIBRATE	C	C	O	E	E	E	E	E
18h	RECALIBRATE	C	C	O	E	E	E	E	E
19h	RECALIBRATE	C	C	O	E	E	E	E	E
1Ah	RECALIBRATE	C	C	O	E	E	E	E	E
1Bh	RECALIBRATE	C	C	O	E	E	E	E	E
1Ch	RECALIBRATE	C	C	O	E	E	E	E	E
1Dh	RECALIBRATE	C	C	O	E	E	E	E	E
1Eh	RECALIBRATE	C	C	O	E	E	E	E	E
1Fh	RECALIBRATE	C	C	O	E	E	E	E	E
20h	READ SECTORS	C	C	C	C	C	C	C	C
21h	READ SECTORS WITHOUT RETRY	C	C	C	C	O	O	O	O
22h	READ LONG	C	C	C	O	O	O	O	O
23h	READ LONG WITHOUT RETRY	C	C	C	O	O	O	O	O
24h	READ SECTORS EXT	R	R	R	R	R	C	C	C
25h	READ DMA EXT	R	R	R	R	R	C	C	C
26h	READ DMA QUEUED EXT	R	R	R	R	R	C	C	C
27h	READ NATIVE MAX ADDRESS EXT	R	R	R	R	R	C	C	C
28h		R	R	R	R	R	R	R	R
29h	READ MULTIPLE EXT	R	R	R	R	R	C	C	C
2Ah	READ STREAM DMA	R	R	R	R	R	R	C	C
2Bh	READ STREAM	R	R	R	R	R	R	C	C
2Ch		R	R	R	R	R	R	R	R
2Dh		R	R	R	R	R	R	R	R
2Eh		R	R	R	R	R	R	R	R
2Fh	READ LOG EXT	R	R	R	R	R	C	C	C
30h	WRITE SECTORS	C	C	C	C	C	C	C	C
31h	WRITE SECTORS WITHOUT RETRY	C	C	C	C	O	O	O	O
32h	WRITE LONG	C	C	C	O	O	O	O	O
33h	WRITE LONG WITHOUT RETRY	C	C	C	O	O	O	O	O
34h	WRITE SECTORS EXT	R	R	R	R	O	C	C	C
35h	WRITE DMA EXT	R	R	R	R	R	C	C	C
36h	WRITE DMA QUEUED EXT	R	R	R	R	R	C	C	C
37h	SET NATIVE MAX ADDRESS EXT	R	R	R	R	R	C	C	C
38h	CFA WRITE SECTORS WITHOUT ERASE	R	R	R	C	C	C	C	C
39h	WRITE MULTIPLE EXT	R	R	R	R	R	C	C	C

Table 118 - Historical Command Assignments

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8
3Ah	WRITE STREAM DMA	R	R	R	R	R	R	C	C
3Bh	WRITE STREAM	R	R	R	R	R	R	C	C
3Ch	WRITE VERIFY	C	C	C	O	O	O	O	O
3Dh	WRITE DMA FUA EXT	R	R	R	R	R	R	C	C
3Eh	WRITE DMA QUEUED FUA EXT	R	R	R	R	R	R	C	C
3Fh	WRITE LOG EXT	R	R	R	R	R	C	C	C
40h	READ VERIFY SECTORS	C	C	C	C	C	C	C	C
41h	READ VERIFY SECTORS WITHOUT RETRY	C	C	C	C	O	O	O	O
42h	READ VERIFY SECTORS EXT	R	R	R	R	R	C	C	C
43h		R	R	R	R	R	R	R	R
44h		R	R	R	R	R	R	R	R
45h	WRITE UNCORRECTABLE EXT	R	R	R	R	R	R	R	C*
46h		R	R	R	R	R	R	R	R
47h		R	R	R	R	R	R	R	C*
48h		R	R	R	R	R	R	R	R
49h		R	R	R	R	R	R	R	R
4Ah		R	R	R	R	R	R	R	R
4Bh		R	R	R	R	R	R	R	R
4Ch		R	R	R	R	R	R	R	R
4Dh		R	R	R	R	R	R	R	R
4Eh		R	R	R	R	R	R	R	R
4Fh		R	R	R	R	R	R	R	R
50h	FORMAT TRACK	C	C	C	O	O	O	O	O
51h	CONFIGURE STREAM	R	R	R	R	R	R	C	C
52h		R	R	R	R	R	R	R	R
53h		R	R	R	R	R	R	R	R
54h		R	R	R	R	R	R	R	R
55h		R	R	R	R	R	R	R	R
56h		R	R	R	R	R	R	R	R
57h		R	R	R	R	R	R	R	C*
58h		R	R	R	R	R	R	R	R
59h		R	R	R	R	R	R	R	R
5Ah		R	R	R	R	R	R	R	R
5Bh		R	R	R	R	R	R	R	R
5Ch	TRUSTED RECEIVE	R	R	R	R	R	R	R	T*
5Dh	TRUSTED RECEIVE DMA	R	R	R	R	R	R	R	T*
5Eh	TRUSTED SEND	R	R	R	R	R	R	R	T*
5Fh	TRUSTED SEND DMA	R	R	R	R	R	R	R	T*
60h	SATA (reserved)	R	R	R	R	R	R	S	S
61h	SATA (reserved)	R	R	R	R	R	R	S	S
62h	SATA (reserved)	R	R	R	R	R	R	S	S
63h	SATA (reserved)	R	R	R	R	R	R	S	S
64h	SATA (reserved)	R	R	R	R	R	R	S	S
65h	SATA (reserved)	R	R	R	R	R	R	S	S
66h	SATA (reserved)	R	R	R	R	R	R	S	S
67h	SATA (reserved)	R	R	R	R	R	R	S	S
68h		R	R	R	R	R	R	S	S
69h		R	R	R	R	R	R	S	S
6Ah		R	R	R	R	R	R	S	S
6Bh		R	R	R	R	R	R	S	S
6Ch		R	R	R	R	R	R	S	S
6Dh		R	R	R	R	R	R	S	S
6Eh		R	R	R	R	R	R	S	S
6Fh		R	R	R	R	R	R	S	S
70h	SEEK	C	C	C	C	C	C	O	O
71h	SEEK	C	C	O	E	E	E	E	E

Table 118 - Historical Command Assignments

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8
72h	SEEK	C	C	O	E	E	E	E	E
73h	SEEK	C	C	O	E	E	E	E	E
74h	SEEK	C	C	O	E	E	E	E	E
75h	SEEK	C	C	O	E	E	E	E	E
76h	SEEK	C	C	O	E	E	E	E	E
77h	SEEK	C	C	O	E	E	E	E	E
78h	SEEK	C	C	O	E	E	E	E	E
79h	SEEK	C	C	O	E	E	E	E	E
7Ah	SEEK	C	C	O	E	E	E	E	E
7Bh	SEEK	C	C	O	E	E	E	E	E
7Ch	SEEK	C	C	O	E	E	E	E	E
7Dh	SEEK	C	C	O	E	E	E	E	E
7Eh	SEEK	C	C	O	E	E	E	E	E
7Fh	SEEK	C	C	O	E	E	E	E	E
80h	(vendor unique)	V	V	V	V	V	V	V	V
81h	(vendor unique)	V	V	V	V	V	V	V	V
82h	(vendor unique)	V	V	V	V	V	V	V	V
83h	(vendor unique)	V	V	V	V	V	V	V	V
84h	(vendor unique)	V	V	V	V	V	V	V	V
85h	(vendor unique)	V	V	V	V	V	V	V	V
86h	(vendor unique)	V	V	V	V	V	V	V	V
87h	(vendor unique) / CFA TRANSLATE SECTOR	V	V	V	F	F	F	F	F
88h	(vendor unique)	V	V	V	V	V	V	V	V
89h	(vendor unique)	V	V	V	V	V	V	V	V
8Ah	(vendor unique)	V	V	V	V	V	V	V	V
8Bh	(vendor unique)	V	V	V	V	V	V	V	V
8Ch	(vendor unique)	V	V	V	V	V	V	V	V
8Dh	(vendor unique)	V	V	V	V	V	V	V	V
8Eh	(vendor unique)	V	V	V	V	V	V	V	V
8Fh	(vendor unique)	V	V	V	V	V	V	V	V
90h	EXECUTE DEVICE DIAGNOSTICS	C	C	C	C	C	C	C	C
91h	INITIALIZE DEVICE PARAMETERS	C	C	C	C	C	O	O	O
92h	DOWNLOAD MICROCODE	R	C	C	C	C	C	C	C
93h		R	R	R	R	R	R	R	R
94h	STANDBY IMMEDIATE	C	C	C	E	E	E	E	E
95h	IDLE IMMEDIATE	C	C	C	E	E	E	E	E
96h	STANDBY	C	C	C	E	E	E	E	E
97h	IDLE	C	C	C	E	E	E	E	E
98h	CHECK POWER MODE	C	C	C	E	E	E	E	E
99h	SLEEP	C	C	C	E	E	E	E	E
9Ah	(vendor unique)	V	V	V	V	V	V	V	V
9Bh		R	R	R	R	R	R	R	R
9Ch		R	R	R	R	R	R	R	R
9Dh		R	R	R	R	R	R	R	R
9Eh		R	R	R	R	R	R	R	R
9Fh		R	R	R	R	R	R	R	R
A0h	PACKET	R	R	C	C	C	C	C	C
A1h	IDENTIFY PACKET DEVICE	R	R	C	C	C	C	C	C
A2h	SERVICE	R	R	C	C	C	C	C	C
A3h		R	R	R	R	R	R	R	R
A4h		R	R	R	R	R	R	R	R
A5h		R	R	R	R	R	R	R	R
A6h		R	R	R	R	R	R	R	R
A7h		R	R	R	R	R	R	R	R
A8h		R	R	R	R	R	R	R	R
A9h		R	R	R	R	R	R	R	R
AAh		R	R	R	R	R	R	R	R
ABh		R	R	R	R	R	R	R	R
ACh		R	R	R	R	R	R	R	R
ADh		R	R	R	R	R	R	R	R

Table 118 - Historical Command Assignments

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8
AEh		R	R	R	R	R	R	R	R
AFh		R	R	R	R	R	R	R	R
B0h	SMART	R	R	C	C	C	C	C	C
B1h	CFA DEVICE CONFIGURATION	R	R	R	R	R	C	C	C
B2h		R	R	R	R	R	R	R	R
B3h		R	R	R	R	R	R	R	R
B4h		R	R	R	R	R	R	R	R
B5h		R	R	R	R	R	R	R	R
B6h	NV CACHE	R	R	R	R	R	R	R	Z*
B7h		R	R	R	R	R	R	R	R
B8h	CFA (reserved)	R	R	R	R	A	A	A	A
B9h	CFA (reserved)	R	R	R	R	A	A	A	A
BAh	CFA (reserved)	R	R	R	R	A	A	A	A
BBh	CFA (reserved)	R	R	R	R	A	A	A	A
BCh	CFA (reserved)	R	R	R	R	A	A	A	A
BDh	CFA (reserved)	R	R	R	R	A	A	A	A
BEh	CFA (reserved)	R	R	R	R	A	A	A	A
BFh	CFA (reserved)	R	R	R	R	A	A	A	A
C0h	(vendor unique) / CFA ERASE SECTORS	V	V	V	F	F	F	F	F
C1h	(vendor unique)	V	V	V	V	V	V	V	V
C2h	(vendor unique)	V	V	V	V	V	V	V	V
C3h	(vendor unique)	V	V	V	V	V	V	V	V
C4h	READ MULTIPLE	C	C	C	C	C	C	C	C
C5h	WRITE MULTIPLE	C	C	C	C	C	C	C	C
C6h	SET MULTIPLE MODE	C	C	C	C	C	C	C	C
C7h	READ DMA QUEUED	R	R	R	C	C	C	C	C
C8h	READ DMA	C	C	C	C	C	C	C	C
C9h	READ DMA WITHOUT RETRIES	C	C	C	C	O	O	O	O
CAh	WRITE DMA	C	C	C	C	C	C	C	C
CBh	WRITE DMA WITHOUT RETRIES	C	C	C	C	O	O	O	O
CCh	WRITE DMA QUEUED	R	R	R	C	C	C	C	C
CDh	CFA WRITE MULTIPLE WITHOUT ERASE	R	R	R	C	C	C	C	C
CEh	WRITE MULTIPLE FUA EXT	R	R	R	R	R	R	C	C
CFh		R	R	R	R	R	R	R	R
D0h		R	R	R	R	R	R	R	R
D1h	CHECK MEDIA CARD TYPE	R	R	R	R	R	C	C	C
D2h	MediaCardPassThru (reserved)	R	R	R	R	R	M	M	M
D3h	MediaCardPassThru (reserved)	R	R	R	R	R	M	M	M
D4h	MediaCardPassThru (reserved)	R	R	R	R	R	M	M	M
D5h		R	R	R	R	R	R	R	R
D6h		R	R	R	R	R	R	R	R
D7h		R	R	R	R	R	R	R	R
D8h		R	R	R	R	R	R	R	R
D9h		R	R	R	R	R	R	R	R
DAh	GET MEDIA STATUS	R	R	R	C	C	C	C	C
DBh	ACKNOWLEDGE MEDIA CHANGE	C	C	O	E	E	E	E	E
DCh	BOOT POST BOOT	C	C	O	E	E	E	E	E
DDh	BOOT PRE BOOT	C	C	O	E	E	E	E	E
DEh	MEDIA LOCK	C	C	C	C	C	C	C	C
DFh	MEDIA UNLOCK	C	C	C	C	C	C	C	C
E0h	STANDBY IMMEDIATE	C	C	C	C	C	C	C	C
E1h	IDLE IMMEDIATE	C	C	C	C	C	C	C	C
E2h	STANDBY	C	C	C	C	C	C	C	C
E3h	IDLE	C	C	C	C	C	C	C	C
E4h	READ BUFFER	C	C	C	C	C	C	C	C
E5h	CHECK POWER MODE	C	C	C	C	C	C	C	C
E6h	SLEEP	C	C	C	C	C	C	C	C
E7h	FLUSH CACHE	R	R	R	C	C	C	C	C
E8h	WRITE BUFFER	C	C	C	C	C	C	C	C

Table 118 - Historical Command Assignments

Opcode	Command Name	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8
E9h	WRITE SAME	C	C	O	E	E	E	E	E
EAh	FLUSH CACHE EXT	R	R	R	R	R	C	C	C
EBh		R	R	R	R	R	R	R	R
ECh	IDENTIFY DEVICE	C	C	C	C	C	C	C	C
EDh	MEDIA EJECT	R	C	C	C	C	C	C	C
EEh	IDENTIFY DEVICE DMA	R	R	C	O	O	O	O	O
EFh	SET FEATURES	C	C	C	C	C	C	C	C
F0h	(vendor unique)	V	V	V	V	V	V	V	V
F1h	SECURITY SET PASSWORD	V	V	C	C	C	C	C	C
F2h	SECURITY UNLOCK	V	V	C	C	C	C	C	C
F3h	SECURITY ERASE PREPARE	V	V	C	C	C	C	C	C
F4h	SECURITY ERASE UNIT	V	V	C	C	C	C	C	C
F5h	SECURITY FREEZE LOCK	V	V	C	C	C	C	C	C
F6h	SECURITY DISABLE PASSWORD	V	V	C	C	C	C	C	C
F7h	(vendor unique)	V	V	V	V	V	V	V	V
F8h	READ NATIVE MAX ADDRESS	V	V	V	C	C	C	C	C
F9h	SET MAX ADDRESS	V	V	V	C	C	C	C	C
FAh	(vendor unique)	V	V	V	V	V	V	V	V
FBh	(vendor unique)	V	V	V	V	V	V	V	V
FCh	(vendor unique)	V	V	V	V	V	V	V	V
FDh	(vendor unique)	V	V	V	V	V	V	V	V
FEh	(vendor unique)	V	V	V	V	V	V	V	V
FFh	(vendor unique)	V	V	V	V	V	V	V	V

Key:
C= a defined command.
E= a retired command.
O= Obsolete.
R= Reserved, undefined in current specifications.
V= Vendor specific commands.

A=Reserved for assignment by the CompactFlash Association
F= If the device does not implement the CFA feature set, this command code is Vendor specific.
M=Reserved for the Media Card Pass Through Command feature set.
S=Reserved for Serial ATA
Y=Reserved for Trusted Computing
Z=Reserved for e05106
*Indicates this definition is new to ATA8

Table 119 - Historical SET FEATURE Code Assignments

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8
01h	Enable 8-bit data transfers	C	C	O	E	F	F	F	F
02h	Enable write cache	V	V	C	C	C	C	C	C
03h	Set transfer mode based on value in the count field	C	C	C	C	C	C	C	C
04h	Enable all automatic defect reassignment	R	R	C	O	O	O	O	O
05h	Enable advanced power management	R	R	R	C	C	C	C	C
06h	Enable Power-Up in Standby feature set	R	R	R	R	C	C	C	C
07h	Power-up in Standby feature set device spin-up	R	R	R	R	C	C	C	C
09h	Reserved for Address offset reserved boot area method technical report	R	R	R	R	C	C	C	C
0Ah	Enable CFA power mode 1	R	R	R	R	C	C	C	C
20h	Reserved for Technical Report (T13/DT1696)	R	R	R	R	R	R	T	T
21h	Reserved for Technical Report (T13/DT1696)	R	R	R	R	R	R	T	T
31h	Disable Media Status Notification	R	R	R	C	C	C	C	C
33h	Disable retry	V	V	C	C	O	O	O	O
42h	Enable Automatic Acoustic Management feature set	R	R	R	R	R	R	C	C
43h	Set Maximum Host Interface Sector Times	R	R	R	R	R	R	C	C
44h	Vendor unique length of ECC on read long/write long commands	C	C	C	O	O	O	O	O
54h	Set cache segments to the count field value	V	V	C	O	O	O	O	O
55h	Disable read look-ahead feature	C	C	C	C	C	C	C	C
5Dh	Enable release interrupt	R	R	R	C	C	C	C	C
5Eh	Enable SERVICE interrupt	R	R	R	C	C	C	C	C
66h	Disable reverting to power on defaults	C	C	C	C	C	C	C	C
77h	Disable ECC	V	V	C	O	O	O	O	O
81h	Disable 8-bit data transfers	C	C	O	E	F	F	F	F
82h	Disable write cache	V	V	C	C	C	C	C	C
84h	Disable all automatic defect reassignment	R	R	C	O	O	O	O	O
85h	Disable advanced power management	R	R	R	C	C	C	C	C
86h	Disable Power-Up in Standby feature set	R	R	R	R	C	C	C	C
88h	Enable ECC	V	V	C	C	C	O	O	O
89h	Reserved for Address offset reserved boot area method technical report	R	R	R	R	C	C	C	C
8Ah	Disable CFA power mode 1	R	R	R	R	C	C	F	F
90h	Reserved for Serial ATA	R	R	R	R	R	R	S	S
95h	Enable Media Status Notification	R	R	R	C	C	C	C	C
99h	Enable retries	V	V	C	O	O	O	O	O
9Ah	Set device maximum average current	R	R	C	O	O	O	O	O
AAh	Enable read look-ahead features	C	C	C	C	C	C	C	C
ABh	Set maximum prefetch using the count field value	V	V	C	O	O	O	O	O
BBh	4 bytes of ECC apply on read long/write long commands	C	C	C	O	O	O	O	O
C2h	Disable Automatic Acoustic Management feature set	R	R	R	R	R	R	C	C
CCh	Enable reverting to power on defaults	C	C	C	C	C	C	C	C
DDh	Disable release interrupt	R	R	R	C	C	C	C	C
DEh	Disable SERVICE interrupt	R	R	R	C	C	C	C	C
E0h	Vendor unique	R	R	R	R	R	R	O	O
E1h	Vendor unique	R	R	R	R	R	R	O	O
E2h	Vendor unique	R	R	R	R	R	R	O	O
F0h		R	R	R	R	A	A	A	A

Table 119 - Historical SET FEATURE Code Assignments

Feature Code	Description	ATA1	ATA2	ATA3	ATA4	ATA5	ATA6	ATA7	ATA8
F1h		R	R	R	R	A	A	A	A
F2h		R	R	R	R	A	A	A	A
F3h		R	R	R	R	A	A	A	A
F4h		R	R	R	R	A	A	A	A
F5h		R	R	R	R	A	A	A	A
F6h		R	R	R	R	A	A	A	A
F7h		R	R	R	R	A	A	A	A
F8h		R	R	R	R	A	A	A	A
F9h		R	R	R	R	A	A	A	A
FAh		R	R	R	R	A	A	A	A
FBh		R	R	R	R	A	A	A	A
FCh		R	R	R	R	A	A	A	A
FDh		R	R	R	R	A	A	A	A
FEh		R	R	R	R	A	A	A	A
FFh		R	R	R	R	A	A	A	A
Key: C= a defined command. E= a retired command. O= Obsolete. R= Reserved, undefined in current specifications. V= Vendor specific commands.		A=Reserved for assignment by the CompactFlash Association. F= If the device does not implement the CFA feature set, this command code is Vendor specific. M=Reserved for the Media Card Pass Through Command feature set. S=Reserved for Serial ATA. T=Reserved for Technical Report T13/DT1696 (Time-Limited Commands).							

ANNEX C - DESIGN AND PROGRAMMING CONSIDERATIONS FOR LARGE PHYSICAL SECTOR DEVICES (INFORMATIVE)

C.1 Introduction

Since the inception of the ATA interface the smallest addressable unit of data has been the 512 byte sector. In hard disk drives each sector has an associated error correcting code field to allow detection and correction of read errors. Over time, error correcting code fields have been lengthened to provide greater detection and correction capability. As a result, the proportion of device media devoted to ECC fields has risen. Increasing the length of data sectors on the media increases the efficiency of ECC by enabling better error detection and correction using a smaller proportion of media.

C.2 Physical sectors

Because the 512 byte sector has been a constant since the beginning of ATA many software changes would be required if device logical sectors were made larger. To preserve the legacy software that assumes a 512 byte sector, logical addressing based on 512 byte sectors has been retained. Larger physical sectors are implemented as power of two multiples of 512 byte logical sectors, 1,2,4,8,16, etc. For example, devices may have physical sectors that are 8 logical sectors long or 4096 bytes total. It is not possible to create a logical sector that spans two physical sectors.

C.3 Unaligned write

While retaining the 512 byte logical sector maintains software compatibility it introduces a potential performance issue, unaligned write, which must be avoided. A physical sector must be written to the media in a single operation. To complete a write command that writes a fraction of a physical sector the device must read the entire physical sector into buffer memory update the buffer memory with the write data and then write the entire physical sector to the media. This will incur a performance penalty of at least a drive revolution.

Write commands can begin mid physical sector and end mid physical sector resulting in two unaligned writes. In this case the device has to read both the beginning and ending physical sector of the write into the buffer.

To avoid the performance penalty from an unaligned write all write operations must begin with the first sector of a physical sector and end with the last sector of a physical sector.

The first logical sector must be the first 512 bytes of the first physical sector on the device. This allows a host to align write operations with the physical sectors.

Supporting unaligned write operations is optional, but highly recommended to maintain backward compatibility with software. See IDENTIFY DEVICE 7.17.

Figure 10 illustrates an unaligned write on a device with 2048 byte physical sectors. The first four logical sectors, LBA0 - LBA3, reside on physical sector 0. To write only LBA3 the host sends a conventional write command and the data for LBA3. On receipt of the write command the device seeks to the physical sector that contains LBA3, which is physical sector 0. Physical sector 0 is read into the device buffer. Then the new write data for LBA3 is placed in the buffer, overwriting a segment of the buffer. The buffer data is then written to the media, physical sector 0.

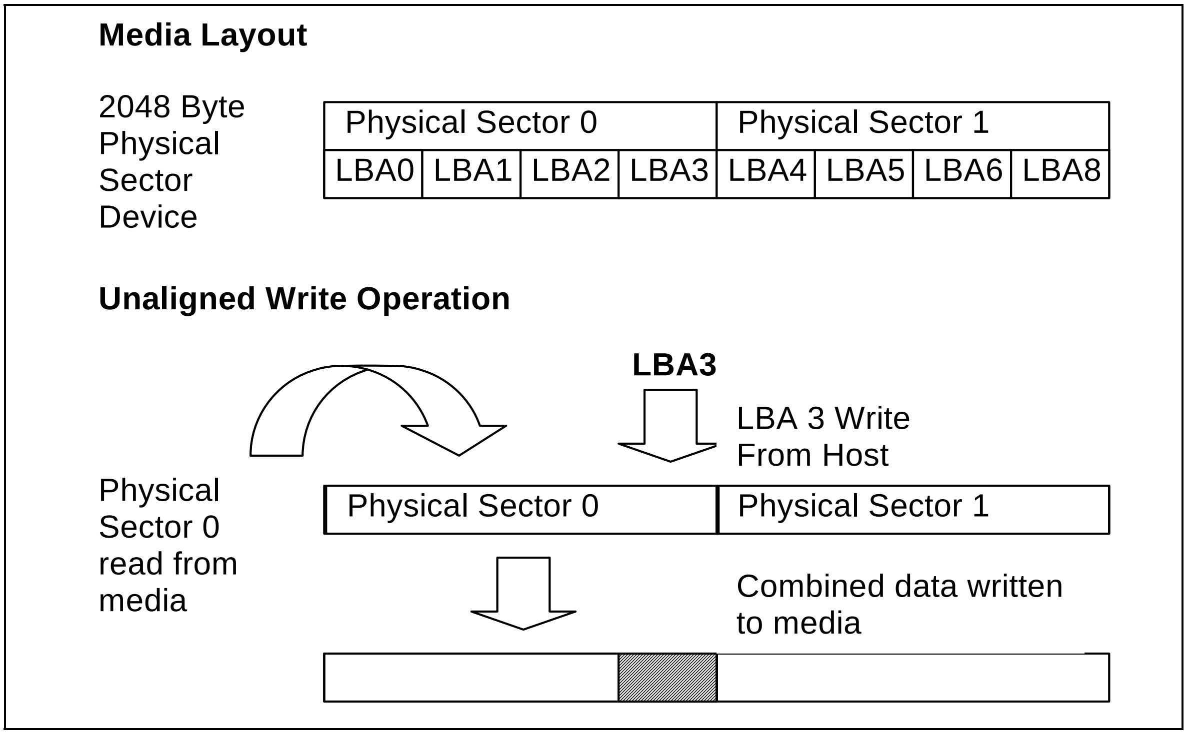


Figure 10 - Unaligned Write Example

C.4 SET MAX

Hosts which use the SET MAX command should set a value to the last logical sector of a physical sector to allow writes to the end of the user area without requiring an unaligned write. Devices should accommodate a SET MAX setting to any LBA address to maintain compatibility.

C.5 Software compatibility

While the current specification allows devices to report up to 2^{15} or 32,768 logical sectors per physical sector there are file system limitations in existing systems that restrict practical device implementations to 4096 bytes per physical sector.

ANNEX D - HOW TO USE SCT COMMANDS

D.1 How to use SCT commands overview

SCT commands piggy-back on the standard ATA commands: SMART READ LOG and SMART WRITE LOG, or READ LOG EXT and WRITE LOG EXT. As viewed through an ATA protocol analyzer, an SCT command is seen as data being transferred by these commands; whereas from the perspective of a device that implements this feature set, this “data” would be interpreted as an SCT command request, an SCT command response, SCT command status, or SCT command data.

Figure 11 is an example flowchart that shows how to process SCT commands using SMART READ LOG and SMART WRITE LOG commands:

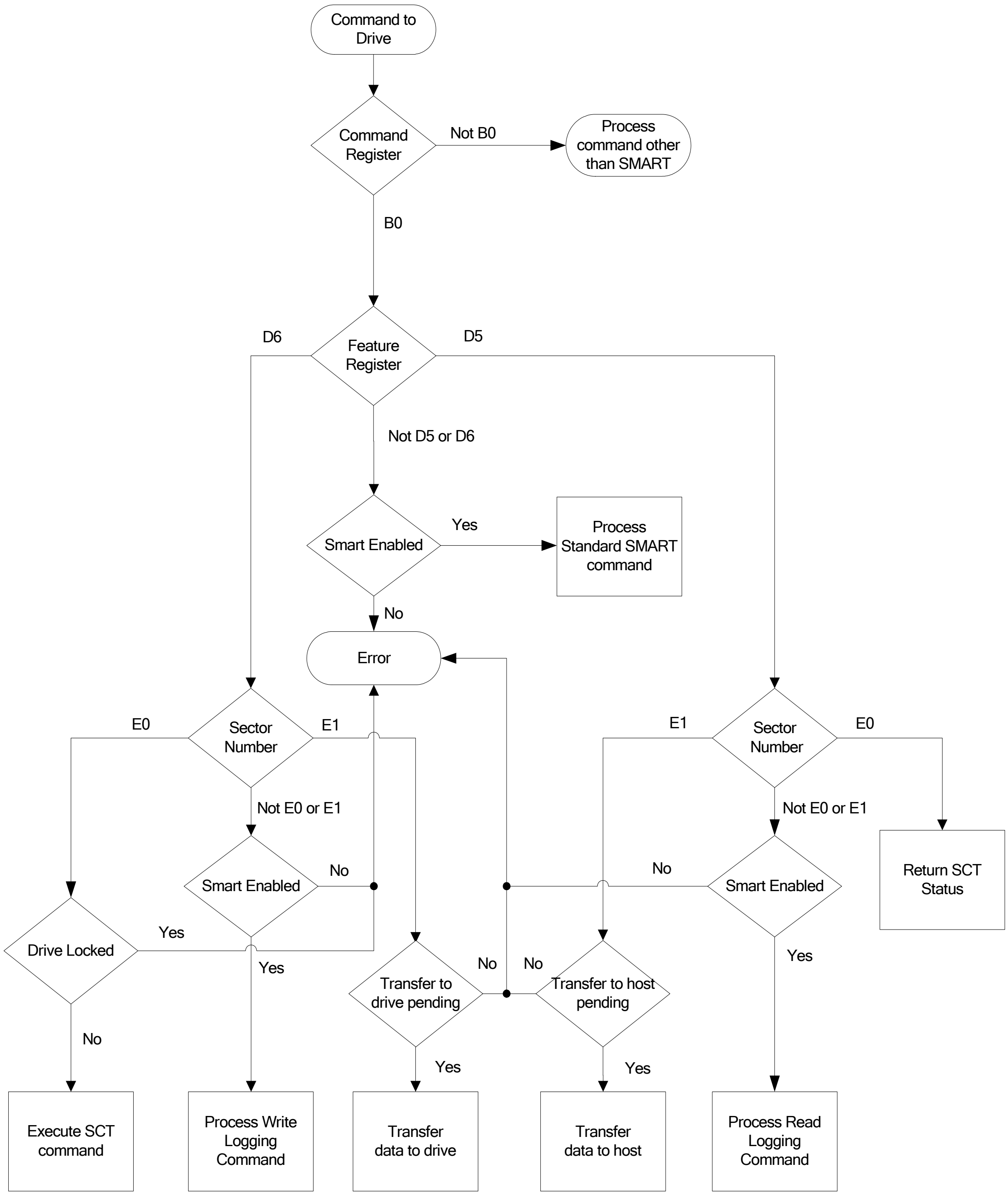


Figure 11 – Example flowchart for SCT commands

D.2 Examples of Log page command sequences

Figure 12 shows an example of a foreground write same with with a repeating write pattern.

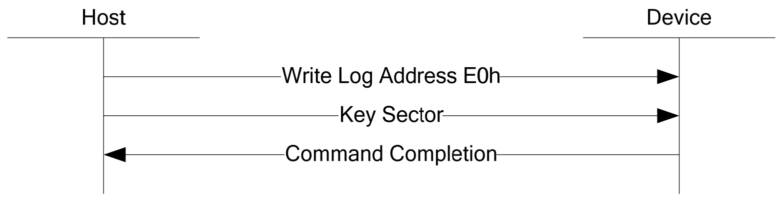


Figure 12 – Example sequence for foreground write same with a repeating patern

Figure 13 shows an example of a foreground write same with with a repeating sector.

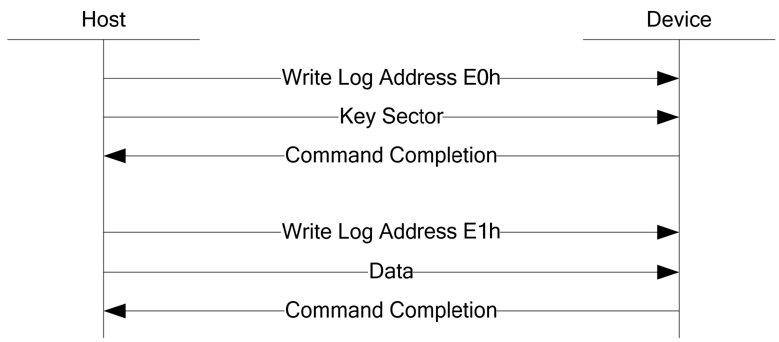


Figure 13 – Example sequence for foreground write same with a repeating sector

Figure 15 shows an example command sequence for reading data from a device using an SCT command with no background activity.

Figure 14 shows an example command sequence for writing data to a device using an SCT command with no background activity.

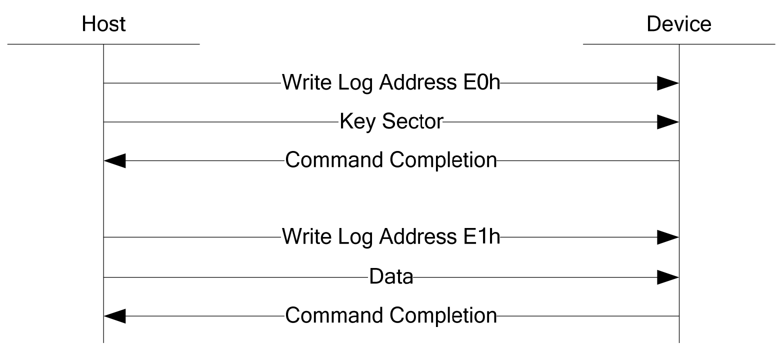


Figure 14 – Example sequence for writing data using an SCT command with no background activity

Figure 15 shows an example command sequence for reading data from a device using an SCT command with no background activity.

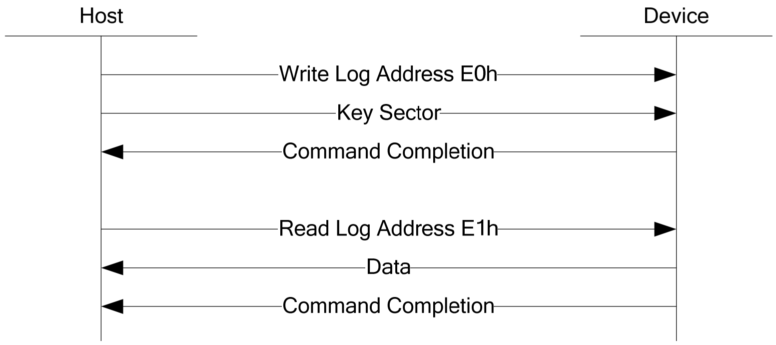


Figure 15 – Example sequence for reading data using an SCT command with no background activity

Figure 16 shows an example command sequence for issuing a Log page command that does not transfer data and has no background activity.

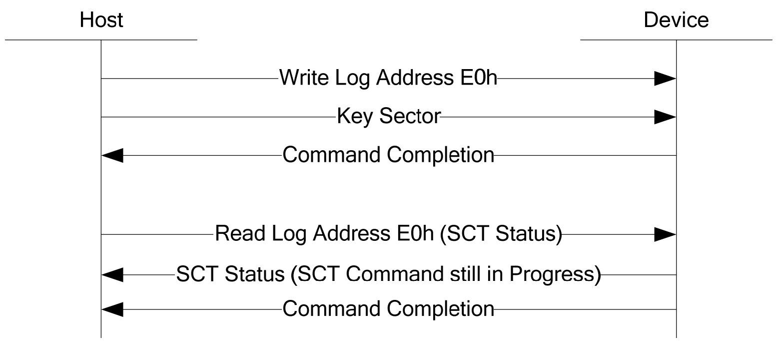


Figure 16 – Example Sequence for a non-datan SCT command with no background activity

Figure 17 shows an example command sequence for issuing an SCT command that writes data in the background.

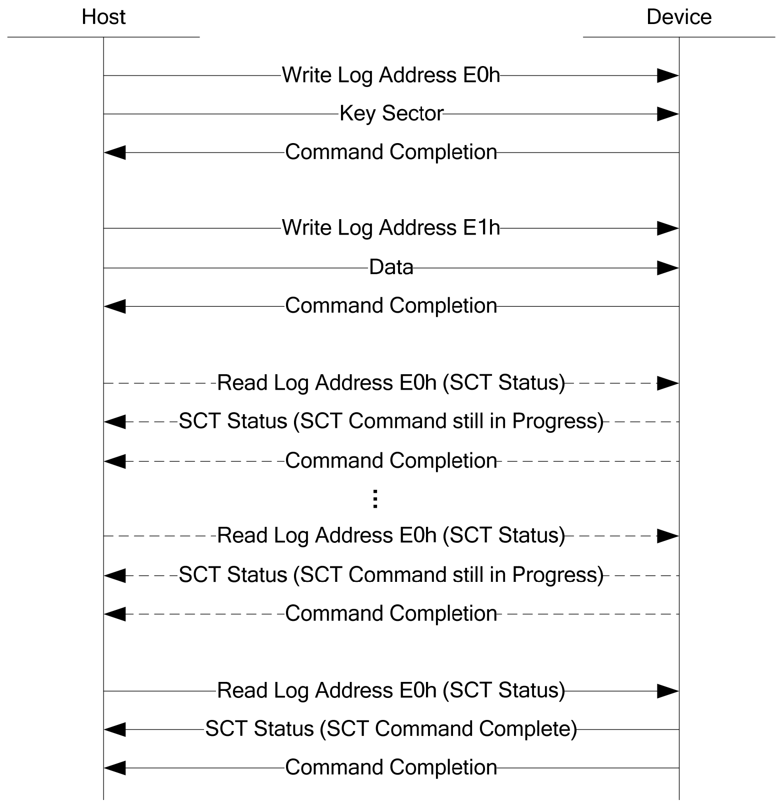


Figure 17– Example sequence for writing data using an SCT command with background activity

Figure 18 shows an example command sequence for issuing an SCT command that executes in the background but does not require the transfer of data to or from the host.

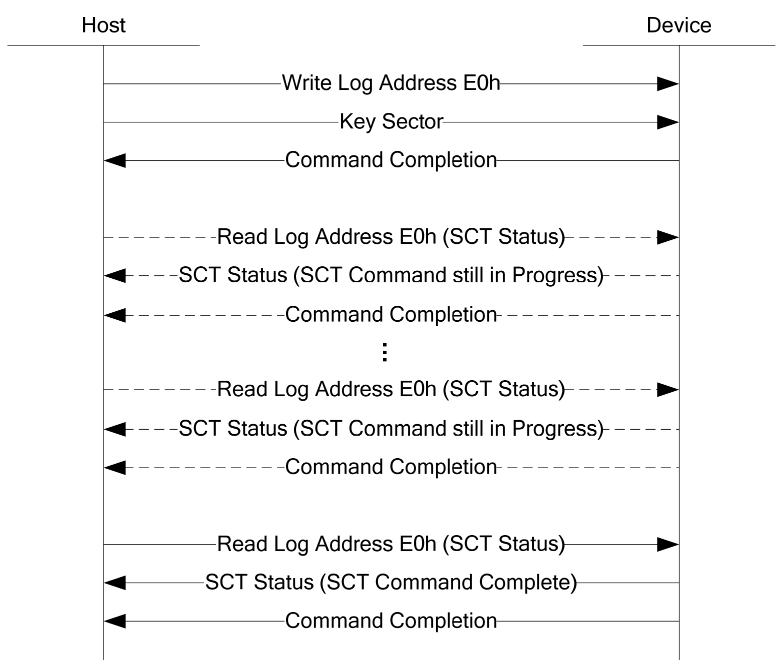


Figure 18 – Example sequence for a non-datan SCT command with background activity

D.3 Issuing an SCT command to a device

D.3.1 Step 1 - Build a Key Sector

The host builds the key sector in a host buffer for the appropriate action and parameters.

D.3.2 Step 2 - Issue the SCT command

The host issues the SCT command (see Table 18 or Table 19, and sends the key sector to the device.

Table 120 – SCT command using SMART WRITE LOG command

Register	Value
Features	D6h (SMART WRITE LOG subcommand code)
Sector Count	01h (Shall always be 01h)
LBA Low	E0h (Command port)
LBA Mid	4Fh (SMART enable code)
LBA High	C2h (SMART enable code)
Command	B0h (SMART)

Table 121 – SCT command using WRITE LOG EXT command

Register		Value
Features	Current	Reserved
	Previous	Reserved
Sector Count	Current	01h 1 sector for SCT commands
	Previous	00h
LBA Low	Current	E0h
	Previous	Reserved
LBA Mid	Current	00h There is no offset when commands are issued
	Previous	00h
LBA High	Current	Reserved
	Previous	Reserved
Command		3Fh (WRITE LOG EXT)

The device responds with successful status (see Table 59). If the command is aborted (i.e., Status = 51h and Error = 04h), then either the key sector format is invalid, the task file contains an invalid value or the command encountered an execution error. The host checks the Sector Count and LBA Low registers for the error code (see Table 60 and Table 61). If the command was a “write” command, the command is terminated, there is no data transfer, and the host skips Step 3. However, if the command was a “read” command, there maybe partial output available. For example, on a sector read command, the data up to and including the sector in error is available. In this case, the host may proceed to Step 3 to get the partial data. In certain cases the error is not fatal and serves only as a warning.

If the status is 50h, then the host checks the LBA Mid and LBA High fields. If the values are 0, then the command is complete, terminated without error, and the host proceeds to Step 4. If the values are greater than 0, then the host proceeds to Step 3.

D.3.3 Step 3 - Transfer Data if Required

To transfer data from the device to the host, the host issues a SMART READ LOG or READ LOG EXT command to address E1h (see Table 62 and Table 63). To transfer data from the host to the device, the host issues a SMART WRITE LOG or WRITE LOG EXT command to address E1h (See Table 62 and Table 63). The transfer request is in the range of 1 sector up to the total number of sectors not yet transferred. The number of sectors remaining was posted in the LBA Mid and LBA High registers in the previous step. If the requested number of sectors is larger than the number of the sectors remaining, the device reports an error. If the value is less then the number of sectors remaining, the host may repeat Step 3 until all sectors have been transferred.

For SCT commands that access the media, the device advances the sector pointer by the number of sectors transferred, and reports in the LBA Mid and LBA High registers the number of sectors remaining to be transferred. If both registers contain zero, then the command is complete, and the host proceeds to Step 4. The host has complete control over the number of sectors to transfer at a time. Note, if the number of sectors to be transferred is greater or equal to FFFFh, the device sets the LBA Mid and High fields to FFFFh. The value remains FFFFh until the number of sectors remaining drops below FFFFh. The exact number to be transferred is reported by the SCT Status command. Upon receiving the last block of data, the device performs the specified operation. In the case of very large amounts of data, such as Write Same, some data may be processed (e.g., written to the disk) prior to receiving all of the data from the host.

D.3.4 Step 4 - Final Status/SCT Command Completion

The host reads the SCT status response (See Table 64, Table 65, and Table 66) to determine how the command completed. If the command has not completed (i.e., by reporting FFFFh in Table 66 byte 14) then the host waits for some period of time and repeats Step 4 until the command is complete. For SCT commands that require transfer of data to the device (e.g., a write command), the command is not complete until the last block of data has been transferred to the device.